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1. **INTRODUCTION**

The purpose of this report is to provide context and documentation to the accompanying *Cost Estimate Components for ITS Projects* spreadsheet.

2. **COST ESTIMATE SPREADSHEET LAYOUT**

The cost estimate spreadsheet was developed to provide capital costs, annual operations and maintenance costs, and expected lifecycle for specific ITS elements as they are being combined to form an ITS project. These costs will be utilized for the ITS Deployment Analysis System (IDAS) based benefit-cost assessment, the Turbo Architecture database, as well as for strategic deployment plan project cost reporting.

2.1 **ITS Elements**

The majority of the cost estimate spreadsheet defines all of the elements that could be used to form an ITS project in North Carolina. The elements are grouped into similar themes such as roadway devices or TMC components. Each element also is defined in unit terms of “per item” for devices, “per mile” for communications, and “lump sum” for software and integration elements. Finally, the last two columns of the spreadsheet give context to each element by giving a brief description and listing a number of specific items that were used to build the element costs.

2.2 **Capital Costs**

The capital costs for each ITS element are presented in 2009 dollars. It is important to note that the capital costs are for the installation of that ITS element within a larger construction project. Thus, the capital costs do not consider construction costs such as mobilization and training, which are considered “soft costs”, and will be discussed in Section 3.1 Soft Costs.

The capital costs for the spreadsheet were developed using a number of references.

- Actual project bid tabs for NCDOT construction projects from January 2003 to June 2008
- Inventory of regional transit-related technologies compiled by ITRE
- 2007-2012 plan for regional transit-related technologies compiled by ITRE
- Informal conversations with product vendors

2.3 **Operations and Maintenance Costs**

The annual operations and maintenance costs also are presented in 2009 dollars. These costs are intended to portray the total cost for operating and maintaining an ITS element over its life, but are averaged to provide an annual cost. It is important to note that this does not include any replacement costs associated with a device at the end of its life. It is expected that the actual operations and maintenance costs for an ITS element would be lower than the annual average early in the lifecycle but higher than the annual average later in the lifecycle.

The operations and maintenance costs for the spreadsheet were developed using a number of references.

- Estimates of annual operations and maintenance costs from NCDOT Division 5
2009 budget for SCDOT ITS Maintenance (provided during the Best Practices task)
Inventory of regional transit-related technologies compiled by ITRE
2007-2012 plan for regional transit-related technologies compiled by ITRE

2.4 Lifecycle

The lifecycle of an ITS element is presented in the expected number of years between installation and replacement. For some elements, the expected replacement is not based on product malfunction and inoperability, but rather, based on the end of vendor support or product compatibility (such as computers and software).

The lifecycle estimates for the spreadsheet were developed using a number of references.

- Estimates of annual operations and maintenance costs from NCDOT Division 5
- 2009 budget for SCDOT ITS Maintenance (provided during the Best Practices task)
- Inventory of regional transit-related technologies compiled by ITRE
- 2007-2012 plan for regional transit-related technologies compiled by ITRE

3. OTHER COST CONSIDERATIONS

As mentioned above, the cost estimate spreadsheet does not consider other soft costs that are not tied to a specific construction element, but nonetheless, are part of an overall project. When considering costs for ITS elements and projects over an uncertain timeframe, it is important to also consider and account for an inflation rate and discount rate. These other cost considerations are discussed below.

3.1 Soft Costs

After combining desired ITS elements from the spreadsheet to form a construction cost, other costs should be added to form a total project cost. Below are the most typical soft costs.

- Design engineering typically is about 10% of the construction cost.
- Construction engineering and administration typically is about 15% of the construction cost.
- Mobilization of the contractor typically is about 5% of the construction cost.
- Traffic control for the work typically is about 2% of the construction cost.
- Training of the end-users (NCDOT or municipality) typically is 2% of the construction cost.

3.2 Inflation Rate

In this context, the inflation rate refers to an annual rate of change (increase or decrease) in the purchase price of a good or service. This is important because the costs presented in the spreadsheet are based on 2009 dollars. If the ITS element is not going to be purchased until later, the inflation rate must be applied to determine what the cost will be at that time.

Using historical bid tab data from NCDOT starting in 2003, a general inflation rate for ITS projects in North Carolina was determined to be 3%. This inflation rate was determined by looking at similar groups of ITS elements.

- Commodity elements that are defined by NCDOT standards that do not change much over time (such as fiber optic cable, messenger cable, junction boxes, conduit, etc.) appear to have
a recent annual inflation rate around 2%. These elements typically comprise about 40% of an ITS project’s total cost.

- Electronic elements that are defined by NCDOT standards that do not change much over time (such as field cabinets, signal controllers, etc.) appear to have a recent annual inflation rate around 2%. These elements typically comprise about 20% of an ITS project’s total cost.

- Electronic elements that use constantly-changing technologies (such as CCTV cameras, dynamic message signs, vehicle detectors, etc) appear to have a recent annual inflation rate around 0% because these vendors tend to offer levels of product functionality (such as basic and advanced). Over time, the prices for each level will remain the same, but features and functionality trickle down from the top as they become less expensive. These elements typically comprise about 10% of an ITS project’s total cost.

- Software elements that are project-specific are difficult to analyze for cost over time because each instance is different. Thus, it is recommended that an annual inflation rate of 0% be applied to these elements, for similar reasons to those explained in the previous bullet. These elements typically comprise about 10% of an ITS project’s total cost.

- Labor elements (such as integration and installation) appear to have a recent annual inflation rate around 10%. These typically comprise about 20% of an ITS project’s total cost.

The inflation rate is applied using the following equation:

- Future Amount = Present Amount x (1 + Inflation Rate)^Number of Years

### 3.3 Discount Rate

Typically, a discount rate is used in benefit-cost analysis to account for the time value of money. When considering benefits and costs, they both have a greater value if they are recognized sooner and must be discounted if recognized later. The discount rate also accounts for interest rates and inflation rates.

Selecting the proper discount rate for a benefit-cost analysis is often difficult. The U.S. Government published *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* in 1992 suggesting that a discount rate of 7% be used for benefit-cost analysis of federally funded programs. FHWA published *Life-Cycle Cost Analysis in Pavement Design – Interim Technical Bulletin* in 1998 that looked at discount rates for various pavement design programs over time and determined an appropriate range of 3-5% for discount rates. Overall, determining an applicable discount rate is debatable and constantly changing.

It is important to note that a discount rate is only applicable to benefit-cost analysis and should not be used in calculations where a future cost is determined from a present cost (such as shown in the inflation rate section above). This report presents a discount rate for an agency that is using the cost spreadsheet for developing a benefit-cost analysis in the IDAS program and desires to change the software’s default value of 7% for the discount rate.

The discount rate is calculated using the following equation:

- Discount Rate = [(1 + Interest Rate) / (1 + Inflation Rate)] – 1

Or a simple approximation is: Discount Rate = Interest Rate – Inflation Rate

Using an inflation rate of 3% as developed above and a current Federal Reserve interest rate of 0.25%, a current recommendation for a discount rate would be -2.75%.
4. **PROJECT EXAMPLE**

A simple example is presented here to illustrate how to use the cost estimate spreadsheet and inflation rate when developing projects. For this example, assume a Triangle agency is planning to expand their existing DMS system in 2015 by installing two arterial DMS units with short haul electrical service and dial-up modems.

Using the cost estimate spreadsheet, the expected capital construction cost in 2009 dollars of **$164,500**.

- DMS, Arterial (quantity of 2 with a unit cost of $80,000 each) = $160,000
- Electrical service for device, short haul (quantity of 2 with a unit cost of $1,500 each) = $3,000
- Dial-up connection to device (quantity of 2 with a unit cost of $750 each) = $1,500
- Assume that the central software and hardware is already in place.

To convert this capital cost to equivalent dollars in 2015, apply an inflation rate of 3%. This equates to a capital construction cost in 2015 of about **$196,500**.

\[ $164,500 \times (1.03)^6 = $196,421 \]

Finally, the soft costs discussed above are applied to construction costs to develop a total project deployment cost of about **$259,400** in 2015 dollars.

- Design engineering (10%) = $19,650
- Construction engineering and administration (15%) = $29,475
- Mobilization (5%) = $9,825
- Traffic control (2%) = $3,930
- Assume no training is necessary since there is an existing DMS system.
BIBLIOGRAPHY


APPENDIX A – COST ESTIMATE SPREADSHEET