EXAMINATION OF POTENTIAL COST BENEFITS FOR CONVERTING SURFACED ROADS TO UNSURFACED ROADS IN TEXAS

THESIS

Presented to the Graduate Council of
Texas State University-San Marcos
in Partial Fulfillment
of the Requirements

for the Degree

Master of SCIENCE

by

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San Marcos, Texas
December 2012

EXAMINATION OF POTENTIAL COST BENEFITS FOR CONVERTING

SURFACED ROADS TO UNSURFACED ROADS IN TEXAS

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ACKNOWLEDGEMENTS

First, I would like to acknowledge and thank my father, Mark Humphries, for introducing me to highway construction and putting me on my first jobsite. His work in construction in the United States taught me the fundamentals of roads, his work in Afghanistan taught me that roads do more than transport goods, they can unite a nation. His death was my wake-up call to get off a bulldozer and go back to school, and all my work, both in industry and in academia, is a tribute to his life.

Second, I would like to thank the wonderful community at Texas State University – San Marcos. From the time I started as an undergraduate, all the advisers, financial aid representatives, administrators, and numerous other people have all worked to create a learning environment that has nurtured me and allowed me to excel.

This is especially true of the faculty and staff in the Department of Engineering Technology, without whom I would not have made it this far. Dr. Andy Batey has been a role model since I began the program, and his belief and faith in my success inspire me every day. Dr. Gary Winek brought me into the construction program, and his passion and his energy for his work motivates me greatly. I certainly would not have learned as much as I have without the guidance of Dr. Jeff Lee. His patience and positivity kept me going when I was at my most frustrated.

I would not have been able to complete this paper without the help of the staff at the Texas Department of Transportation. Their advice on methods, materials, and cost was the backbone of my research.

Finally, I would like to thank the rest of my family. They have been my biggest cheerleaders every step of the way, and I know they are as proud of me as I am of myself. And I especially want to acknowledge my wife, who has handled the last 10 years with unbelievable grace and patience as I have made my way down this path.

I look forward to a continued career in academia, and know that the education I received, the people I met, and the things we accomplished together at Texas State University will continue to shape who I am and the work that I do.

This manuscript was submitted on October 17, 2012.

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ABSTRACT

EXAMINATION OF POTENTIAL COST BENEFITS FOR CONVERTING SURFACED ROADS TO UNSURFACED ROADS IN TEXAS

by

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December 2012

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Conversion of roadways from a surfaced type to an un-surfaced type in order to achieve agency cost savings is currently being studied and practiced in selected regions in other states. Conversion from surfaced to un-surfaced may be a more economical option for low-volume roads. In Texas, TxDOT manages tens of thousands of miles of low-volume roads, and wishes to know if conversion of those roadways could save significant money in maintenance over time. This paper describes the practice of conversion as it has been utilized in other states. It then develops hypothetical conversion and maintenance

plans for a given situation and applies real costs to estimate base-line costs. Road deterioration modeling program HDM-III is used to evaluate the maintenance costs over a 25-year analysis period and generate yearly maintenance costs based on real data. Average daily traffic (ADT) was identified as the most important factor. Conversion was found to be a viable option in some places, but due to high reconversion costs, presents risks that must be examined thoroughly before action is taken.

CHAPTER 1

INTRODUCTION

Background

The population of Texas is expected to grow in the near future, increasing to 17 million by 2030. This growth will ultimately lead to an increase in transportation demands, as well as transportation costs. Limited financial resources and funding will inevitably create potential problems when trying to meet these projected demands. If economical alternatives are not investigated, this population increase and its effect on transportation could eventually create a possible roadblock to growth. In order to cope with this fundamental issue, costs will need to be optimized and budgeted wisely for future demands. Money will be the key issue, and if a method is found to reduce costs in an effective and safe manner, then further investigation into that method is necessary.

One idea is that different types of roadways can be used effectively in various scenarios. The selection of a particular road type can greatly affect the total cost of a project. Generally, when roadways are being selected, they can be surfaced (paved) or un-surfaced (unpaved). Most studies usually classify paved roads as either asphalt concrete or concrete, and unpaved roads as gravel or any road that does not contain portland cement concrete, asphalt concrete or other type of surface treatment.

When deciding whether to use a paved or unpaved road, several factors come into play including initial costs and maintenance costs. Most roadway surfacings require some maintenance intervention during their design life. Thus, when comparing the costs of alternative roadway surfacings, one must consider the anticipated future maintenance costs in addition to the initial construction cost (Maher, 2005). Interviews with county engineers and managers made it clear that the primary motivating factor for returning paved roads back to gravel is the lack of funding for construction and preventive maintenance (CTC & Associates, 2010). The maintenance costs for both paved and unpaved roads are rising, and reduced funding and resources requires more efficient spending of available funds. High costs and tight budgets have prompted communities in Maine, Michigan, Indiana, Pennsylvania and Vermont to convert or consider converting their cracked asphalt roads back to gravel to cut maintenance costs (Rajala, 2010). Preparing for future maintenance and or conversions, however, will allow for better managing of budgeted funds. Maintenance costs for all roadways are difficult to predict, and depend on how much careful planning, research and preparation are incorporated. Cost is an important criterion for most projects. Roadway surfacings have a wide range of unit costs, ranging from unpaved, unbound surfacings at the low end to hand placed cobblestones at the high end. In an application involving a small area of specialty pavement, cost may not be a concern. However, for larger projects, such as 30 km (19 miles) of forest access road, low cost may be an important factor. Cost may also be a primary concern when road construction funding is limited (Maher, 2005). While the maintenance of roadways can be implemented effectively to help reduce unnecessary spending, a better understanding of costs related to both surface types is necessary.

Problem

Agencies, both public and private, are working to do more with less. Road management agencies are no exception. They need to get the most out of their already-existing infrastructure, and that could mean utilizing one type of roadway over another. In order to better compare surfaced roadways and unsurfaced roadways, life-cycle costs should be examined. In addition to future maintenance costs, differences in the expected service lives of different surfacings must also be considered. By taking into consideration initial construction costs, expected maintenance costs, expected service life, and the time value of money, a life-cycle cost can be calculated for a specified analysis period. The overall objective of a life-cycle cost approach to surfacing selection strategy is to provide the best long-term value to the owner or agency for their investment in road infrastructure (Maher, 2005). However, the validity of the life-cycle costs analysis depends on the scope and location of the project, and those variables can be affected by several cost factors. Life-cycle cost is the net present value of a surfacing for a specified analysis period, taking into consideration initial construction costs, user costs, expected maintenance costs, any required rehabilitation, and the time value of money. The value of life-cycle costs is that they provide a relative comparison of long-term costs for different surfacing types. Often, a rough estimate of life-cycle cost can be determined quickly based on available information and may be adequate for the purposes of comparing a range of surfacing options (Maher, 2005).

The simplest criteria for selecting candidate roads for paving is traffic volume. A correlation exists between traffic volume and maintenance costs for unsurfaced roads. Therefore, traffic volume can be utilized as an indicator for roads that may be candidates for paving (Shuler, 2007). When the roadway surfacing is gravel, the annual routine maintenance activities remain fairly constant until parameters start to change. What typically changes is the traffic volumes increase, or the mix of vehicles changes, or both. In a growth area, the traffic volumes increase over time. There also tends to be an increase in the number of trucks and other heavy vehicles that service this growth area. As the traffic volumes increase, the routine annual gravel road maintenance activities increase in order to maintain the established level of service. As the activities increase so does the associated cost. When the maintenance costs escalate to a certain level and other problems become more acute, the decision is usually made to make a major investment in the infrastructure (Jahren, 2005). In the end, traffic volume and type have the greatest impact on roadway performance. This study validates that as the traffic volume increases, a gravel roadway's maintenance will also go up along with a rise in its associated costs. Viewed from the opposite perspective, however, as the traffic volume decreases, maintenance should also go down, and the associated costs should decrease as well. Simulation software such as HDM-III (Highway Design and Maintenance Standard

Model, 3rd ed.) will aid in determining how ADT really effects the routine maintenance of a given road type.

Purpose of the Study

While previous research helps to explore the idea of converting surfaced roadways to unsurfaced roadways in Texas, it fails to completely answer all of the necessary questions. For instance, several states have already decided to convert their surfaced roadways to unsurfaced roadways but only when the surfaced roadway is close to failure. It isn’t yet proven that deciding to convert a roadway when it is not close to failure would be cost-effective under low-volume conditions. Also, the costs to actually convert the existing roadways may be a deal breaker. Historical initial costs and maintenance costs are known, but it is difficult to calculate the conversion process. Different methods need to be analyzed, such as recycling or integrating the existing surfaced roadway into the new unsurfaced roadway.

Significance of the Study

The objective of this project will be to compile and compare existing research to determine the best methods of converting surfaced roadways to unsurfaced roadways. Applying current knowledge, utilizing existing research, and further conducting this research will ultimately determine whether the idea of converting surfaced roadways into unsurfaced roadways is feasible in Texas, specifically on low-volume roadways. This information can then be considered by any road management agency when deciding if conversion may be a good option for cost savings on a particular roadway. This could lead to increased savings overall, freeing up funds elsewhere in the budget where they may be better utilized for the public good.

Similar studies have been conducted in other parts of the United States that compare the costs of unsurfaced roads versus surfaced roads. According to *Recommended Criteria in the Decision Process for Paving Unsurfaced Roadways*, initially the costs of gravel roads are relatively low and if maintained effectively, they provide an adequate riding surface, and depending on the structure of the subgrade and base course the road may be easier and less expensive to maintain (Shuler,2007). However, a study conducted in Minnesota found that over a 20-year period, the annual maintenance costs for gravel roads are higher than for bituminous roads. Clearly a roadway’s location greatly influences its general maintenance costs, and since these studies were done in states that don’t have nearly the variety of environments that Texas possesses, it is apparent that further research needs to be conducted to evaluate the effectiveness of unpaved roads.

CHAPTER 2

REVIEW OF LITERATURE AND DEVELOPMENT

OF RESEARCH QUESTIONS

Low-Volume Roads

Definition and Uses. Behrens (1999) defines a low-volume road as those in a rural environment that enable automobile operation and account for less than 500 vehicles per day. *The Manual on Uniform Traffic Control Devices* defined an LVR as "a facility lying outside of built-up areas of cities, towns, and communities, and it shall have a traffic volume of less than 400 AADT" (MUTCD, 2009). The American Association of State Highway and Transportation Officials (AASHTO) defined it as "0.7 to 1 million ESAL in a given performance period with 500,000 ESAL as a practical maximum." Depending on the definition chosen, the ultimate number of roads in the U.S. that are considered LVR will vary but the Federal Highway Administration reported that 70% of the roads in the United States are low-volume roadways, yet those roads carry only 15% of the nation's traffic (Local Low-volume, 1992). For the purposes of this research, an LVR was defined as a road having less than or equal to 500 ADT.

Surfaced Type Roads. There are many types of agencies involved in maintaining bituminous pavements. For the purposes of this project, a surfaced road will be defined as an existing asphaltic roadway, or, in the case of reconversion, a two-course seal coat.

When LVRs are paved, the bituminous surface is usually less than 40 mm and does not contribute significantly to the structural capacity of the pavement (Pidwerbesky et al., 1997).

Typically, surfaced low-volume roads do not benefit from the advanced pavement design afforded to high volume roadways. Timm et al. elaborate, “Long-life pavements are often associated with high traffic volume facilities, and in such situations, perpetual pavements make good engineering and economic sense” (2006). Zimmerman & Wolters (2002) reinforce this concept, stating that “on higher volume paved roads…decision-making has evolved into a fairly sophisticated process done under the framework of a pavement management system (PMS)” but that for LVRs “the decision making process is very different. Most local governmental units do not use the same decision tools to help them with the maintenance and rehabilitation decisions made in conjunction with a PMS.”

If a surfaced roadway is under continual low volume conditions, it may be more cost effective to use an unsurfaced road instead. For the purposes of this study, Gravel roads are generally the lowest service provided to the traveling public and are usually considered greatly inferior to paved roads. Yet, in many rural regions, the volume of traffic is so low that paving and maintaining a paved road is not economically feasible (Skorseth, 2000). The previous research that has already been conducted in other states like Minnesota, South Dakota, and Colorado analyzes the advantages of one roadway type over the other. However, since little research currently exists on roadway performances in Texas, it will be beneficial to perform similar research here due to its unique climate and terrain.

In Texas, surfaced roads are maintained according to the Texas Department of Transportation *Seal Coat and Surface Treatment Manual* (2010). Based on this manual, typical maintenance of a surfaced road consists of the application of a seal coat (specifically chip seal) every seven years on average.

Un-Surfaced Type Roads. For the purposes of this project, an “un-surfaced road” will be defined as a road with a surface course consisting of aggregate not held together with any binder (such as tar or bitumen), or chemical additives (such as lime or cement). The major maintenance activities of a gravel or un-surfaced road are typically regular blading. Worldwide, after construction, LVRs are typically selected for maintenance utilizing a “worst-first policy,” (Veeraragavan & Krishna, 2011). Despite this continuing practice, attempts to decrease the costs of maintaining LVRs and to increase the sophistication by which such roads are managed have been ongoing for more than 20 years. In 1991, Anderson & Session developed a mathematical formulation for management of intermittent roads, which are roads that experience short periods of use and long periods of little or no use. Skorseth & Selim (2000) produced *Gravel Roads: Maintenance and Design Manual* that provides design and maintenance guidelines for gravel roads in a frequently referenced document. More and more studies aimed at improving decision-making and maintenance practices find treatment in the literature (Veeraragavan & Krishna, 2011; Huntington & Ksaibati, 2011; Douglas, 2011; Kivilands & Strezs, 2011; Mladenovic et al., 2011; Chamorro & Tighe, 2011; Reddy & Veeraragavan, 2011). Of particular importance to anyone involved in the maintenance of un-surfaced roads are four manuals listed below (in chronological order):

- Gravel Roads Maintenance and Design Manual: geared toward maintenance officials. (Skorseth & Selim, 2000).
- Low-volume Roads Engineering: Best Management Practices Field Guide: geared toward constructors and designers. (Kellar & Sherar, 2003).
- Environmentally Sensitive Maintenance for Dirt and Gravel Roads: geared toward constructors and designers. (Gesford & Anderson, 2006).
- Unsealed Roads Manual: Guidelines to Good Practice: geared toward network managers (Giumarra, *ed.*, 2009).

Blading is the most common maintenance activity for use on un-surfaced roads. The timing and frequency of blading is the most important aspect of un-surfaced road maintenance and as such many strategies have been considered and many attempts to model the practice have been undertaken. One study by Van Zyl (2011) sought to use a practical approach at developing a grader maintenance plan and found that frequent light bladings will ultimately serve to maintain an adequate surface more effectively than occasional hard bladings, as seen in Figure 2-1.

The study by Van Zyl (2011) was performed after a blading optimization module developed in South Africa was tested and determined to contain several shortcomings. The conclusion of the testing was that due to the complexity and numerous variables involved in maintenance needs, the generalizations required for an optimization model are not as effective as a process that utilizes the local knowledge of maintenance professionals (Burger et al., 2007). This determination that un-surfaced roads require significant professional experience and input to appropriately maintain is a recurrent theme throughout the literature.

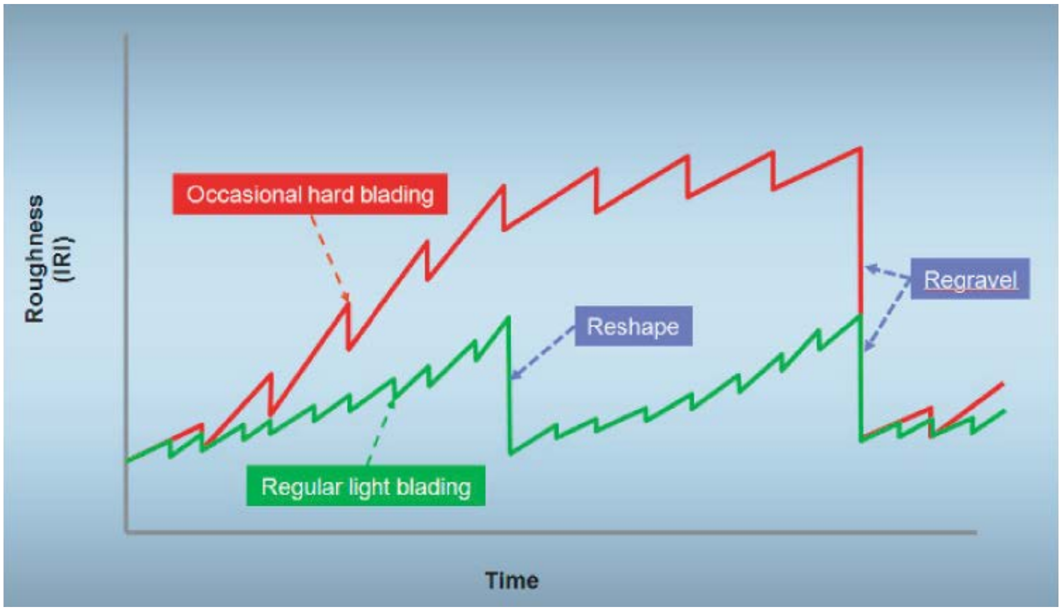

Figure 2-1. Effect of Occasional Hard Blading Versus Effect of Regular Light Blading and Reshaping (Van Zyl, 2011)

In 2007, 36% of the publicly owned roads in the United States were classified as unpaved roads (Highway Statistics, 2008). That statistic would mean that of the 70% of the roads in the United States that are classified as LVR, just over half of them are un-surfaced roads. The even division of surfaced and un-surfaced roads among LVRs means that agencies in charge of maintaining these roads must have in depth knowledge of two quite different surface types in order to adequately maintain their full network.

LVR Considerations. There are several factors that can influence the implementation of unpaved roads: roadway surfacing product use, performance, and cost can vary significantly, depending on the project location. Project-specific factors that vary by location include climate, environmental setting and conditions, availability of materials, equipment, and experienced contractors, local construction practices, maintenance practices, labor and material costs, and traffic characteristics (Maher, 2005). Selecting which type of road to apply is not an easy decision because of the many variables that affect its application, especially in a state as large as Texas. Among the other variables, traffic volume is a critical tool used to determine surface choice.

Additionally, Zimmerman & Wolters (2002) state that, “in the past, having access to appropriate decision making tools for agencies maintaining low-volume roads has not been a high priority in the United States.” Because of limited resources on LVR maintenance design, construction, maintenance and cost, especially with regards to un-surfaced roads, much of the recent research has focused on methods of mechanistic/empiricalistic design and modeling deterioration of these roads. The goal has been to bring design and maintenance practices to a level of sophistication more near that of high volume roadways. The justification for this effort is that “timely maintenance can significantly reduce agency cost” (Veeraragavan & Krishna, 2011) and that “the cost of maintaining unsealed roads is going up while the cost of managing information is going down,” (Huntington & Ksaibati, 2011). To meet these calls for more sophistication, design manuals have been developed over the last decade and a half. Evans (1995) generated a manual on geometric design practices for LVRs for the USDA Forest Service and was followed in 2001 by AASHTO with Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT<400) and more recently the Unsealed Roads Manual: Guidelines to Good Practice in 2006.

Conversion

Definition. As the name would suggest, conversion is the changing from one surface type to another. However, the process will be different for the conversion to both Deteriorating road conditions and lack of funding sources to rehabilitate those roads led Benzie County to convert several road segments to gravel in the past few years. Only roads that were considered failed and unsafe to drive on were candidates for conversion. Other factors included cost savings as a result of the conversion and the very low vehicle per day counts on sections of the road (CTC & Associates, 2010). The cost of road maintenance and the cost of the upgrade are necessary inputs for the decision. It is generally understood that the cost of maintaining a gravel road increases with the traffic volume. As traffic volume increases, the road becomes rougher more quickly and this necessitates more frequent surface smoothing with road graders. Also, more gravel is thrown off the road or blown away as dust, necessitating more gravel replacement (Jahren, 2005).

Converting from Un-Surfaced to Surfaced. Agencies experientially determined that at certain traffic volumes, un-surfaced roads will deteriorate at a pace that makes maintenance cost prohibitive. Therefore, studies were commissioned beginning in the late 1970’s to determine the optimal time to upgrade an un-surfaced road to surfaced (Bhander, 1979; Reckard, 1983; Luhr & McCollough, 1983; Kentucky Transportation Center, 1988).

More recently, Departments of Transportation in South Dakota (Zimmerman & Wolters, 2002) and Minnesota (Jahren et al., 2005) have examined the economics of surface upgrades. Despite extensive literature review and interviews of national stakeholders in un-surfaced roads, no studies examining the reversion of surfaced roads to un-surfaced roads has been found. From the literature, the conversion threshold whereby it becomes more economical to pave an un-surfaced road will occur between 100 and 200 vehicles per day.

Clemmons & Saager’s 2011 study found that the break-even point for upgrading from an un-surfaced road to a chip sealed road occurs at just under 200 vehicles per day but recommends that chip sealing any road with more than 145 vehicles per day as the most cost-effective practice. These results look at agency costs as well as user costs, which they place at $0.10 per mile per car savings on a surfaced road over an un-surfaced road.

The idea of converting un-surfaced LVR to surfaced roads has been considered for some time. The first study that could be found on this topic was a 1979 report by Bhander that evaluated the effect of timing and opportunity costs of paving a road. In 1983, an FHWA Report by Reckard concluded that there are some gravel roads that should never be upgraded to a surfaced road. In 1988 the Kentucky Transportation Center developed 10 questions to guide decision makers through the consideration of paving an un-surfaced road. This study also summarized the purpose fueling such considerations:

> The decision to pave is a matter of trade-offs. Paving helps to seal the surface from rainfall, and thus protects the base and subgrade material. It eliminates dust problems, has high user acceptance because of increased smoothness, and can accommodate many types of vehicles such as tractor-trailers that do not operate as effectively on un-surfaced roads. In spite of the benefits of paved roads, well-maintained gravel roads are an effective alternative. In fact, some local agencies are reverting to gravel roads.
>
> Gravel roads have the advantage of lower construction and sometimes lower maintenance costs. They may be easier to maintain, requiring less equipment and possibly lower operator skill levels. Potholes can be patched more effectively. Gravel roads generate lower speeds than paved surfaces. Another advantage of the unpaved road is its forgiveness of external forces. For example, today vehicles with gross weights of 100,000 pounds or more operate on Kentucky’s local roads. Such vehicles would damage a lightly paved road so as to require resealing, or

> even reconstruction. The damage on a gravel road would be much easier and less expensive to correct.
>
> There is nothing wrong with a good gravel road. Properly maintained, a gravel road can serve general traffic adequately for many years."

In 1983 Luhr & McCullough used a design and management program to predict the appropriate timing for conversion. After these studies, Zimmerman and Wolters were the next to tackle the question in 2002. In lieu of these aforementioned studies, Zimmerman and Wolters (2002) concluded that, "while there is substantial documentation on decision making for paved roads, there is a lack of guidance on maintaining, rehabilitating and determining appropriate surface types for low-volume roads." After the 2002 study, several more studies, including those listed above, have increased the available documentation on the decision of surface conversion yet a hesitancy to generalize findings to local conditions have resulted in continued interest in funding studies of this nature. Additionally, most of these studies have looked at the economics of upgrading an un-surfaced road to a surfaced road.

Alternatives to the costly asphalt cement materials conventionally used in HMA have been sought as surfacing options. One of these alternatives is asphalt-treated mixtures (ATM). These mixtures consist of crushed rock or natural gravel mixed with low percentages (2.5% - 4.5%) of paving-grade asphalt cement (Rostron et al., 1971). Often, substandard materials that would not be acceptable for use on higher volume roads are considered for use in LVR. Bhusal et al. (2011) found that using recycled-concrete aggregate (RCA), being a low quality aggregate, may be a good option for constructing LVR because LVR experience fewer equivalent single-axle loads as compared with interstates or highways. The current practices in the State of Texas will be determined and those practices will be utilized to estimate costs for this research.

Converting from Surfaced to Un-Surfaced. A new consideration is the conversion of a surfaced road to an un-surfaced road. Many more questions arise when this consideration is approached and the answers are not as simple as comparing the costs of maintenance presented in the existing literature. In fact, no literature directly addressing "unpaving" roads was found. This could be due to the unpopularity of "unpaving" a road. Clemmons & Saager (2011) discuss a situation in which inadequate funding necessitated the reversion of 10 miles of LVR from chip seal to gravel roads that was supported by local officials and transportation plans. Despite the fact that the sealed road was in terrible condition, the conversion to gravel was "very unpopular" with residents.

Previous research in Minnesota and South Dakota addresses when a road should be paved, but does not address de-surfacing a road for cost savings. The process for converting a surfaced road to an un-surfaced road will have to be determined with the assistance of the thesis advisor, the TxDOT expert who is willing to verify pricing and processing, and personal experience.

HDM-III Road Deterioration Modeling Software

Software models are commonly used to simulate road costs on surfaced roads and are usually focused on roughness as the main performance factor (McManus & Metcalf, 2003). The models range from very sophisticated predictors of deterioration with dozens of inputs (such as HDM-4) to more simple programs that are focused on usability for smaller agencies (Zimmerman & Wolters, 2002).

For gravel roads there are two methods to determine deterioration, ride quality and gravel loss (Uys, 2011). There are several models which are used to model deterioration of gravel roads: the World Bank's Highway Development and Management Model (HDM-III & HDM-4), Roads Economic Decision Model (RED) and Deterioration of Unpaved Roads model (DETOUR), the Technical Recommendations for Highways Manual 20 (TRH20), Australian Road Research Board (ARRB) gravel loss deterioration model, Brazilian gravel loss deterioration model and the Kenya Maintenance Study. Of these models, HDM-4 is the most widely used deterioration model for unsealed roads as well as for sealed roads internationally. The HDM-4 model is based on the previous version HDM-III with minor modifications to the text and with the addition of local calibration and adaptation factors to facilitate use. Of these models, "it is apparent that the TRH20 model or the HDM-4 model will be most suited to be calibrated or amended for future use…to be used worldwide" (Uys, 2011).

Models specific to gravel roads, referred to as gravel road management systems (GRMS) such as the South African GRMS include dynamic core penetrometer measurements, Atterberg limits, layer thicknesses, gradations and visual distress ratings (Van Zyl et al., 2003). This data is usually not collected by the small agencies that maintain the majority of un-surfaced roads in the US. More simple methods have been developed in order to allow smaller agencies to more easily manage their road networks. One system developed by the Wyoming Technology Transfer Center uses visual distress ratings that are easier for small agencies to gather to calculate a surfacing serviceability index (SSI) and then develops a decision matrix to aid officials in prioritizing maintenance activities based on functional road class (Huntington & Ksaibati, 2011).

HDM-III is a road deterioration-modeling program based on use (average daily traffic, or ADT) and cost. Since it is a computer-based application which runs on a DOS platform it can be used virtually anywhere in the world, one of the aims of its development. The user can analyze different maintenance strategies by cost, available materials, environmental impacts (such as topography), etc., over time in order to determine the annual maintenance cost for a given road. It can be used to analyze paved roads of various surface types, according to each agency's own known costs and procedures. The user enters data (inputs) into predetermined cells, and the program uses algorithms to model the roads behavior and predicted cost over time. Additionally, part of the HDM-III model includes different maintenance strategies that may be set as scheduled or reactive. Since the program is held to international specifications, all data, information, reports, etc, should be input as, and are given in, metric.

In order to assist in the appraisal of road investments, the World Bank initiated four studies aimed at developing road deterioration models to evaluate what effect construction and maintenance activities had on road user costs on LVRs. These studies occurred between 1973 and 1982 and were:

- Kenya study (Abaynayaka et. al., 1977): Develop relationships for road deterioration and road user costs
- Caribbean study (Morosiuk & Abaynayaka, 1982): Compared road geometry effect on vehicle operating costs
- India study (CRRI, 1982): Investigated operational concerns on Indian roads.
- Brazil study (GEIPOT, 1982): Validated previous model relationships.

Drawing on the above research, the World Bank developed a comprehensive deterioration model in 1987 and adapted it for use with the personal computer in 1995. This model, known as HDM-III, was the primary model until 2000. In 2000, the World

Bank updated the model to reflect state of the art practice to the HDM-4 model with additions and updates including:

- Cold climate effects
- Traffic congestion effects
- A wider range of pavement types and structures
- Road safety
- Road works zone effects on road users
- Environmental effects, consisting of noise, energy consumption and vehicle emissions

The main difference in HDM-III and HDM-4 with regard to the sub-models is:

"…the lowering of vehicle operating costs and the increase in travel speed which resulted from the fact that the models have been adjusted for the increase in the efficiency of motorised vehicles over the last 30 years…As a result of the last mentioned aspect HDM-4 produced lower values for the benefit-cost ratio and internal rate of return of the case study. When compared to the justification level, however, this reduction did not influence the economic viability of the project" (Pienar et al., 2001).

This study will utilize HDM-III, as user costs are not being evaluated. Additionally, HDM-III is available for free download from the World Bank website at:

http://www.worldbank.org/transport/roads/rd_tools/hdm3.htm

Research Questions

If the cost to maintain an unsurfaced road in Texas is less than the cost of maintaining a surfaced roadway, then there is potential for agency cost savings. However, the problem is bigger than just maintaining what already exists. If unsurfaced proves to be a more economical surface type, then the cost to convert a roadway from surfaced to unsurfaced, and back when necessary, must also be examined. All the previous research directs question one:

1. Is the cost of maintaining unsurfaced roads more economical than the cost of maintaining surfaced roads in Texas?

Before that question can be answered, however, the ADT “break-even” point for a low volume road, the level at which it costs the same amount to maintain a surfaced and an unsurfaced road, must be determined. This can be found by examining the average daily traffic and its impact on road maintenance costs, and leads to question two:

2. What is the ADT level at which unsurfaced roads and surfaced roads cost the same to maintain for each district?

It is important to keep in mind that maintenance is only half of the picture. Before a road can be maintained at it’s optimum surface type, conversion may be necessary to change the surface. This process will have agency cost associated with it. Part one of a two-part question presents itself:

3.a. What are the costs involved in the conversion process?

It is widely known that costs across different regions of Texas can vary greatly when it comes to transportation construction needs. Proximity to resources, as well as the availability of equipment and labor, all have an impact on conversion construction costs. It is important that this research looks at the whole picture, and so conversion from surfaced to un-surfaced will be examined, as well as conversion from un-surfaced to surfaced. The maintenance costs for both types of roadways will also need to be analyzed. After considering the data that will need to be pulled for the previous three questions, the second part of the question progresses naturally:

3.b. Is conversion an economical option?

Since no other studies have addressed the un-surfacing as a road for cost savings, it is unknown if substantial savings can realistically be obtained by converting a road from surfaced to un-surfaced. In order to determine if conversion is a viable option, the prices across the state will need to be examined to determine if conversion is an economical choice in a particular area.

CHAPTER 3

METHODOLOGY

Data Collection

To answer all of the research questions, there were two types of data required: cost and traffic. The traffic data could be obtained fairly easily, as TxDOT keeps track of ADT on all of their roads. The cost data was the most difficult to determine, and to accurately represent the costs incurred by an agency such as TxDOT, the entire picture needed to be examined. To accomplish this, work plans for the maintenance activities and conversion processes were developed so that costs could be assigned according to a realistic schedule for each activity.

Work Plans. The first step was to build hypothetical conversion and maintenance models in a spreadsheet so that all costs could be calculated with their district specific modifications accounted for. A workbook was developed that contained schedules for each activity, along with detailed processes to assign cost. Labor, equipment, and material were all included. The workbook includes information for the different climatic regions as well as by individual TxDOT districts. The different activities required for the conversions and maintenance of both types of roads are detailed, as are the costs associated with each activity. The workbook also takes into account production rates for equipment. The scenario used to estimate quantities and costs was defined as one section of an asphaltic or un-surfaced roadway 24’ wide and 5280’ long. All calculations for quantity were based on this definition.

The Microsoft Excel workbook that was generated for this project (“Cost Analysis_Final,” or “CAF”) is key to the results, and the different sheets will be referenced in following portions of this paper. Information will be sourced back to its page in the workbook by sheet name, for example “CAF-S-US Convert” is the sheet “S-US Convert” in the “Cost Analysis_Final” workbook. The costs, procedures, and data yielded by the workbook also helped to determine inputs for HDM-III. The workbook is attached as Appendix A, though it has been edited down to fit onto the pages.

The author has personal experience in road construction, and was able to develop realistic work plans for each activity. For verification purposes, the thesis advisor and TxDOT personnel with firsthand knowledge of the activities being evaluated reviewed the work plans. Comments, suggestions, and recommendations were offered, and changes were made so the final work plans accurately reflect the activity being described.

Sources. Once all of the production elements were established, cost data was gathered from TxDOT records and from RSMeans Heavy/Civil 2012. RSMeans allowed all labor and equipment costs to be included on a district specific basis using the City Cost Indexes, which were built into the CAF workbook. TxDOT provided cost data from their own systems. Costs for items that are not available to the general public (for example, level-ups prior to chip seal application) were determined by TxDOT and given to the research team for inclusion. Other information provided by TxDOT included what materials to estimate the unpaved scenarios with: Grade 4 rock, seal coat oil, and flexbase. In this way, all costs used are supported by either a nationally recognized source (RSMeans, 2012) or by the agency itself.

Since all pricing is based on TxDOT costs, TxDOT directed the author in reconciling cost issues. For example, where costs for individual districts were not available, and so as not to have "$0" as an entry, then the costs for the other districts in the same region were averaged and used. Once costs had been assigned to every activity and preliminary subtotals had been calculated, the workbook was once again reviewed by the thesis advisor and by TxDOT. Comments, suggestions, and recommendations were offered, and changes were made so the final totals should reflect the average costs of each activity for each district. Because contractors are not generally willing to share their cost data, the totals developed for the conversion processes are best-estimates that generally fell in line with what TxDOT personnel have seen.

Conversion Process – Surfaced to Un-surfaced. A hypothetical conversion process for surfaced to un-surfaced roads was developed. All costs (including labor, equipment, and material) and the calculations are included in "CAF-S-US Convert." The schedule that was developed is included in “CAF-S-US Schedule.” This situation was defined as “A surfaced roadway has reached its maximum sustainable lifetime and due to the low capacity of traffic volume the roadway must be converted to an un-surfaced roadway.”

Assumptions were made for standardization purposes:

- Thickness of existing roadway surface is two (2) inches of chip sealed asphaltic roadway.
- Under the pavement layer will be at least eight (8) inches of Type 1 Flexible base material, however this process will affect ONLY the top four (4) inches of Flexible base.
- The width of the roadway will be set to (24) feet for estimating purposes.
- The surface area for the roadway was determined as follows:

  A: Surfaced Area

  W: Width of Roadway

  L: Length of 1 Mile

  $A = W \times L$

  $A = 24\text{ ft} \times 5{,}280\text{ ft/mi}$

  $A = 126{,}720\text{ ft}^2\text{/mi}$

Once all of this was established, the process for un-surfacing was established:

1. The roadway shall be ripped with a motor grader to a depth no greater than (0.5) feet.
2. The roadway shall then be watered thoroughly (for amount needed see below at Water per Cubic Yard).
3. The roadway shall then be processed with a mixer or soil stabilization machine at a depth no greater than (0.5) feet.
4. The roadway shall then be leveled off by a motor grader in order to disperse the processed material to near final grade (± 0.1 ft.) of the designed final surface.
5. The roadway shall then be compacted to recommended compaction levels as set by appropriate engineer by district.
6. The roadway shall then be finished by motor grader to an accuracy of (± 0.05 ft) of the designed final surface.

Visually, Figure 3-1 represents the before and after of a surfaced to un-surfaced conversion.

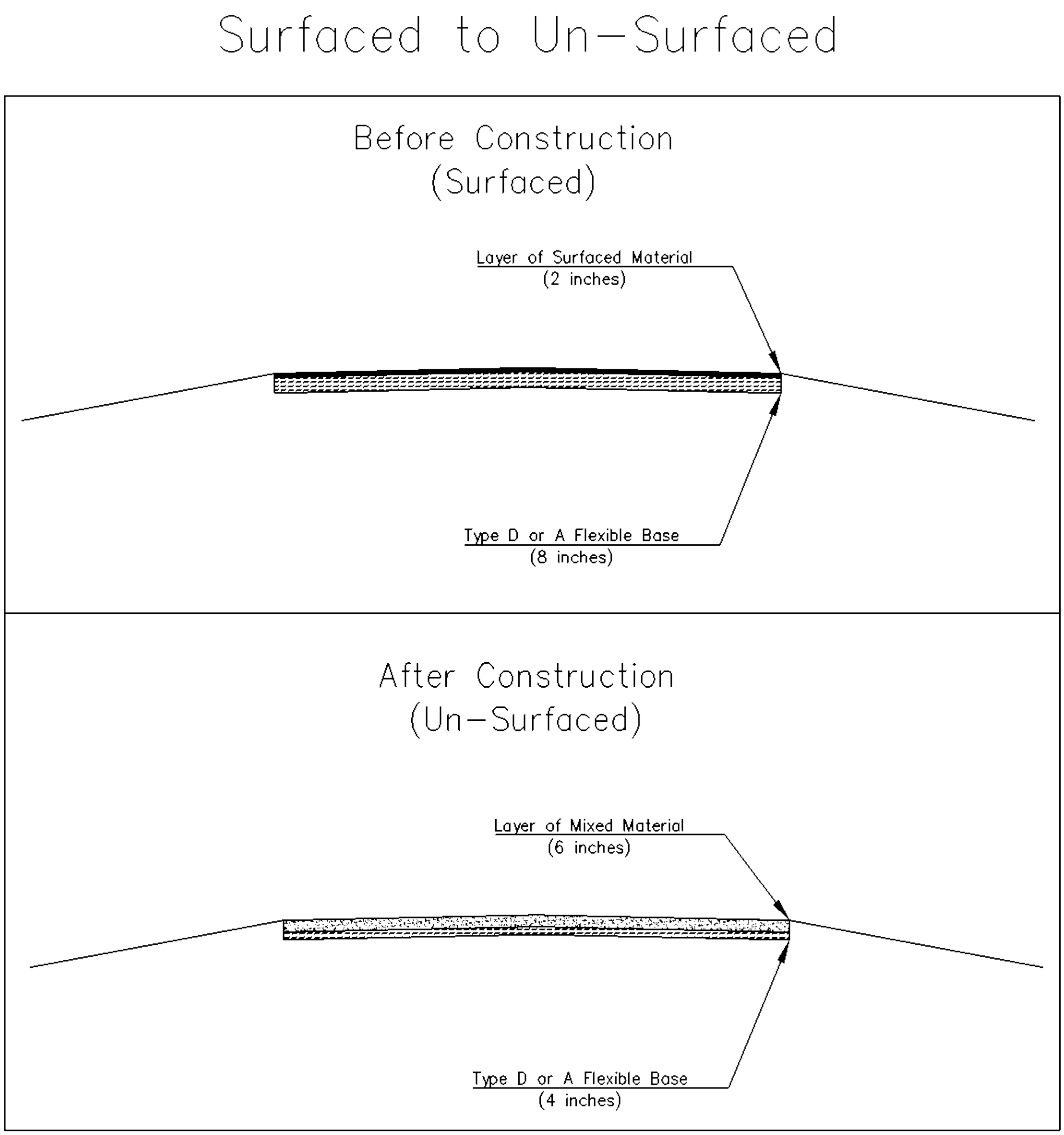

Figure 3-1. Surfaced to Un-Surfaced Conversion Visual Description

After defining the size and scope of the conversion process, materials were included to ensure all cost factors were considered. For an un-surfaced road, the materials needed for conversion were determined to be water and aggregate. Quantities were established using the formulas below:

1. Aggregates

Volume per mile

- Mixture of 4" Asphalt & 2" Flexible Base

Cy: Cubic Yards of Material per Mile (yd^3/mi)

Td: Total Depth of disturbance = (6/12) ft

L : Length of 1 mile = 5,280 ft

W: Width of roadway = 24 ft

$$Cy = (Td \times L \times W) / (27\ ft^3/yd^3)$$

$$Cy = ((6/12\ ft) \times (5{,}280\ ft/mi) \times (24\ ft)) / (27\ ft^3/yd^3)$$

$$\approx 2350\ yd^3/mi$$

2. Water

Volume per mile

W_v : Water volume per mile

$W_{/Cy}$: Water added per Cubic Yard = 15 gal/yd^3

Cy : Cubic yards per mile = 2350 yd^3/mi

$$W_v = W_{/Cy} \times Cy$$

$$W_v = 15\ gal/yd^3 \times 2{,}350\ yd^3/mi$$

$$= 35{,}250\ gal/mi$$

Cost per mile

$Cost_{/Gal}$ = \$1.50 per 1,000 gal [Assumed]

= \$0.0015 / gal

$Cost_{/Mile}$ = (\$0.0015 / gal) x (15 gal / yd^3) x (2,350 yd^3/mi)

= \$ 52.875 / mi

It should be noted that the above cost for water is an estimate based on research into various sources. The price of water was found to be highly variable based on the location of the project. The closer to a city or main water supply the project is located, the lower the cost. However, in Texas, extreme environmental fluctuations and water availability can have a great impact on the price of water. The author found that in the broad scheme, water did not have a great impact on the overall cost of the project, however, it is understood that in certain extreme circumstances it can be an important factor.

Lastly, equipment pricing was gathered. The production data for all equipment needed to perform the conversion of a road from surfaced to un-surfaced was gathered from the Caterpillar Handbook, 38th ed. Costs were gathered from RSMeans 2012 and calculated for each piece of equipment according to the work plan and schedule, specific to each district. These costs are detailed in "CAF-S-US Convert," which is supported by "CAF-S-US Schedule."

Conversion Process – Un-surfaced to Surfaced. A realistic conversion process had to be developed for turning an un-surfaced road into a surfaced road. All costs (including labor, equipment, and material) and the calculations are included in "CAF-US-S Convert." The schedule that was developed is included in "CAF-US-S Schedule." The process is a basic prepare-and-pave, but requires more equipment, materials, labor, and planning than the surfaced to un-surfaced conversion. Again, a situation was defined, "An un-surfaced roadway has reached its maximum sustainable capacity of traffic volume and must be converted to an asphalt surfaced roadway."

The assumptions made were as follows:

- Thickness of existing un-surfaced roadway surface is at least (8) inches in total depth and is to be treated as compacted Type 1 Flex Base.
- There will be residual amounts of Recycled Asphalt Pavement in the existing roadway due to gravel loss effects, the effect of the RAP in the composition of the aggregate will not be considered.
- A nominal (2) inches of Type 1 Flex Base will be used as level up material.
- The width of the roadway will be set to (24) feet for estimating purposes.
- The surface area for the roadway was determined as follows:

    A: Surfaced Area

    W: Width of Roadway

    L: Length of 1 Mile

$$A = W \times L$$
$$= 126{,}720 \text{ ft}^2/\text{mi}$$

Once all of this was established, the process for surfacing was established:

1. The roadway shall be ripped and processed according to TxDOT Spec 247.4 A Preparation of Subgrade or Existing Base:

"When new base is required to be mixed with existing base, deliver, place, and spread the new flexible base in the required amount per station. Manipulate and thoroughly mix the new base with existing material to provide a uniform mixture to the specified depth before shaping."

2. The roadway shall then be watered thoroughly (for amount needed see below).
3. The roadway shall then be processed with a mixer or soil stabilization machine at a depth no greater than (0.5) feet.
4. The roadway shall then be leveled off by a motor grader in order to disperse the processed material to near final grade (± 0.1 ft) of the designed final surface.
5. The roadway shall then be compacted to recommended compaction levels as set by appropriate engineer of district according to regional material characteristics.
6. The roadway shall then be finished according to TxDOT Spec 247.5 D. Finishing: "After completing compaction, clip, skin, or tight-blade the surface with a maintainer or subgrade trimmer to a depth of approximately 1/4 in. Remove loosened material and dispose of it at an approved location. Seal the clipped surface immediately by rolling with a pneumatic tire roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades as shown on the plans or as directed. In areas where surfacing is to be placed, correct grade deviations greater than 1/4 in. in 16 ft. measured longitudinally or greater than 1/4 in. over the entire width of the cross-section.

Correct by loosening, adding, or removing material. Reshape and recompact in accordance with Section 247.4.C, “Compaction.”

7. The additional layers of the surface shall be designed according to a State of Texas Professional Engineer and is considered beyond the scope of this project.

Visually, Figure 3-2 represents the before and after of an un-surfaced to surfaced conversion.

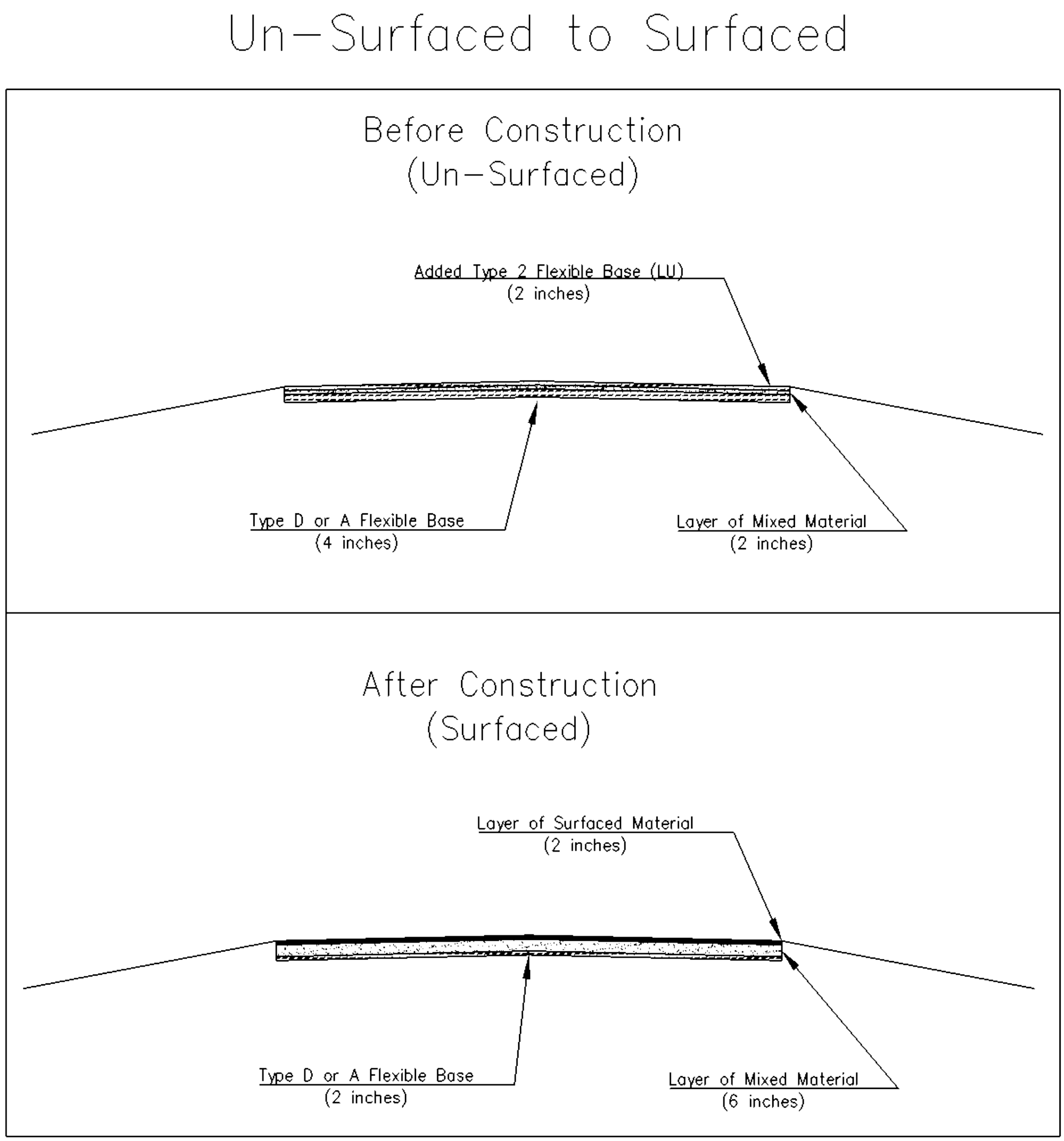

Figure 3-2. Un-Surfaced to Surfaced Conversion Visual Description

After defining size and scope, materials needed for the conversion were determined:

1. ***Base Aggregate***

- The ratio of thickness of loose gravel to compacted gravel is 1.28:1; therefore, a 2-inch compacted gravel lift requires placement of 2.56 inches of loose gravel (Skorseth and Selim, 2000, pp. C1-C2).

Volume per mile

- 6" of Existing Materials to be blended with additional material

  Cy: Cubic Yards of Existing Material per Mile (yd^3/mi)

  Td : Total Depth of aggregates = (6/12) ft

  L : Length of 1 mile = 5,280 ft

  W: Width of roadway = 24 ft

  $$Cy = (Td \times L \times W) / (27\ ft^3/yd^3)$$

  $$Cy = ((6/12\ ft) \times (5{,}280\ ft/mi) \times (24\ ft)) / (27\ ft^3/yd^3)$$

  $$\approx 2{,}350\ yd^3/mi$$

- Add 2" Flexible Base

  Cy_o: Cubic Yards of Material per Mile (yd^3/mi)

  Td : Total Depth of aggregates = (2/12) ft

  L : Length of mile = 5,280 ft

W: Width of roadway = 24 ft

Cy_o = (Td x L x W) / (27 ft^3/yd^3)

Cy_o = ((2/12 ft) x (5,280 ft/mi) x (24 ft)) / (27 ft^3/yd^3)

≈ 783 yd^3/mi

- 2" Flexible Base Volume with swell multiplier

Cy_{Sw}: Cubic Yards of Material with swell factor per Mile (yd^3/mi)

Cy_o: Cubic Yards of Material without swell per Mile (yd^3/mi)

Z : Swell factor = 1.28

Cy_{Sw}= Cy_o x Z

Cy_{Sw}= (783 yd^3/mi) x (1.28)

≈ 1,000 yd^3/mi

- Total Cubic Yards to be mixed per mile

Cy_T = Cy + Cy_{Sw}

Cy_T = (2,350 yd^3/mi) + (1,000 yd^3/mi)

≈ 3,350 yd^3/mi

Cost per Mile

- Please refer to "CAF-TxDOT's Price Info x Dist&CZ" for flex base costs, as these were determined on a per district basis.

2. Water

Volume per mile

W_v *: Water volume per mile*

W_ϱ *: Water added per Cubic Yard = 19 gal/yd*^{3}

Cy_T *: Total Cubic yards to be mixed = 3,350 yd*^{3}*/mi*

$$W_v = W_\varrho \times Cy_T$$

$$W_v = 19 \text{ gal/yd}^3 \times 3{,}350 \text{ yd}^3\text{/mi}$$

$$= 63{,}650 \text{ gal/mi}$$

Cost per mile

$$Cost_{/Gal} = \$1.50 \text{ per } 1{,}000 \text{ gal [Assumed]}$$

$$= \$0.0015 \text{ / gal}$$

$$Cost_{/Mile} = (\$0.0015 \text{ / gal}) \times (19 \text{ gal / yd}^3) \times (3{,}350 \text{ yd}^3\text{/mi})$$

$$= \$\ 95.475 \text{ / mi}$$

3. Prime

Volume per mile

PC_T *: Total amount of Prime coat (Type Miscellaneous)*

PC_1 *: Prime Coat added per Cubic Yard = 0.35 gal/yd*^{2}

SYT_M *: Total Square yards to be covered = 14,080 yd*^{s}*/mi*

$$PC_T = PC_1 \times SYT_M$$

$$PC_T = 0.35 \text{ gal/yd}^2 \times 14{,}080 \text{ yd}^2\text{/mi}$$

$$= 4{,}928 \text{ gal/mi}$$

The cost of Prime Coat per mile is not calculated here because it varies by district. TxDOT provided the average bid prices for most districts (except for Amarillo, which the author averaged per the PD), so the individual Prime Coat costs can be found on ("CAF-TxDOT's Price Info x Dist&CZ.").

4. Seal Coat

Volume per mile

SC_T *: Total amount of Seal Coat (Type Miscellaneous)*

SC_1 *: Seal Coat added per Cubic Yard = 0.35 gal/yd*^{2}

SYT_M *: Total Square yards to be covered = 14,080 yd*^{s}*/mi*

$$SC_T = SC_1 \times SYT_M$$

$$SC_T = 0.35\ gal/yd^2 \times 14{,}080\ yd^2/mi$$

$$= 4{,}928\ gal/mi$$

The cost of Seal Coat per mile is not calculated here because it varies by district. TxDOT provided the average bid prices for all districts so the individual Seal Coat costs can be found on “CAF-TxDOT’s Price Info x Dist&CZ.”

5. Grade 4 Rock

Volume per mile

RG_4 : Total amount of Grade 4 Rock needed to cover one square mile

SYT_M : Total Square yards to be covered = 14,080 yd^s/mi

AR : Application Rate = 110 yds^2/yd^3

$$RG_4 = SYT_M / AR$$

$$RG_4 = 14{,}080\ yd^2/mi\ /\ 110\ yds^2/yd^3$$

$$= 128\ yd^3/mi$$

The cost of Grade 4 rock per mile is not calculated here because it varies by district. TxDOT provided the average bid prices for most districts (all except for Dallas, which the research team averaged per TxDOT), so the individual Grade 4 Rock costs can be found on “CAF-TxDOT’s Price Info x Dist&CZ.” All average bid prices provided by TxDOT are “in-place” pricing, in that they include all costs such as overhead, transportation, installation, etc.

Lastly, equipment pricing was gathered for all equipment needed to perform the conversion of a road from un-surfaced to surfaced. As with the surfaced to un-surfaced conversion, the production data was gathered from the Caterpillar Handbook, 38^{th} ed.

Costs were gathered from RSMeans 2012 and calculated for each piece of equipment according to the work plan, including the schedule. The cost data can be found on "CAF-US-S Convert."

Maintenance Process – Surfaced. The maintenance procedure for surfaced roads was developed using the sources and processes discussed in the Literature Review. The maintenance plan included adding a layer of Seal Coat and a layer of Grade 4 Rock every 7 years. Per TxDOT, an average level-up of 20% per one mile was factored in, as well as the cost of materials and equipment, including centerline striping. The details of the maintenance plan can be found in "CAF-Maintain Surfaced." The price for surface treatments was taken from Item 316, and was provided by TxDOT.

Maintenance Process – Un-Surfaced. In order to estimate the maintenance cost of an un-surfaced road, the author established a maintenance schedule, found in "CAF-Maintain Un-surfaced," and supported by "CAF-Blading Logic." The maintenance process takes into account the equipment, labor, and materials costs to maintain an un-surfaced road on a bi-monthly basis. Based on information gathered in the Literature Review, the assumption was made that on an un-surfaced road with an ADT of 250 cars per day, maintenance would need to be performed every 60 days, or 15,000 cars. The equipment needed is a motor grader and an operator, so production and cost data was easy to obtain.

Using individual data for each district, a maintenance schedule and cost was developed ("CAF-Blading Logic") that included both routine blading and gravel resurfacing. This yielded the maintenance cost of un-surfaced road per mile per year for each district. It should be noted that since only one type of gravel was used for evaluating every district (which may not be the preferred or most cost effective material in every district), there could be variations in the estimated and actual un-surfaced road maintenance costs of individual districts. It is possible that each district has a preferred aggregate, which may have an impact on the overall cost and performance of an un-surfaced road, but that analysis was outside the scope of this project.

Finding the conversion costs (which are "one time" costs in that they theoretically should only occur once for any portion of road) gave the author part of the agency cost picture. The second part involved the evaluation of the maintenance costs associated with each road type. Annual maintenance can be estimated, but there are so many factors that can impact the need for maintenance that a road-deterioration modeling program was utilized to determine the maintenance costs over time.

Data Analysis

Since the goal of this paper was to evaluate the costs over time, a road-deterioration modeling program was used to evaluate the environmental effects to the road surfaces over time. The user provides the data in HDM-III, which in this case was the author. As previously noted, production data was gathered from the Caterpillar Handbook, cost data was gathered from TxDOT, and any gaps in any data were supplemented with RSMeans. However, due to the nature of this project, it was imperative that the costs used for inputs in the HDM-III program were as accurate as possible, especially those that are weighted most heavily.

HDM-III – Sensitivity Analysis. There were a potential 106 inputs concerning surfaced road, and 90 concerning un-surfaced. It was beyond the scope of this project to gather accurate data for every possible input, and verifying all data to the same level of assurance would be difficult, given the time frame and scope of the project. Examples of such inputs included specific gradation sizes for aggregate, curvature of the road, and other highly specialized engineered aspects of the roadway construction. In order to determine the most critical inputs for the final simulations, a sensitivity analysis of the HDM-III program was needed to identify the variables that had the greatest effect.

To find and focus on the inputs with the most impact, a workbook was developed to measure the weight of the impact of each variable on a baseline output figure developed as a control variable. This file is named “HDM3_Sensitivity Analysis_Final” or “SAF”. As with the cost analysis file, the sheets contain all data and calculations and are referred to by sheet title. Sheets from the sensitivity analysis will start with “SAF” rather than “CAF”. The sensitivity analysis is included as Appendix B. Hundreds of variables such as environmental conditions, material conditions, frequency of work done, cost factors, material specifications, material properties, and many more as identified in the "SAF-Master Sheet," were defined and given ranges. The workbook was designed to test each input from the lowest-possible to the highest-reasonable range of each variable to indicate the influence on the results given by HDM-III by defining one set of data that would act as the constant. Each input was assigned a range (n=5). An analysis was run at each interval for each input (more than 300 simulations). In order to determine the impact of each variable within each range, and using the results of these simulations, a comparative analysis was used to determine which variables had impact at the traffic level being evaluated. For each variable that was altered and a simulation run, the simulation was compared to the baseline constant to see where and by how much it differed.

Data based on cost had the most impact. Maintenance intervals and material cost were found to have the greatest impact. Variables such as the environmental conditions (including climate and in situ soil condition), material condition, and other non-cost related variables had no relevant impact on the overall cost evaluation of either surface. The list of inputs with the highest weights can be found in "SAF-PAVED Analysis" and "SAF-UNPAVED Analysis." The complete list of relevant inputs, weighted in percent difference, can be found in "SAF-PAVED" and "SAF-UNPAVED."

HDM-III – Simulations. The Sensitivity Analysis indicated which variables had an effect on the overall cost, and to what extent, but HDM-III provides the numbers needed to make final recommendations and conclusions. Once the relevant inputs were determined and complete, calculations were done in the workbook "Cost Analysis_Final.xlsx" (CAF) to get the final inputs for HDM-III. All cost data for each district and region was converted into metric and loaded into the program. Simulations were run for each district, climate region, and the state as a whole as the independent variables. Because the sensitivity analysis ruled out plasticity index and climate as long-term contributing factors to cost, ADT was used as the independent variable. Additionally, it was only relevant to cost over time for un-surfaced roads. Each of these simulations generated a 25-year economic analysis by forecasting the annual maintenance cost of a road based on the inputs provided.

Based on information gathered in the Literature Review, as well as preliminary Sensitivity Analysis results, the research team chose ADT as the independent variable for the simulations. A control simulation was run using the actual costs in order to identify costs without any effect of ADT. In total, there were 187 simulations run: there were thirty-one (31), one for each of the twenty-five (25) TxDOT districts, five (5) climate regions, and one (1) for Texas as a whole; for unpaved, each was run six (6) times, with levels of ADT at 0, 100, 200, 300, 400, and 500. Additionally, one simulation for a paved road was run, but more were not necessary due to the lack of impact of ADT on surfaced roadways. The results of these simulations, or the annual maintenance cost for one mile of a road with the characteristics given in the inputs, were then entered into sheet “CAF-ADT ANALYSIS” so that they could be compared to find the point at which it is the same cost to maintain both an un-surfaced and a surfaced road, which is referred to as the “break-even” point.

ADT Analysis. Since cost was directly influenced by ADT, an analysis was performed to determine at which ADT (according to the HDM-III models) the cost to maintain an un-surfaced and a surfaced road was the same. This was done for each TxDOT district, each climatic region, and the state as a whole. This analysis can be found in “CAF-ADT ANALYSIS.”

First all data was converted from metric back into standard. The results of each simulation were entered for each district, zone, and the state as a whole, for each ADT. Using linear interpolation, the break-even point was calculated for each district, climatic region, and the state as a whole.

To this point, research questions two and three have been addressed. Once the cost benefit break-even points were established, the entire picture could be examined, and question one could be addressed. Once the break-even point was identified, the cost to maintain them at their given ADT could be calculated. This also allowed for the calculation of the total cost to convert. The total costs associated with conversion of a road from surfaced to un-surfaced, and vice versa, as well as the maintenance costs for both types of surfaces, and the costs associated with having to re-convert a road that has been previously un-surfaced are discussed in Chapter IV, Findings.

CHAPTER 4

FINDINGS

There was a large amount of data collected and analyzed for this project. The research questions were straightforward, but answering them proved to require a lot of information. Once the information was gathered and examined, however, the answers to all of the research questions were available. Questions two assisted in answering question one. At first glance, the results appeared very black and white, and when compared mathematically there appears to be a “winner” and a “loser” in terms of maintenance costs, though not by much. However, upon pairing and comparison with conversion costs, a different picture emerges. First, the research questions will be addressed, along with the findings related to each. Then, a scenario will be presented with several possible outcomes, and the results will be presented in the context of each outcome.

Economy of the Cost to Maintain Surfaced and Un-Surfaced Roadways

1. Is the cost of maintaining unsurfaced roads more economical than the cost of maintaining surfaced roads?

Yes, if material costs are low and growth rates are stable or predictable for low-volume roads over long periods of time. In general, it is cheaper to maintain an unsurfaced road than to maintain a surfaced road. However, it is not much cheaper. No matter what surface type, roadways need to be maintained. Un-surfaced road costs changed with each ADT range (100, 200, 300, 400, and 500), this was not the case with surfaced roads. Un-surfaced roads are more susceptible to variations in traffic, whereas surfaced roads were shown to have no discernable fluctuations in cost due to this factor. The simulations suggest that the ADT level would have to be much higher than 500 to cause increases in maintenance costs on surfaced roads. Table 4-1 gives an example of the range of costs for the State of Texas as a whole.

Table 4-1. Example of Effect of ADT on Annual Maintenance Cost for a Surfaced and Un-Surfaced Roadways.

	Unpaved Annual Cost					Paved Annual Cost
Location	ADT @ 100	ADT @ 200	ADT @ 300	ADT @ 400	ADT @ 500	~
Zone 6 - Texas	$6,115.51	$6,437.38	$6,920.18	$7,402.98	$7,724.85	$6,276.44
Zone 1	$6,598.31	$7,081.11	$7,402.98	$7,885.79	$8,207.65	$6,437.38
Zone 2	$4,184.29	$4,506.16	$4,988.97	$5,471.77	$5,793.64	$6,115.51
Zone 3	$4,988.97	$5,471.77	$5,793.64	$6,276.44	$6,759.24	$6,115.51
Zone 4	$5,954.57	$6,437.38	$6,759.24	$7,242.05	$7,563.92	$5,954.57
Zone 5	$8,529.52	$8,851.39	$9,334.20	$9,817.00	$10,138.87	$6,276.44

Table 4-1. Example of Effect of ADT on Annual Maintenance Cost for a Surfaced and Un-Surfaced Roadway

Once converted to un-surfaced, the process to maintain the roadway is relatively simple and cheap, though more frequent. For the State of Texas as a whole, the average annual cost to maintain a surfaced roadway is $6,276/two-lane mile. The average annual cost to maintain an un-surfaced roadway is $6,116/two-lane mile, a difference of $161 per year per mile. However, these numbers can vary based on factors such as the material price for the aggregate used. It is important to note here that when costs were being gathered, one material was chosen for each material needed. In other words, all districts were asked about pricing for Type A aggregate, rather than the average price for all types of aggregate. The same is true of the flexbase material, prime, and seal coats. In this way, a broad assessment could be carried out. However, there are limitations to this approach, which are discussed in Chapter V, Conclusions.

Table 4-2 below compares the average annual maintenance cost per two-lane mile for both surfaced and un-surfaced road types. The average annual cost for ADT’s at all ranges up to 500 is given next to the average annual cost for a paved roadway. The difference is given in the last column. The difference was found by subtracting the un-surfaced average annual cost from the surfaced annual cost, so if the number is negative, on average, it is more cost effective to maintain a surfaced road. It is within these numbers that the answer to research question two lies, and so the ADT analysis was done for each district to determine at what point it costs the same amount to maintain a surfaced and an un-surfaced roadway.

Table 4-2. Maintenance Costs for Surfaced and Un-Surfaced Roadways

(This data can be found in "CAF-ADT ANALYSIS.")

	Unpaved Annual Cost	Paved Annual Cost	
Location	Average for All ADTs	~	Difference
Zone 6 - Texas	$6,920.18	$6,276.44	($643.74)
Zone 1	$7,435.17	$6,437.38	($997.79)
Zone 2	$4,988.97	$6,115.51	$1,126.54
Zone 3	$5,858.01	$6,115.51	$257.50
Zone 4	$6,791.43	$5,954.57	($836.86)
Zone 5	$9,334.20	$6,276.44	($3,057.75)
Abilene	$6,244.25	$7,081.11	$836.86
Amarillo	$5,664.89	$5,954.57	$289.68
Childress	$7,402.98	$5,632.70	($1,770.28)
Lubbock	$9,591.69	$7,402.98	($2,188.71)
W. Falls	$8,368.59	$6,276.44	($2,092.15)
Atlanta	$3,347.44	$6,276.44	$2,929.01
Dallas	$5,600.52	$6,437.38	$836.86
FT Worth	$5,375.21	$5,471.77	$96.56
Paris	$5,536.14	$6,437.38	$901.23
Tyler	$4,988.97	$5,793.64	$804.67

El Paso	$8,497.34	$7,885.79	($611.55)
Laredo	$5,021.15	$5,471.77	$450.62
Odessa	$6,083.32	$5,954.57	($128.75)
Pharr	$4,055.55	$5,793.64	$1,738.09
San Angelo	$5,922.39	$5,793.64	($128.75)
San Antonio	$5,632.70	$6,115.51	$482.80
Austin	$5,503.96	$6,115.51	$611.55
Brownwood	$5,664.89	$6,437.38	$772.49
Bryan	$9,913.56	$6,276.44	($3,637.12)
Waco	$6,083.32	$5,149.90	($933.42)
Beaumont	$8,336.40	$6,598.31	($1,738.09)
Corpus	$7,499.54	$6,276.44	($1,223.10)
Houston	$6,373.00	$6,115.51	($257.50)
Lufkin	$12,327.58	$6,437.38	($5,890.20)
Yokum	$12,134.45	$5,632.70	($6,501.75)

ADT Level at Which Maintenance Cost Is the Same for Surfaced and Un-Surfaced Roadways

2. What is the ADT level at which unsurfaced roads and surfaced roads cost the same to maintain for each district?

As seen in the maintenance cost data in question one, there appears to be, in each district, some traffic point on a low-volume road at which it costs the same to maintain the road as either a surfaced or an un-surfaced roadway. On average, for all districts in the State of Texas, the ADT maintenance cost break-even was at around 150, as seen in Figure 4-1, though it ranges from less than 100 to more than 500 depending on the district, as evidenced by Table 4-3.

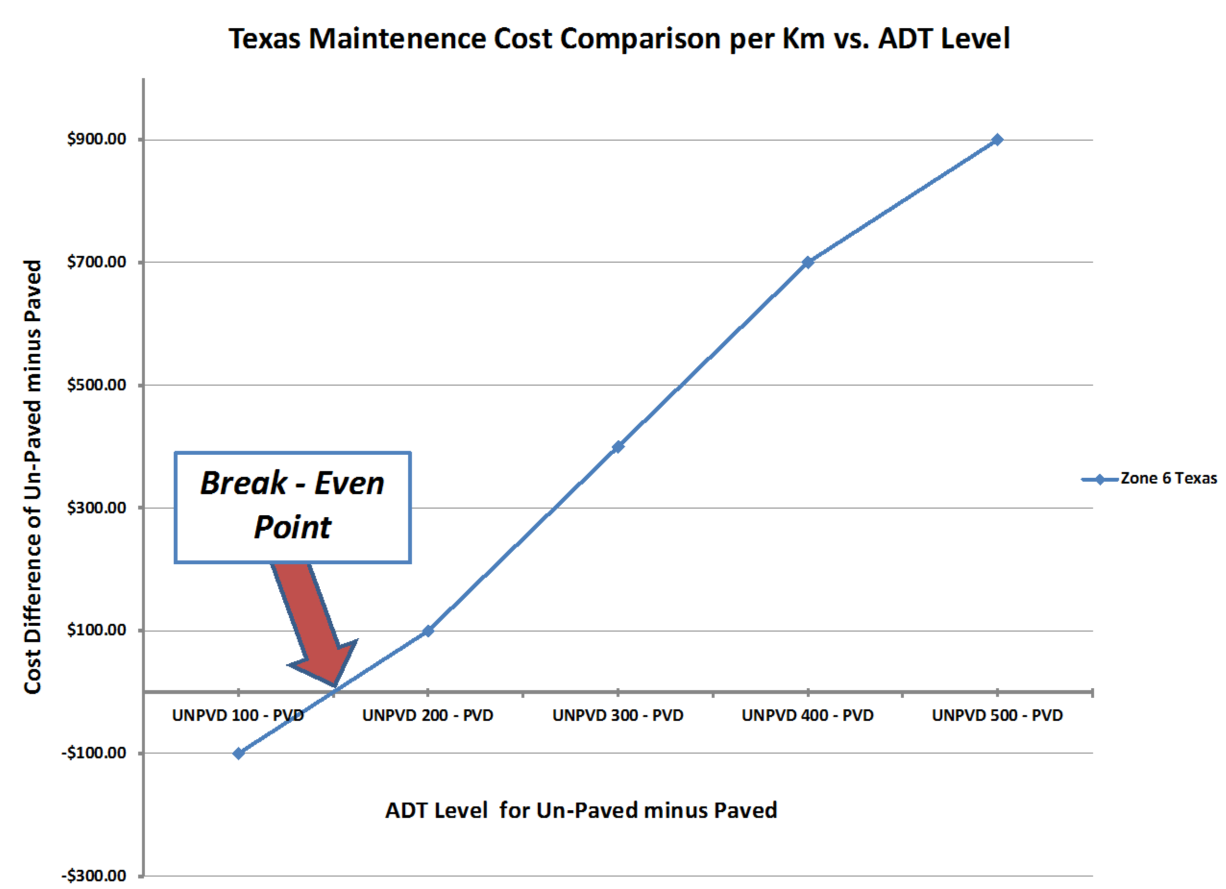

Figure 4-1 ADT Break-Even Graph

Table 4-3. Break-Even ADT by State, Climate Region, and District

(This data can be found on “CAF-ADT ANALYSIS.”)

LOCATION	**BREAK-EVEN ADT**
Texas	~ 150
Zone 1 – North	< 0
Abilene [8]	500
Amarillo [4]	367
Childress [25]	< 0
Lubbock [5]	< 0
Wichita Falls [3]	< 0
Zone 2 – North East	500+
Atlanta [19]	500+
Dallas [18]	500
Ft. Worth [2]	333
Paris [1]	500
Tyler [10]	500
Zone 3 – South West	367
El Paso [24]	150
Laredo [22]	400
Odessa [6]	267
Pharr [21]	500+
San Angelo [7]	267
San Antonio [15]	400
Zone 4 – Central	100
Austin [14]	450
Brownwood [23]	500
Bryan [17]	< 0
Waco [9]	67
Zone 5 - Coastal	< 100
Beaumont [20]	< 0
Corpus Christi [16]	< 0
Houston [12]	233
Lufkin [11]	< 0
Yokum [13]	< 0

Figure 4-2 below is a visual representation of the ADT break-even point by district and zone (Table 4-1, above). Red represents where the ADT break-even point was found to be above 500, meaning that district where it would be economically viable for the agency to have un-surfaced roads with an ADT above 500. Dark blue represents districts with an ADT break-even point of less than 0 ADT. In those districts, based on the costs used and the simulations run, there is no cost benefit to having an un-surfaced road over a surfaced road. The heavy pink lines distinguish the climate zones.

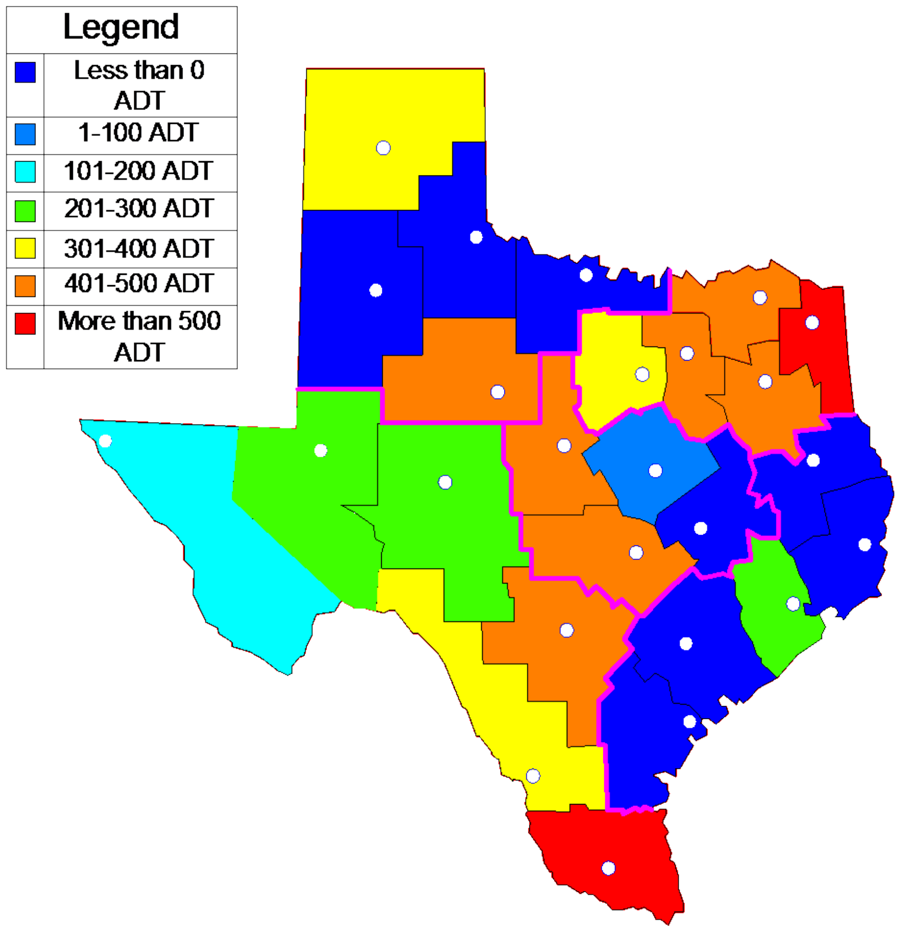

Figure 4-2. ADT Break-Even Point by District Map

The break-even ADT's were found using the costs associated with maintenance. The ADT break-even point for maintenance costs is driven mostly by material costs. As mentioned previously, only one bid item was chosen for each material needed across the state. This means that each district reported pricing for the same item, which provided consistency, but not necessarily the most accurate reflection of material cost in that district. Districts such as Pharr and Atlanta (red above) may use different aggregate than

Houston. In order to fully understand how much of an impact the materials cost has on each district, individual analyses of each would need to be done that take into account the normal engineered specification for un-surfaced roads, including the correct quantities of the preferred materials for each separate district.

Economy and Costs of the Conversion Process for Surfaced and Un-Surfaced Roadways

3. a. What are the costs involved in the conversion process?

3. b. Is conversion an economical option?

In regards to question 3.a, the cost data for conversion did not require any other programs for analysis, it was simply totals of construction activities and their associated costs. Once the process were defined, the totals for conversion were calculated.

Table 4-4. Conversion Cost for Surfaced and Un-surfaced Roads

(This data can be found on “CAF-ADT ANALYSIS.”)

Location	**Per Mile Surfaced to Un-Surfaced**	**Per Mile Un-surfaced to**
Zone 6 - Texas	$7,649.35	$106,770.64
Zone 1- North	$7,586.97	$116,175.32
Zone 2 - North East	$7,714.28	$98,324.71
Zone 3 - South	$7,621.84	$98,701.59
Zone 4 - Central	$7,516.63	$103,020.19
Zone 5 - Coastal	$7,785.98	$116,722.87
Abilene	$7,498.20	$121,254.34
Amarillo	$7,531.92	$99,937.68
Childress	$7,503.01	$105,639.74

Lubbock	$7,901.13	$137,379.69
W. Falls	$7,500.61	$116,665.18
Atlanta	$7,678.72	$91,204.72
Dallas	$7,863.06	$101,847.29
FT Worth	$7,574.89	$95,302.98
Paris	$7,766.37	$107,749.11
Tyler	$7,688.36	$95,519.45
El Paso	$7,490.97	$126,179.32
Laredo	$7,486.03	$87,536.43
Odessa	$7,706.89	$97,769.57
Pharr	$7,778.86	$87,201.49
San Angelo	$7,524.69	$100,728.50
San Antonio	$7,743.57	$92,794.25
Austin	$7,492.05	$96,623.41
Brownwood	$7,493.38	$105,010.24
Bryan	$7,575.66	$122,711.18
Waco	$7,505.42	$87,735.95
Beaumont	$7,560.00	$120,663.96
Corpus	$7,781.27	$105,244.79
Houston	$7,998.21	$91,773.46
Lufkin	$7,693.18	$139,552.82
Yokum	$7,897.23	$126,379.29

As evidenced by Table 4-4, it is substantially cheaper to convert a surfaced road to an un-surfaced road than vice versa. The costs associated with conversion are detailed in the Methodology above.

The conversion process itself is a loss for the agency. The cost of both conversion processes costs money. The only way to save money is in maintenance of the converted roads. However, the difference is so minor that it literally takes decades to break-even. Comparing three scenarios using Texas as the example is the best way to examine the actual implications of conversion and the risks and considerations involved. To address question 3.b, the entire picture was put together. This is illustrated in the following scenario.

Hypothetical Conversion/Maintenance Scenario

The Situation: One surfaced lane mile in Texas, at ADT 100 (below the break even ADT 150), is under consideration for conversion to un-surfaced roadway. All maintenance costs used are based on the HDM-III simulations.

Scenario 1**:** The roadway is converted. The cost to convert from surfaced to un-surfaced is $7,649. The annual cost to maintain one mile of un-surfaced roadway is $6,116. The annual cost to maintain one mile of surfaced roadway is $6,276, which is a savings of $161 per year per mile in maintenance with un-surfaced. When the cost to convert is divided by the savings per year resulting from the conversion, it would take 48 years for the conversion to pay for itself.

Scenario 2: The roadway is converted, then needs reconversion at some point. The initial cost to convert one mile from surfaced to un-surfaced is $7,649. The cost to reconvert one mile from un-surfaced to surfaced is $106,771. Together, that is a total conversion cost of $114,420. Just like in Scenario 1, the difference of the two annual maintenance costs per mile is $161. To break-even on the un-surfacing then reconversion of one lane mile in Texas, that reconversion would have to take place at least 711 years after the initial conversion to un-surfaced. In other words, it takes 711 years of saving $161 per year to pay for the reconversion from un-surfaced to surfaced.

Scenario 3: The roadway is left as is. No conversion takes place, and the cost to maintain one mile of surfaced roadway is $6,276 per year. The savings in this scenario is in the money not spent on conversion, especially reconversion (a total of $114,420 per mile).

The scenarios above illustrate the need to examine the long-term situation of the road and area under consideration, and draw attention to the importance of the consideration of the high conversion rates. It also demonstrates how growth, or a rise in ADT, can have a dramatic impact on the ultimate savings goals of un-surfacing a roadway. Based on this information, it is possible to say that conversion from one surface type to the other may be economical, depending on material costs and expected ADT trends.

CHAPTER 5

CONCLUSIONS

Summary and Discussion of Major Findings

The point at which it is the same cost to maintain both an un-surfaced and a surfaced road is referred to as the break-even point. For the state of Texas as a whole, when all districts are averaged together, the ADT break-even point is around 150 ADT. Beyond 150 ADT, it is more cost effective to maintain a surfaced road than an un-surfaced road. However this number can be deceptive, as it varies greatly by district, and each district needs to be looked at on an individual basis for decision-making purposes.

The concept of conversion for agency cost savings could work, but a detailed analysis would need to be done of the road under consideration. It would need to take into account material properties and costs, labor and equipment costs, and projected area growth. The ADT break-even point for maintenance costs is driven mostly by material costs. In order to fully understand how much of an impact the materials cost has on each district, individual analyses of each district would need to be done that take into account the normal engineered specification for un-surfaced roads, including the correct quantities of the preferred materials for each separate district, as addressed below.

Limitations

As mentioned previously, only one material chosen for each cost in both maintenance in conversion. It is recognized that each district likely has its own preferred materials based on environmental factors, available materials, etc. For this study, access to district engineers was restricted. It was therefore impossible to determine these materials for this paper.

The second limitation had to do with the maintenance as input into the HDM-III program. Due to the lack of knowledge of preferred materials for each individual district, scheduled maintenance had to be used instead of responsive. If access to that information was available, the HDM-III program could have been utilized to evaluate maintenance activities based on the International Roughness Index (IRI). If the correct aggregates had been used for each district, the maintenance could have been calculated based on when that IRI number dropped below the minimum allowable threshold as defined by the Department of Transportation.

Additionally, because IRI was not utilized as the maintenance determinant, Plasticity Index and climate did not have an impact. However, this was rationalized because this project dealt only with already existing roads, and it is assumed that the subgrade of the existing roadway mitigated the effects of these factors. Additionally, there would have been no way to gather the data on the subgrade materials or construction without doing destructive sampling.

Lastly, additives such as lime, cement, dust control, etc. were not included due to high cost and lack of knowledge of usage practices across the state. When discussing these costs with TxDOT, they suggested it be left out completely, as it was not what would be considered a consistent cost. If these products are used, then they need to be factored in to the analysis by the engineer performing it, as they will have an impact on conversion costs, if not maintenance costs as well.

Future Studies

Future studies should utilize an analysis of the materials with the optimum physical and cost characteristics for a specific roadway. This would present a more accurate depiction of costs per district. Additionally, if this is done, then future studies should also utilize the IRI parameter for maintenance in the HDM-III program. This will provide more accurate maintenance costs for the ADT levels being evaluated.

ADT Analysis

Descriptions						Simulation Analysis					Eligible for Conversion		Totals		
District Info			Climate Info		Geography	Unpaved - Paved					Break-Even	at BE ADT	0-500 ADT	LVR % Eligible	0-100 ADT
District Order	Location	Location Description	Climate Zone	Climate Type	Geographic Region	UNPVD 100 - PVD	UNPVD 200 - PVD	UNPVD 300 - PVD	UNPVD 400 - PVD	UNPVD 500 - PVD	ADT	Miles	Miles	%	Miles
Z6	Zone 6 Texas	State Average	0.0	All	State (Whole)	($160.93)	$160.93	$643.74	$1,126.54	$1,448.41	150	13,109.40	26,147.50	50%	6,661.40
Z1	Zone 1	CZ Regional Average	0.1	Dry - Cold	North	$160.93	$643.74	$965.61	$1,448.41	$1,770.28	< 0	3,806.90	10,063.80	38%	3,244.30
Z2	Zone 2	CZ Regional Average	0.2	Wet - Cold	North East	($1,931.21)	($1,609.34)	($1,126.54)	($643.74)	($321.87)	500+	2,888.20	3,056.10	95%	324.90
Z3	Zone 3	CZ Regional Average	0.3	Dry - Warm	South West	($1,126.54)	($643.74)	($321.87)	$160.93	$643.74	367	4,401.20	5,918.40	74%	1,808.30
Z4	Zone 4	CZ Regional Average	0.4	Mixed	Central	$0.00	$482.80	$804.67	$1,287.48	$1,609.34	100	1,917.50	3,617.80	53%	684.20
Z5	Zone 5	CZ Regional Average	0.5	Wet Warm	Coastal	$2,253.08	$2,574.95	$3,057.75	$3,540.56	$3,862.43	< 0	95.60	3,491.40	3%	599.70
8	Abilene	District	1.0	Dry - Cold	North	($1,609.34)	($1,287.48)	($804.67)	($482.80)	$0.00	500	2,103.20	2,103.20	100%	706.40
4	Amarillo	District	1.0	Dry - Cold	North	($1,126.54)	($643.74)	($321.87)	$160.93	$482.80	367	1,703.70	2,090.70	81%	688.10
25	Childress	District	1.0	Dry - Cold	North	$965.61	$1,287.48	$1,770.28	$2,253.08	$2,574.95	< 0	-	1,723.10	0%	761.70
5	Lubbock	District	1.0	Dry - Cold	North	$1,287.48	$1,770.28	$2,253.08	$2,574.95	$3,057.75	< 0	-	2,788.70	0%	698.40
3	W. Falls	District	1.0	Dry - Cold	North	$1,287.48	$1,609.34	$2,092.15	$2,574.95	$2,896.82	< 0	-	1,358.10	0%	389.70
19	Atlanta	District	2.0	Wet - Cold	North East	($3,701.49)	($3,379.62)	($2,896.82)	($2,574.95)	($2,092.15)	500 +	458.20	458.20	100%	45.20
18	Dallas	District	2.0	Wet - Cold	North East	($1,609.34)	($1,287.48)	($804.67)	($482.80)	$0.00	500	466.10	466.10	100%	90.30
2	FT Worth	District	2.0	Wet - Cold	North East	($965.61)	($482.80)	($160.93)	$321.87	$804.67	333	305.90	473.80	65%	55.90
1	Paris	District	2.0	Wet - Cold	North East	($1,770.28)	($1,287.48)	($965.61)	($482.80)	$0.00	500	1,050.40	1,050.40	100%	98.70
10	Tyler	District	2.0	Wet - Cold	North East	($1,609.34)	($1,287.48)	($804.67)	($321.87)	$0.00	500	607.60	607.60	100%	34.80
24	El Paso	District	3.0	Dry - Warm	South West	($160.93)	$160.93	$643.74	$965.61	$1,448.41	150	608.00	816.20	74%	430.90
22	Laredo	District	3.0	Dry - Warm	South West	($1,287.48)	($804.67)	($482.80)	$0.00	$321.87	400	858.10	1,000.80	86%	329.00
6	Odessa	District	3.0	Dry - Warm	South West	($643.74)	($321.87)	$160.93	$482.80	$965.61	267	877.00	1,235.10	71%	436.70
21	Pharr	District	3.0	Dry - Warm	South West	($2,574.95)	($2,092.15)	($1,770.28)	($1,287.48)	($965.61)	500 +	279.70	279.70	100%	32.90
7	San Angelo	District	3.0	Dry - Warm	South West	($643.74)	($321.87)	$160.93	$482.80	$965.61	267	977.20	1,605.20	61%	423.00
15	San Antonio	District	3.0	Dry - Warm	South West	($1,287.48)	($965.61)	($482.80)	$0.00	$321.87	400	801.20	981.40	82%	155.80
14	Austin	District	4.0	Mixed	Central	($1,448.41)	($965.61)	($643.74)	($160.93)	$160.93	450	475.00	536.50	89%	110.30
23	Brownwood	District	4.0	Mixed	Central	($1,609.34)	($1,126.54)	($804.67)	($321.87)	$0.00	500	1,397.50	1,397.50	100%	355.90
17	Bryan	District	4.0	Mixed	Central	$2,735.88	$3,218.69	$3,701.49	$4,023.36	$4,506.16	< 0	-	682.60	0%	84.40
9	Waco	District	4.0	Mixed	Central	$160.93	$482.80	$965.61	$1,287.48	$1,770.28	67	45.00	1,001.20	4%	133.60
20	Beaumont	District	5.0	Wet Warm	Coastal	$965.61	$1,287.48	$1,770.28	$2,092.15	$2,574.95	< 0	-	375.30	0%	43.40
16	Corpus	District	5.0	Wet Warm	Coastal	$321.87	$804.67	$1,287.48	$1,609.34	$2,092.15	0	-	1,070.30	0%	246.60
12	Houston	District	5.0	Wet Warm	Coastal	($643.74)	($160.93)	$321.87	$643.74	$1,126.54	233	95.60	163.80	58%	74.30
11	Lufkin	District	5.0	Wet Warm	Coastal	$4,988.97	$5,471.77	$5,954.57	$6,276.44	$6,759.24	< 0	-	804.20	0%	75.30
13	Yokum	District	5.0	Wet Warm	Coastal	$5,632.70	$6,115.51	$6,437.38	$6,920.18	$7,402.98	< 0	-	1,077.80	0%	160.10

TOTAL MILEAGE				TOTAL MILEAGE						ACTUAL ELEIGABLE MILEAGE						Simulation Results			
101-200 ADT	201-300 ADT	301-400 ADT	401-500 ADT	0-100 ADT	101-200 ADT	201-300 ADT	301-400 ADT	401-500 ADT		0-100 ADT	101-200 ADT	201-300 ADT	301-400 ADT	401-500 ADT	Total	Unpaved			
Miles	Miles	Miles	Miles	% of Total ADT	% of Total ADT	% of Total ADT	% of Total ADT	% of Total ADT		Miles	Miles	Miles	Miles	Miles	Miles	ADT @ 100	ADT @ 200	ADT @ 300	ADT @ 400
6,712.10	**5,189.20**	**4,107.90**	**3,476.90**	**25%**	**26%**	**20%**	**16%**	**13%**	**100%**	**4,113.20**	**3,750.60**	**2,632.70**	**1,639.30**	**973.60**	**13,109.40**	**$ 6,115.51**	**$ 6,437.38**	**$ 6,920.18**	**$ 7,402.98**
2,887.10	1,838.60	1,182.10	911.70	32%	29%	18%	12%	9%	**100%**	1,394.50	1,154.20	726.60	377.50	154.10	**3,806.90**	$ 6,598.31	$ 7,081.11	$ 7,402.98	$ 7,885.79
545.20	760.70	681.80	743.50	11%	18%	25%	22%	24%	**100%**	324.90	545.20	760.70	626.60	630.80	**2,888.20**	$ 4,184.29	$ 4,506.16	$ 4,988.97	$ 5,471.77
1,482.00	996.40	899.30	732.40	31%	25%	17%	15%	12%	**100%**	1,808.30	1,419.60	759.80	345.90	67.60	**4,401.20**	$ 4,988.97	$ 5,471.77	$ 5,793.64	$ 6,276.44
1,002.60	752.50	703.60	474.90	19%	28%	21%	19%	13%	**100%**	511.20	618.50	377.40	289.30	121.10	**1,917.50**	$ 5,954.57	$ 6,437.38	$ 6,759.24	$ 7,242.05
795.20	841.00	641.10	614.40	17%	23%	24%	18%	18%	**100%**	74.30	13.10	8.20	-	-	**95.60**	$ 8,529.52	$ 8,851.39	$ 9,334.20	$ 9,817.00
624.50	403.20	215.00	154.10	34%	30%	19%	10%	7%	**100%**	706.40	624.50	403.20	215.00	154.10	**2,103.20**	$ 5,471.77	$ 5,793.64	$ 6,276.44	$ 6,598.31
529.70	323.40	276.00	273.50	33%	25%	15%	13%	13%	**100%**	688.10	529.70	323.40	162.50		**1,703.70**	$ 4,828.03	$ 5,310.84	$ 5,632.70	$ 6,115.51
469.30	240.70	160.50	90.90	44%	27%	14%	9%	5%	**100%**	-	-	-	-	-	-	$ 6,598.31	$ 6,920.18	$ 7,402.98	$ 7,885.79
843.00	633.30	374.20	239.80	25%	30%	23%	13%	9%	**100%**	-	-	-	-	-	-	$ 8,690.46	$ 9,173.26	$ 9,656.06	$ 9,977.93
420.60	238.00	156.40	153.40	29%	31%	18%	12%	11%	**100%**	-	-	-	-	-	-	$ 7,563.92	$ 7,885.79	$ 8,368.59	$ 8,851.39
53.50	134.60	97.60	127.30	10%	12%	29%	21%	28%	**100%**	45.20	53.50	134.60	97.60	127.30	**458.20**	$ 2,574.95	$ 2,896.82	$ 3,379.62	$ 3,701.49
86.60	110.20	81.60	97.40	19%	19%	24%	18%	21%	**100%**	90.30	86.60	110.20	81.60	97.40	**466.10**	$ 4,828.03	$ 5,149.90	$ 5,632.70	$ 5,954.57
87.00	109.60	108.60	112.70	12%	18%	23%	23%	24%	**100%**	55.90	87.00	109.60	53.40		**305.90**	$ 4,506.16	$ 4,988.97	$ 5,310.84	$ 5,793.64
239.50	272.20	224.20	215.80	9%	23%	26%	21%	21%	**100%**	98.70	239.50	272.20	224.20	215.80	**1,050.40**	$ 4,667.10	$ 5,149.90	$ 5,471.77	$ 5,954.57
78.60	134.10	169.80	190.30	6%	13%	22%	28%	31%	**100%**	34.80	78.60	134.10	169.80	190.30	**607.60**	$ 4,184.29	$ 4,506.16	$ 4,988.97	$ 5,471.77
239.50	52.00	60.10	33.70	53%	29%	6%	7%	4%	**100%**	430.90	177.10	-	-	-	**608.00**	$ 7,724.85	$ 8,046.72	$ 8,529.52	$ 8,851.39
248.00	178.90	102.20	142.70	33%	25%	18%	10%	14%	**100%**	329.00	248.00	178.90	102.20	-	**858.10**	$ 4,184.29	$ 4,667.10	$ 4,988.97	$ 5,471.77
347.90	166.00	144.80	139.70	35%	28%	13%	12%	11%	**100%**	436.70	347.90	92.40	-	-	**877.00**	$ 5,310.84	$ 5,632.70	$ 6,115.51	$ 6,437.38
48.70	66.30	64.20	67.60	12%	17%	24%	23%	24%	**100%**	32.90	48.70	66.30	64.20	67.60	**279.70**	$ 3,218.69	$ 3,701.49	$ 4,023.36	$ 4,506.16
359.70	305.50	348.50	168.50	26%	22%	19%	22%	10%	**100%**	423.00	359.70	194.50	-	-	**977.20**	$ 5,149.90	$ 5,471.77	$ 5,954.57	$ 6,276.44
238.20	227.70	179.50	180.20	16%	24%	23%	18%	18%	**100%**	155.80	238.20	227.70	179.50	-	**801.20**	$ 4,828.03	$ 5,149.90	$ 5,632.70	$ 6,115.51
134.80	92.20	104.20	95.00	21%	25%	17%	19%	18%	**100%**	110.30	134.80	92.20	104.20	33.50	**475.00**	$ 4,667.10	$ 5,149.90	$ 5,471.77	$ 5,954.57
483.70	285.20	185.10	87.60	25%	35%	20%	13%	6%	**100%**	355.90	483.70	285.20	185.10	87.60	**1,397.50**	$ 4,828.03	$ 5,310.84	$ 5,632.70	$ 6,115.51
124.50	130.10	162.00	181.60	12%	18%	19%	24%	27%	**100%**	-	-	-	-	-	-	$ 9,012.33	$ 9,495.13	$ 9,977.93	$ 10,299.80
259.60	245.00	252.30	110.70	13%	26%	24%	25%	11%	**100%**	45.00	-	-	-	-	**45.00**	$ 5,310.84	$ 5,632.70	$ 6,115.51	$ 6,437.38
55.10	72.80	87.30	116.70	12%	15%	19%	23%	31%	**100%**	-	-	-	-	-	-	$ 7,563.92	$ 7,885.79	$ 8,368.59	$ 8,690.46
279.00	262.50	161.40	120.80	23%	26%	25%	15%	11%	**100%**	-	-	-	-	-	-	$ 6,598.31	$ 7,081.11	$ 7,563.92	$ 7,885.79
13.10	25.50	18.50	32.40	45%	8%	16%	11%	20%	**100%**	74.30	13.10	8.20	-	-	**95.60**	$ 5,471.77	$ 5,954.57	$ 6,437.38	$ 6,759.24
212.80	177.30	206.80	132.00	9%	26%	22%	26%	16%	**100%**	-	-	-	-	-	-	$ 11,426.34	$ 11,909.15	$ 12,391.95	$ 12,713.82
235.20	302.90	167.10	212.50	15%	22%	28%	16%	20%	**100%**	-	-	-	-	-	-	$ 11,265.41	$ 11,748.21	$ 12,070.08	$ 12,552.88

		Maintenance								Convert Surfaced to UnSurfaced		Convert UnSu
	Paved	Unpaved						Paved	US-S	Cost to Convert 1 Mile		Cost to Convert 1 Mile
ADT @ 500	PVD	ADT @ 100	ADT @ 200	ADT @ 300	ADT @ 400	ADT @ 500	Total Annual Maintenance Cost	Total Annual Maintenance Cost	Total Annual Maintenance Cost Difference	$/Mile	Total Conversion Cost	$/Mile
$ 7,724.85	**$ 6,276**	**$ 25,154,304**	**$ 24,144,022**	**$ 18,218,756**	**$ 12,135,709**	**$ 7,520,915**	**$ 87,173,707**	**$ 82,280,384**	**$ 4,893,323**	**$ 7,649.35**	**$ 100,278,351.11**	**$ 106,770.64**
$ 8,207.65	$ 6,437	$ 9,201,344	$ 8,173,021	$ 5,379,007	$ 2,976,884	$ 1,264,800	**$ 26,995,056**	$ 24,506,447	$2,488,609	$ 7,586.97	$ 28,882,851.87	$ 116,175.32
$ 5,793.64	$ 6,116	$ 1,359,477	$ 2,456,760	$ 3,795,107	$ 3,428,611	$ 3,654,627	**$ 14,694,582**	$ 17,662,808	($2,968,226)	$ 7,714.28	$ 22,280,384.99	$ 98,324.71
$ 6,759.24	$ 6,116	$ 9,021,548	$ 7,767,724	$ 4,402,006	$ 2,171,021	$ 456,925	**$ 23,819,225**	$ 26,915,570	($3,096,346)	$ 7,621.84	$ 33,545,222.41	$ 98,701.59
$ 7,563.92	$ 5,955	$ 3,043,978	$ 3,981,517	$ 2,550,939	$ 2,095,124	$ 915,990	**$ 12,587,548**	$ 11,417,893	$1,169,655	$ 7,516.63	$ 14,413,132.60	$ 103,020.19
$ 10,138.87	$ 6,276	$ 633,744	$ 115,953	$ 76,540	$ -	$ -	**$ 826,237**	$ 600,028	$226,209	$ 7,785.98	$ 744,339.36	$ 116,722.87
$ 7,081.11	$ 7,081	$ 3,865,258	$ 3,618,127	$ 2,530,661	$ 1,418,637	$ 1,091,200	**$ 12,523,883**	$ 14,892,998	($2,369,115)	$ 7,498.20	$ 15,770,208.48	$ 121,254.34
$ 6,437.38	$ 5,955	$ 3,322,169	$ 2,813,149	$ 1,821,616	$ 993,770	$ -	**$ 8,950,705**	$ 10,144,806	($1,194,101)	$ 7,531.92	$ 12,832,132.89	$ 99,937.68
$ 8,207.65	$ 5,633	$ -	$ -	$ -	$ -	$ -	**$ -**	$ -	$0	$ 7,503.01	$ -	$ 105,639.74
$ 10,460.74	$ 7,403	$ -	$ -	$ -	$ -	$ -	**$ -**	$ -	$0	$ 7,901.13	$ -	$ 137,379.69
$ 9,173.26	$ 6,276	$ -	$ -	$ -	$ -	$ -	**$ -**	$ -	$0	$ 7,500.61	$ -	$ 116,665.18
$ 4,184.29	$ 6,276	$ 116,388	$ 154,980	$ 454,897	$ 361,266	$ 532,661	**$ 1,620,191**	$ 2,875,866	($1,255,675)	$ 7,678.72	$ 3,518,391.47	$ 91,204.72
$ 6,437.38	$ 6,437	$ 435,971	$ 445,981	$ 620,724	$ 485,893	$ 627,000	**$ 2,615,570**	$ 3,000,461	($384,891)	$ 7,863.06	$ 3,664,971.91	$ 101,847.29
$ 6,276.44	$ 5,472	$ 251,895	$ 434,040	$ 582,068	$ 309,380	$ -	**$ 1,577,382**	$ 1,673,814	($96,432)	$ 7,574.89	$ 2,317,158.03	$ 95,302.98
$ 6,437.38	$ 6,437	$ 460,643	$ 1,233,401	$ 1,489,416	$ 1,335,015	$ 1,389,186	**$ 5,907,660**	$ 6,761,820	($854,159)	$ 7,766.37	$ 8,157,797.40	$ 107,749.11
$ 5,793.64	$ 5,794	$ 145,613	$ 354,184	$ 669,020	$ 929,106	$ 1,102,529	**$ 3,200,454**	$ 3,520,215	($319,761)	$ 7,688.36	$ 4,671,447.23	$ 95,519.45
$ 9,334.20	$ 7,886	$ 3,328,638	$ 1,425,074	$ -	$ -	$ -	**$ 4,753,712**	$ 4,794,558	($40,845)	$ 7,490.97	$ 4,554,510.28	$ 126,179.32
$ 5,793.64	$ 5,472	$ 1,376,633	$ 1,157,440	$ 892,526	$ 559,215	$ -	**$ 3,985,814**	$ 4,695,325	($709,511)	$ 7,486.03	$ 6,423,760.32	$ 87,536.43
$ 6,920.18	$ 5,955	$ 2,319,242	$ 1,959,618	$ 565,073	$ -	$ -	**$ 4,843,932**	$ 5,222,160	($378,228)	$ 7,706.89	$ 6,758,943.47	$ 97,769.57
$ 4,828.03	$ 5,794	$ 105,895	$ 180,263	$ 266,749	$ 289,296	$ 326,375	**$ 1,168,577**	$ 1,620,481	($451,904)	$ 7,778.86	$ 2,175,747.02	$ 87,201.49
$ 6,759.24	$ 5,794	$ 2,178,408	$ 1,968,196	$ 1,158,164	$ -	$ -	**$ 5,304,768**	$ 5,661,543	($356,775)	$ 7,524.69	$ 7,353,131.04	$ 100,728.50
$ 6,437.38	$ 6,116	$ 752,207	$ 1,226,706	$ 1,282,567	$ 1,097,734	$ -	**$ 4,359,214**	$ 4,899,744	($540,530)	$ 7,743.57	$ 6,204,148.12	$ 92,794.25
$ 6,276.44	$ 6,116	$ 514,781	$ 694,207	$ 504,497	$ 620,466	$ 210,261	**$ 2,544,212**	$ 2,904,866	($360,654)	$ 7,492.05	$ 3,558,723.58	$ 96,623.41
$ 6,437.38	$ 6,437	$ 1,718,297	$ 2,568,851	$ 1,606,447	$ 1,131,980	$ 563,914	**$ 7,589,489**	$ 8,996,233	($1,406,744)	$ 7,493.38	$ 10,471,998.07	$ 105,010.24
$ 10,782.60	$ 6,276	$ -	$ -	$ -	$ -	$ -	**$ -**	$ -	$0	$ 7,575.66	$ -	$ 122,711.18
$ 6,920.18	$ 5,150	$ 238,988	$ -	$ -	$ -	$ -	**$ 238,988**	$ 231,746	$7,242	$ 7,505.42	$ 337,744.06	$ 87,735.95
$ 9,173.26	$ 6,598	$ -	$ -	$ -	$ -	$ -	**$ -**	$ -	$0	$ 7,560.00	$ -	$ 120,663.96
$ 8,368.59	$ 6,276	$ -	$ -	$ -	$ -	$ -	**$ -**	$ -	$0	$ 7,781.27	$ -	$ 105,244.79
$ 7,242.05	$ 6,116	$ 406,552	$ 78,005	$ 52,786	$ -	$ -	**$ 537,344**	$ 584,642	($47,299)	$ 7,998.21	$ 764,628.71	$ 91,773.46
$ 13,196.62	$ 6,437	$ -	$ -	$ -	$ -	$ -	**$ -**	$ -	$0	$ 7,693.18	$ -	$ 139,552.82
$ 13,035.69	$ 5,633	$ -	$ -	$ -	$ -	$ -	**$ -**	$ -	$0	$ 7,897.23	$ -	$ 126,379.29

rfaced to Surfaced		Maintain Un-Surfaced		Maintain Surfaced			
		Routine Blading	Gravel Resurfacing	Level Up	Seal Coat Oil	Grade 4 Rock	Striping
Total Conversion Cost	CUS2S X CS2US	% of Total ($ / Mile / YEAR)	% of Total ($ / Mile / YEAR)	% of Total ($ / Mile / YEAR)	% of Total ($ / Mile / YEAR)	% of Total ($ / Mile / YEAR)	% of Total ($ / Mile / YEAR)
$ 1,399,698,974.87	**13.96**	**13%**	**87%**	**32%**	**36%**	**21%**	**11%**
$ 442,267,844.74	15.31	12%	88%	30%	37%	22%	11%
$ 283,981,431.53	12.75	18%	82%	32%	37%	19%	12%
$ 434,405,455.47	12.95	15%	85%	32%	35%	22%	11%
$ 197,541,222.05	13.71	13%	87%	33%	37%	19%	12%
$ 11,158,705.94	14.99	9%	91%	32%	36%	21%	11%
$ 255,022,130.83	16.17	14%	86%	28%	45%	17%	10%
$ 170,263,822.65	13.27	16%	84%	33%	35%	21%	12%
$ -	14.08	12%	88%	35%	34%	19%	12%
$ -	17.39	9%	91%	27%	34%	30%	10%
$ -	15.55	10%	90%	31%	36%	21%	11%
$ 41,790,003.24	11.88	28%	72%	32%	41%	16%	11%
$ 47,471,022.56	12.95	16%	84%	31%	40%	18%	11%
$ 29,153,183.00	12.58	16%	84%	36%	34%	18%	13%
$ 113,179,662.47	13.87	16%	84%	30%	37%	22%	11%
$ 58,037,619.26	12.42	18%	82%	34%	33%	21%	12%
$ 76,717,023.65	16.84	10%	90%	25%	37%	30%	9%
$ 75,115,010.92	11.69	17%	83%	36%	28%	24%	13%
$ 85,743,912.40	12.69	15%	85%	33%	37%	18%	12%
$ 24,390,257.94	11.21	23%	77%	34%	36%	18%	12%
$ 98,431,891.26	13.39	15%	85%	34%	34%	19%	12%
$ 74,346,755.93	11.98	16%	84%	32%	37%	19%	12%
$ 45,896,119.04	12.90	16%	84%	32%	38%	18%	11%
$ 146,751,807.63	14.01	15%	85%	31%	37%	21%	11%
$ -	16.20	9%	91%	32%	34%	23%	11%
$ 3,948,117.54	11.69	14%	86%	38%	37%	12%	14%
$ -	15.96	10%	90%	30%	35%	25%	11%
$ -	13.53	12%	88%	32%	34%	23%	11%
$ 8,773,543.24	11.47	14%	86%	33%	36%	20%	12%
$ -	18.14	7%	93%	31%	39%	19%	11%
$ -	16.00	7%	93%	35%	37%	16%	12%

Maintain Surfaced

Descriptions: District Info – District Order	Location	Location Description	Climate Info – Climate Zone	Climate Type	Geography – Geographic Region	Dimensions: Width – YD	Length – YD / Mile	Area – SY / MILE	Level Up Before Paving: Amout of LU – % of LU / Mile	SY of LU / MILE	Cost of LU – $ / SY	$ / Mile	LU Schedule – Years / LU	Annual Cost of LU – $ / Mile / YEAR	Seal Coat Oil: Application Rate – GAL / SY	GAL / MILE	Cost of Seal Coat – $ / GAL	$ / Mile	SC Schedule – Years / SC	Annual Cost of SC – $ / Mile / YEAR
Z6	**Zone 6 Texas**	**State Average**	**0.0**	**All**	**State (Whole)**	**8**	**1760**	**14080**	**20%**	**2816**	**$ 4.90**	**$ 13,798.40**	**7**	**$ 1,971.20**	**0.35**	**4928**	**$ 3.19**	**$ 15,714.41**	**7**	**$ 2,244.92**
Z1	Zone 1	CZ Regional Average	0.1	Dry - Cold	North	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.42	$ 16,843.90	7	$ 2,406.27
Z2	Zone 2	CZ Regional Average	0.2	Wet - Cold	North East	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.21	$ 15,799.17	7	$ 2,257.02
Z3	Zone 3	CZ Regional Average	0.3	Dry - Warm	South West	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.05	$ 15,013.97	7	$ 2,144.85
Z4	Zone 4	CZ Regional Average	0.4	Mixed	Central	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.12	$ 15,375.36	7	$ 2,196.48
Z5	Zone 5	CZ Regional Average	0.5	Wet Warm	Coastal	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.17	$ 15,611.90	7	$ 2,230.27
8	Abilene	District	1.0	Dry - Cold	North	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 4.57	$ 22,520.96	7	$ 3,217.28
4	Amarillo	District	1.0	Dry - Cold	North	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 2.94	$ 14,488.32	7	$ 2,069.76
25	Childress	District	1.0	Dry - Cold	North	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 2.76	$ 13,601.28	7	$ 1,943.04
5	Lubbock	District	1.0	Dry - Cold	North	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.57	$ 17,592.96	7	$ 2,513.28
3	W. Falls	District	1.0	Dry - Cold	North	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.25	$ 16,016.00	7	$ 2,288.00
19	Atlanta	District	2.0	Wet - Cold	North East	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.60	$ 17,740.80	7	$ 2,534.40
18	Dallas	District	2.0	Wet - Cold	North East	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.65	$ 17,987.20	7	$ 2,569.60
2	FT Worth	District	2.0	Wet - Cold	North East	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 2.66	$ 13,108.48	7	$ 1,872.64
1	Paris	District	2.0	Wet - Cold	North East	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.43	$ 16,903.04	7	$ 2,414.72
10	Tyler	District	2.0	Wet - Cold	North East	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 2.69	$ 13,256.32	7	$ 1,893.76
24	El Paso	District	3.0	Dry - Warm	South West	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 4.11	$ 20,254.08	7	$ 2,893.44
22	Laredo	District	3.0	Dry - Warm	South West	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 2.20	$ 10,841.60	7	$ 1,548.80
6	Odessa	District	3.0	Dry - Warm	South West	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.12	$ 15,375.36	7	$ 2,196.48
21	Pharr	District	3.0	Dry - Warm	South West	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 2.90	$ 14,291.20	7	$ 2,041.60
7	San Angelo	District	3.0	Dry - Warm	South West	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 2.77	$ 13,650.56	7	$ 1,950.08
15	San Antonio	District	3.0	Dry - Warm	South West	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.18	$ 15,671.04	7	$ 2,238.72
14	Austin	District	4.0	Mixed	Central	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.35	$ 16,508.80	7	$ 2,358.40
23	Brownwood	District	4.0	Mixed	Central	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.40	$ 16,755.20	7	$ 2,393.60
17	Bryan	District	4.0	Mixed	Central	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.03	$ 14,931.84	7	$ 2,133.12
9	Waco	District	4.0	Mixed	Central	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 2.70	$ 13,305.60	7	$ 1,900.80
20	Beaumont	District	5.0	Wet Warm	Coastal	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.25	$ 16,016.00	7	$ 2,288.00
16	Corpus	District	5.0	Wet Warm	Coastal	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.02	$ 14,882.56	7	$ 2,126.08
12	Houston	District	5.0	Wet Warm	Coastal	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.10	$ 15,276.80	7	$ 2,182.40
11	Lufkin	District	5.0	Wet Warm	Coastal	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 3.50	$ 17,248.00	7	$ 2,464.00
13	Yokum	District	5.0	Wet Warm	Coastal	8	1760	14080	20%	2816	$ 4.90	$ 13,798.40	7	$ 1,971.20	0.35	4928	$ 2.97	$ 14,636.16	7	$ 2,090.88

Grade 4 Rock					Striping							Totals & Conversions					
Rate: 110 SY / CY	Grade 4 rock	Cost of Rock	Rock Schedule	Annual Cost of Rock								Total of Subtotals		Conversion Rate	Total Converted	Conversion Rate	HDM3 Input Values
CY / Mile	$ / CY	$ / Mile	Years / Rock Teat.	$ / Mile / YEAR	LF / Mile	# of Stripes	LF Striping / Mile	$ / LF	$ / Mile	Years / Maint	$ / Mile / YEAR	$ / Mile / YEAR	$/SY/Year	M2 / SY	$ / M2 / YEAR	Km / Mile	$ / Km / YEAR
128	**$ 70.07**	**$ 8,969.23**	**7**	**$ 1,281.32**	**5280**	**2**	**10560**	**$ 0.40**	**$ 4,224.00**	**6**	**$ 704.00**	**$ 6,201.43**	**$ 0.44**	**0.83612736**	**$ 0.53**	**1.609344**	**$ 3,853.39**
128	$ 77.59	$ 9,931.01	7	$ 1,418.72	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,500.19	$ 0.46	0.83612736	$ 0.55	1.609344	**$ 4,039.03**
128	$ 63.34	$ 8,107.20	7	$ 1,158.17	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,090.40	$ 0.43	0.83612736	$ 0.52	1.609344	**$ 3,784.40**
128	$ 73.36	$ 9,390.29	7	$ 1,341.47	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,161.52	$ 0.44	0.83612736	$ 0.52	1.609344	**$ 3,828.59**
128	$ 61.37	$ 7,855.36	7	$ 1,122.19	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 5,993.87	$ 0.43	0.83612736	$ 0.51	1.609344	**$ 3,724.42**
128	$ 70.96	$ 9,082.88	7	$ 1,297.55	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,203.03	$ 0.44	0.83612736	$ 0.53	1.609344	**$ 3,854.38**
128	$ 67.48	$ 8,637.44	7	$ 1,233.92	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 7,126.40	$ 0.51	0.83612736	$ 0.61	1.609344	**$ 4,428.14**
128	$ 68.00	$ 8,704.00	7	$ 1,243.43	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 5,988.39	$ 0.43	0.83612736	$ 0.51	1.609344	**$ 3,721.01**
128	$ 59.65	$ 7,635.20	7	$ 1,090.74	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 5,708.98	$ 0.41	0.83612736	$ 0.48	1.609344	**$ 3,547.40**
128	$ 118.80	$ 15,206.40	7	$ 2,172.34	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 7,360.82	$ 0.52	0.83612736	$ 0.63	1.609344	**$ 4,573.80**
128	$ 74.00	$ 9,472.00	7	$ 1,353.14	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,316.34	$ 0.45	0.83612736	$ 0.54	1.609344	**$ 3,924.79**
128	$ 55.00	$ 7,040.00	7	$ 1,005.71	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,215.31	$ 0.44	0.83612736	$ 0.53	1.609344	**$ 3,862.02**
128	$ 63.34	$ 8,107.52	7	$ 1,158.22	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,403.02	$ 0.45	0.83612736	$ 0.54	1.609344	**$ 3,978.65**
128	$ 53.00	$ 6,784.00	7	$ 969.14	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 5,516.98	$ 0.39	0.83612736	$ 0.47	1.609344	**$ 3,428.09**
128	$ 77.00	$ 9,856.00	7	$ 1,408.00	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,497.92	$ 0.46	0.83612736	$ 0.55	1.609344	**$ 4,037.62**
128	$ 68.35	$ 8,748.80	7	$ 1,249.83	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 5,818.79	$ 0.41	0.83612736	$ 0.49	1.609344	**$ 3,615.63**
128	$ 128.50	$ 16,448.00	7	$ 2,349.71	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 7,918.35	$ 0.56	0.83612736	$ 0.67	1.609344	**$ 4,920.24**
128	$ 71.00	$ 9,088.00	7	$ 1,298.29	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 5,522.29	$ 0.39	0.83612736	$ 0.47	1.609344	**$ 3,431.39**
128	$ 59.77	$ 7,650.56	7	$ 1,092.94	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 5,964.62	$ 0.42	0.83612736	$ 0.51	1.609344	**$ 3,706.24**
128	$ 56.47	$ 7,228.16	7	$ 1,032.59	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 5,749.39	$ 0.41	0.83612736	$ 0.49	1.609344	**$ 3,572.51**
128	$ 60.76	$ 7,777.28	7	$ 1,111.04	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 5,736.32	$ 0.41	0.83612736	$ 0.49	1.609344	**$ 3,564.38**
128	$ 63.67	$ 8,149.76	7	$ 1,164.25	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,078.17	$ 0.43	0.83612736	$ 0.52	1.609344	**$ 3,776.80**
128	$ 60.00	$ 7,680.00	7	$ 1,097.14	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,130.74	$ 0.44	0.83612736	$ 0.52	1.609344	**$ 3,809.47**
128	$ 75.00	$ 9,600.00	7	$ 1,371.43	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,440.23	$ 0.46	0.83612736	$ 0.55	1.609344	**$ 4,001.77**
128	$ 77.88	$ 9,968.64	7	$ 1,424.09	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,232.41	$ 0.44	0.83612736	$ 0.53	1.609344	**$ 3,872.64**
128	$ 32.60	$ 4,172.80	7	$ 596.11	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 5,172.11	$ 0.37	0.83612736	$ 0.44	1.609344	**$ 3,213.80**
128	$ 90.90	$ 11,635.20	7	$ 1,662.17	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,625.37	$ 0.47	0.83612736	$ 0.56	1.609344	**$ 4,116.81**
128	$ 79.29	$ 10,149.12	7	$ 1,449.87	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,251.15	$ 0.44	0.83612736	$ 0.53	1.609344	**$ 3,884.29**
128	$ 66.00	$ 8,448.00	7	$ 1,206.86	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,064.46	$ 0.43	0.83612736	$ 0.52	1.609344	**$ 3,768.28**
128	$ 68.00	$ 8,704.00	7	$ 1,243.43	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 6,382.63	$ 0.45	0.83612736	$ 0.54	1.609344	**$ 3,965.98**
128	$ 50.61	$ 6,478.08	7	$ 925.44	5280	2	10560	$ 0.40	$ 4,224.00	6	$ 704.00	$ 5,691.52	$ 0.40	0.83612736	$ 0.48	1.609344	**$ 3,536.55**

Maintain Un-Surfaced

Descriptions – District Info – District Order	Descriptions – District Info – Location	Descriptions – Climate Info – Climate Zone	Descriptions – Climate Info – Climate Type	Descriptions – Geography – Geographic Region	RSMeans Multipliers – Equipment – Average Multiplier	RSMeans Multipliers – Labor – Average Multiplier	Routine Blading – Work Hours – Act. WH's / Mile (HOURS/Mile)	Routine Blading – Equipment Cost – RS Means w/o Mult ($/HOUR)	Routine Blading – Equipment Cost – RS Means Adjusted ($/HOUR)	Routine Blading – Labor Cost – RS Means w/o Mult ($/HOUR)	Routine Blading – Labor Cost – RS Means Adjusted ($/HOUR)	Routine Blading – Maintenance Cost – Cost to Blade 1 Mile ($/Mile)	Routine Blading – Maintenance Cost – Bladeing Schedule (# / Year)	Routine Blading – Maintenance Cost – Annual Blade Cost ($ / MILE / YEAR)	Gravel Resurfacin – Work Hours – Act. WH's / Mile (HOURS/Mile)	Gravel Resurfacin – Material Cost – Type D or A Flexbase ($/Mile)	Gravel Resurfacin – Equipment Cost – Equipment Cost ($/HOUR)	Gravel Resurfacin – Labor Cost – Labor Cost ($/HOUR)
Z6	Zone 6 Texas	0.0	All	State (Whole)	0.917	0.859	1	$ 83.99	$ 77.01	$ 70.25	$ 60.33	$ 137.34	6	$ 824.04	8	$ 27,267.29	$ 77.01	$ 60.33
Z1	Zone 1	0.1	Dry - Cold	North	0.906	0.858	1	$ 83.99	$ 76.06	$ 70.25	$ 60.25	$ 136.31	6	$ 817.85	8	$ 29,930.95	$ 76.06	$ 60.25
Z2	Zone 2	0.2	Wet - Cold	North East	0.930	0.858	1	$ 83.99	$ 78.08	$ 70.25	$ 60.28	$ 138.35	6	$ 830.12	8	$ 17,465.07	$ 78.08	$ 60.28
Z3	Zone 3	0.3	Dry - Warm	South West	0.910	0.862	1	$ 83.99	$ 76.45	$ 70.25	$ 60.55	$ 137.00	6	$ 822.01	8	$ 22,003.91	$ 76.45	$ 60.55
Z4	Zone 4	0.4	Mixed	Central	0.891	0.861	1	$ 83.99	$ 74.79	$ 70.25	$ 60.51	$ 135.30	6	$ 811.83	8	$ 26,748.09	$ 74.79	$ 60.51
Z5	Zone 5	0.5	Wet Warm	Coastal	0.945	0.855	1	$ 83.99	$ 79.35	$ 70.25	$ 60.04	$ 139.39	6	$ 836.34	8	$ 39,176.82	$ 79.35	$ 60.04
8	Abilene	1.0	Dry - Cold	North	0.889	0.857	1	$ 83.99	$ 74.67	$ 70.25	$ 60.20	$ 134.87	6	$ 809.23	8	$ 23,857.78	$ 74.67	$ 60.20
4	Amarillo	1.0	Dry - Cold	North	0.889	0.871	1	$ 83.99	$ 74.67	$ 70.25	$ 61.19	$ 135.85	6	$ 815.13	8	$ 20,963.56	$ 74.67	$ 61.19
25	Childress	1.0	Dry - Cold	North	0.889	0.859	1	$ 83.99	$ 74.67	$ 70.25	$ 60.34	$ 135.01	6	$ 810.07	8	$ 29,755.73	$ 74.67	$ 60.34
5	Lubbock	1.0	Dry - Cold	North	0.972	0.843	1	$ 83.99	$ 81.64	$ 70.25	$ 59.22	$ 140.86	6	$ 845.15	8	$ 40,480.00	$ 81.64	$ 59.22
3	W. Falls	1.0	Dry - Cold	North	0.889	0.858	1	$ 83.99	$ 74.67	$ 70.25	$ 60.27	$ 134.94	6	$ 809.65	8	$ 34,597.69	$ 74.67	$ 60.27
19	Atlanta	2.0	Wet - Cold	North East	0.905	0.897	1	$ 83.99	$ 76.01	$ 70.25	$ 63.01	$ 139.03	6	$ 834.15	8	$ 9,386.67	$ 76.01	$ 63.01
18	Dallas	2.0	Wet - Cold	North East	0.964	0.845	1	$ 83.99	$ 80.97	$ 70.25	$ 59.34	$ 140.30	6	$ 841.83	8	$ 20,494.22	$ 80.97	$ 59.34
2	FT Worth	2.0	Wet - Cold	North East	0.918	0.826	1	$ 83.99	$ 77.10	$ 70.25	$ 57.99	$ 135.09	6	$ 810.57	8	$ 19,641.60	$ 77.10	$ 57.99
1	Paris	2.0	Wet - Cold	North East	0.956	0.822	1	$ 83.99	$ 80.29	$ 70.25	$ 57.75	$ 138.04	6	$ 828.24	8	$ 20,337.78	$ 80.29	$ 57.75
10	Tyler	2.0	Wet - Cold	North East	0.905	0.901	1	$ 83.99	$ 76.01	$ 70.25	$ 63.30	$ 139.31	6	$ 835.84	8	$ 17,465.07	$ 76.01	$ 63.30
24	El Paso	3.0	Dry - Warm	South West	0.889	0.854	1	$ 83.99	$ 74.67	$ 70.25	$ 59.99	$ 134.66	6	$ 807.96	8	$ 35,200.00	$ 74.67	$ 59.99
22	Laredo	3.0	Dry - Warm	South West	0.886	0.859	1	$ 83.99	$ 74.42	$ 70.25	$ 60.31	$ 134.72	6	$ 808.35	8	$ 17,991.11	$ 74.42	$ 60.31
6	Odessa	3.0	Dry - Warm	South West	0.931	0.853	1	$ 83.99	$ 78.15	$ 70.25	$ 59.92	$ 138.08	6	$ 828.46	8	$ 23,075.56	$ 78.15	$ 59.92
21	Pharr	3.0	Dry - Warm	South West	0.957	0.825	1	$ 83.99	$ 80.38	$ 70.25	$ 57.96	$ 138.33	6	$ 830.01	8	$ 12,812.80	$ 80.38	$ 57.96
7	San Angelo	3.0	Dry - Warm	South West	0.889	0.868	1	$ 83.99	$ 74.67	$ 70.25	$ 60.98	$ 135.64	6	$ 813.86	8	$ 22,410.67	$ 74.67	$ 60.98
15	San Antonio	3.0	Dry - Warm	South West	0.910	0.913	1	$ 83.99	$ 76.43	$ 70.25	$ 64.14	$ 140.57	6	$ 843.41	8	$ 20,533.33	$ 76.43	$ 64.14
14	Austin	4.0	Mixed	Central	0.886	0.861	1	$ 83.99	$ 74.42	$ 70.25	$ 60.49	$ 134.90	6	$ 809.40	8	$ 20,423.82	$ 74.42	$ 60.49
23	Brownwood	4.0	Mixed	Central	0.889	0.855	1	$ 83.99	$ 74.67	$ 70.25	$ 60.06	$ 134.73	6	$ 808.39	8	$ 21,120.00	$ 74.67	$ 60.06
17	Bryan	4.0	Mixed	Central	0.898	0.870	1	$ 83.99	$ 75.42	$ 70.25	$ 61.08	$ 136.51	6	$ 819.03	8	$ 42,240.00	$ 75.42	$ 61.08
9	Waco	4.0	Mixed	Central	0.889	0.860	1	$ 83.99	$ 74.67	$ 70.25	$ 60.42	$ 135.08	6	$ 810.49	8	$ 23,208.53	$ 74.67	$ 60.42
20	Beaumont	5.0	Wet Warm	Coastal	0.898	0.863	1	$ 83.99	$ 75.42	$ 70.25	$ 60.63	$ 136.05	6	$ 816.29	8	$ 34,417.78	$ 75.42	$ 60.63
16	Corpus	5.0	Wet Warm	Coastal	0.957	0.826	1	$ 83.99	$ 80.38	$ 70.25	$ 58.03	$ 138.40	6	$ 830.43	8	$ 30,037.33	$ 80.38	$ 58.03
12	Houston	5.0	Wet Warm	Coastal	0.985	0.856	1	$ 83.99	$ 82.69	$ 70.25	$ 60.13	$ 142.82	6	$ 856.93	8	$ 24,248.89	$ 82.69	$ 60.13
11	Lufkin	5.0	Wet Warm	Coastal	0.905	0.903	1	$ 83.99	$ 76.01	$ 70.25	$ 63.44	$ 139.45	6	$ 836.68	8	$ 54,090.67	$ 76.01	$ 63.44
13	Yokum	5.0	Wet Warm	Coastal	0.980	0.825	1	$ 83.99	$ 82.27	$ 70.25	$ 57.96	$ 140.22	6	$ 841.35	8	$ 53,089.42	$ 82.27	$ 57.96

g		Totals		
Maintenance Cost		Total	Conversion Rate	Total
Maintenance Cost	When done every 5 Years	Unsurfaced Maintenance Cost	Km / Mile	Unsurfaced Maintenance Cost
$/Mile	$ / MILE / YEAR	$ / MILE / YEAR	1.609344	$ / Km / YEAR
$ 28,366.00	**$ 5,673.20**	**$ 6,497.24**	**1.609344**	**$ 4,037.20**
$ 31,021.41	$ 6,204.28	$ 7,022.13	1.609344	**$ 4,363.35**
$ 18,571.90	$ 3,714.38	$ 4,544.50	1.609344	**$ 2,823.82**
$ 23,099.92	$ 4,619.98	$ 5,441.99	1.609344	**$ 3,381.50**
$ 27,830.53	$ 5,566.11	$ 6,377.93	1.609344	**$ 3,963.06**
$ 40,291.93	$ 8,058.39	$ 8,894.72	1.609344	**$ 5,526.92**
$ 24,936.75	$ 4,987.35	$ 5,796.58	1.609344	**$ 3,601.83**
$ 22,050.39	$ 4,410.08	$ 5,225.21	1.609344	**$ 3,246.79**
$ 30,835.83	$ 6,167.17	$ 6,977.24	1.609344	**$ 4,335.45**
$ 41,606.87	$ 8,321.37	$ 9,166.53	1.609344	**$ 5,695.82**
$ 35,677.22	$ 7,135.44	$ 7,945.09	1.609344	**$ 4,936.85**
$ 10,498.87	$ 2,099.77	$ 2,933.92	1.609344	**$ 1,823.06**
$ 21,616.66	$ 4,323.33	$ 5,165.16	1.609344	**$ 3,209.48**
$ 20,722.35	$ 4,144.47	$ 4,955.04	1.609344	**$ 3,078.92**
$ 21,442.10	$ 4,288.42	$ 5,116.66	1.609344	**$ 3,179.34**
$ 18,579.52	$ 3,715.90	$ 4,551.74	1.609344	**$ 2,828.32**
$ 36,277.28	$ 7,255.46	$ 8,063.42	1.609344	**$ 5,010.38**
$ 19,068.91	$ 3,813.78	$ 4,622.13	1.609344	**$ 2,872.06**
$ 24,180.16	$ 4,836.03	$ 5,664.49	1.609344	**$ 3,519.75**
$ 13,919.48	$ 2,783.90	$ 3,613.90	1.609344	**$ 2,245.58**
$ 23,495.82	$ 4,699.16	$ 5,513.03	1.609344	**$ 3,425.64**
$ 21,657.89	$ 4,331.58	$ 5,174.99	1.609344	**$ 3,215.59**
$ 21,503.03	$ 4,300.61	$ 5,110.01	1.609344	**$ 3,175.21**
$ 22,197.85	$ 4,439.57	$ 5,247.95	1.609344	**$ 3,260.93**
$ 43,332.04	$ 8,666.41	$ 9,485.44	1.609344	**$ 5,893.98**
$ 24,289.19	$ 4,857.84	$ 5,668.33	1.609344	**$ 3,522.14**
$ 35,506.17	$ 7,101.23	$ 7,917.53	1.609344	**$ 4,919.72**
$ 31,144.57	$ 6,228.91	$ 7,059.34	1.609344	**$ 4,386.47**
$ 25,391.47	$ 5,078.29	$ 5,935.23	1.609344	**$ 3,687.98**
$ 55,206.24	$ 11,041.25	$ 11,877.93	1.609344	**$ 7,380.60**
$ 54,211.22	$ 10,842.24	$ 11,683.59	1.609344	**$ 7,259.85**

Maintain Un-Surfaced

Maintain Un-Surfaced

				Goal of 1 Mile per Hour				Routine Blading								
								Act. WH's / Mile	Lump Sum Cost	Material Cost	Equipment Cost	Labor Cost	Maintenance Cost	Time Interval (x6 year)	Act. WH's / Mile	Lump Sum Cost
Section	Description	Labor Description	Equipment Description	Amt of Equip / Day	Hours Worked / Day	Material Cost / Day	Actual Cost / Day	HOURS/Mile	$/HOUR	$/Mile	$/HOUR	$/HOUR	$/Mile	$ / MILE / YEAR	HOURS/Mile	$/HOUR
D.1	Routine Blading	Skilled MG Operator	Motor Grader	1.00	8.00	$ -	$ 1,233.92	1.00	$ -	$ -	$ 83.99	$ 70.25	$ 154.24	**$ 925.44**	8.00	

Gravel Resurfacing					Total
Material Cost	Equipment Cost	Labor Cost	Maintenance Cost	Time Interval (5yrs)	Maintenance Cost
$/Mile	$/HOUR	$/HOUR	$/Mile	$ / MILE / YEAR	$ / MILE / YEAR
$ 27,267.29	$ 83.99	$ 70.25	**$ 28,501.21**	$ 5,700.24	$ 6,625.68

if blading is 2" in depth then
2" = .0508m
24' = 7.32m
1' = .3048m
5280'=1609.3m
598.4 cu m

Blading Logic

Surfaced to Unsurfaced

Description	Labor Description	Equipment Description	Amt of Equip / Day	Hours Worked / Day	Lump Sum Cost	Material Cost	Equipment Cost		Labor Cost			Act. WH's / Mile	Lump Sum Cost	Material Cost	Equipment Cost	Labor Cost	Conversion Cost
					$/HOUR	$ / Day	$/HOUR	$ / Day	$/HOUR	$ / Day	Actual Cost / Day	HOURS/ Mile	$/HOUR	$/Mile	$/HOUR	$/HOUR	$/Mile
Traffic Control + Truck	Traffic Control Crew	Traffic Control Vehicle	1.00	8.00	$ 88.00	$ -	$ -	$ -	$ -	$ -	$ 704.00	8.00	$ 88.00	$ -	$ -	$ -	$ 704.00
Foreman + Truck	Foreman	Foreman Truck	1.00	8.00	$ -	$ -	$ 8.70	$ 69.60	$ 36.35	$ 290.80	$ 360.40	8.00	$ -	$ -	$ 8.70	$ 36.35	$ 360.40
Water			-	-	$ -	$ 52.88	$ -	$ -	$ -	$ -	$ 52.88	-	$ -	$ 52.88	$ -	$ -	$ 52.88
Rip	Skilled MG Operator	Motor Grader	1.00	1.00	$ -	$ -	$ 83.99	$ 83.99	$ 70.25	$ 70.25	$ 154.24	1.00	$ -	$ -	$ 83.99	$ 83.99	$ 167.97
Add Water	Truck Driver	Water Truck	1.00	8.00	$ -	$ -	$ 41.03	$ 328.24	$ 54.00	$ 432.00	$ 760.24	7.05	$ -	$ -	$ 41.03	$ 289.26	$ 2,328.56
Mix	Skilled Mixer Operator	Mixer	1.00	8.00	$ -	$ -	$ 435.88	$ 3,487.00	$ 70.25	$ 562.00	$ 4,049.00	5.29	$ -	$ -	$ 435.88	$ 2,304.69	$ 14,490.73
Level-off Fluff	Skilled MG Operator	Motor Grader	1.00	3.00	$ -	$ -	$ 83.99	$ 251.96	$ 70.25	$ 210.75	$ 462.71	3.00	$ -	$ -	$ 83.99	$ 251.96	$ 1,007.82
Compact	Skilled Roller Operator	Compactor	1.00	8.00	$ -	$ -	$ 88.03	$ 704.22	$ 70.25	$ 562.00	$ 1,266.22	3.00	$ -	$ -	$ 88.03	$ 264.08	$ 1,056.33
Final Finish	Skilled MG Operator	Motor Grader	1.00	4.00	$ -	$ -	$ 83.99	$ 335.94	$ 70.25	$ 281.00	$ 616.94	4.00	$ -	$ -	$ 83.99	$ 335.94	$ 1,679.70
			8.00	**48.00**	**$ 88.00**	**$ 52.88**	**$ 825.59**	**$ 5,260.94**	**$ 441.60**	**$ 2,408.80**	**$ 8,426.62**	**39.34**	**$ 88.00**	**$ 52.88**	**$ 825.59**	**$ 3,566.26**	**$ 21,848.38**

Surfaced to Unsurfaced				1 Mile per Day		Act. WH's / Mile			Daily Work Schedule												
Section	Description	Labor Description	Equipment Description	Amt of Equip / Day	Hours Worked / Day	HOURS/Mile	LF / Hour	LF / 1/4 Hour	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	2.75	3.00	3.25
	Traffic Control + Truck	Traffic Control Crew	Traffic Control Vehicle	1.00	8.00	**8.00**															
	Foreman + Truck	Foreman	Foreman Truck	1.00	8.00	**8.00**															
D.1	Rip	Skilled MG Operator	Motor Grader	1.00	1.00	**1.00**	5,280	**1,320.0**	1320	1320	1320	1320									
D.2	Add Water	Truck Driver	Water Truck	1.00	8.00	**7.05**	749	**187.2**	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2
D.3	Mix	Skilled Mixer Operator	Mixer	1.00	8.00	**5.29**	999	**249.6**		249.6	249.6	249.6	249.6	249.6	249.6	249.6	249.6	249.6	249.6	249.6	249.6
D.1	Level-off Fluff	Skilled MG Operator	Motor Grader	1.00	3.00	**3.00**	1,760	**440.0**					440	440	440	440					
D.4	Compact	Skilled Roller Operator	Compactor	1.00	8.00	**3.00**	1,760	**440.0**							440	440	440	440			
D.1	Final Finish	Skilled MG Operator	Motor Grader	1.00	4.00	**4.00**	1,320	**330.0**									330	330	330	330	330

3.50	3.75	4.00	4.25	4.50	4.75	5.00	5.25	5.50	5.75	6.00	6.25	6.50	6.75	7.00	7.25	7.50	7.75	8.00	
																			5280
187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	187.2	37.45				5280
249.6	249.6	249.6	249.6	249.6	249.6	249.6	249.6	249.6	37.45										5280
440	440	440	440						440	440	440	440							5280
		440	440	440	440						440	440	440	440					5280
				330	330	330	330	330					330	330	330	330	330	330	5280

Unsurfaced to Surfaced

					11.00	48.00	$ 88.00	$ 75,066.62	$ 909.57	$ 9,076.18	$ 511.85	$ 3,402.80		42.67	$ 88.00
							Lump Sum Cost	Material Cost	Equipment Cost		Labor Cost		Conversion Cost	Act. WH's / Mile	Lump Sum Cost
Description	Labor Description	Equipment Description	Amt of Material Used / Mile	Unit	Amt of Equip / Day	Hours Worked / Day	$/HOUR	$ / Day	$/HOUR	$ / Day	$/HOUR	$ / Day	$ / Day	HOURS/ Mile	$/HOUR
Traffic Control	Traffic Control Crew	Traffic Control Vehicle			1.00	8.00	$ 88.00		$ -	$ -	$ -		$ 704.00	8.00	$ 88.00
Foreman + Truck	Foreman	Foreman Truck			1.00	8.00			$ 8.70	$ 69.60	$ 36.35	290.80	$ 360.40	8.00	$ -
Flex Base Cost					-	-		$ 27,267.29	$ -		$ -		$ 27,267.29	-	$ -
Level New Material	Skilled MG Operator	Motor Grader			1.00	2.00			$ 83.99	$ 167.97	$ 70.25	140.50	$ 308.47	1.00	$ -
Rip	Skilled MG Operator	Motor Grader			1.00	1.00			$ 83.99	$ 83.99	$ 70.25	70.25	$ 154.24	1.00	$ -
Add Water	Truck Driver	Water Truck			2.00	8.00			$ 41.03	$ 656.48	$ 54.00	864.00	$ 1,520.48	12.73	$ -
Water Cost					-	-		$ 95.48	$ -		$ -		$ 95.48	-	$ -
Mix	Skilled Mixer Operator	Mixer			2.00	8.00			$ 435.88	$ 6,974.00	$ 70.25	1,124.00	$ 8,098.00	5.66	$ -
Level-off Fluff	Skilled MG Operator	Motor Grader			1.00	1.00			$ 83.99	$ 83.99	$ 70.25	70.25	$ 154.24	1.00	$ -
Compact	Skilled Roller Operator	Compactor			1.00	8.00			$ 88.03	$ 704.22	$ 70.25	562.00	$ 1,266.22	4.28	$ -
Final Finish	Skilled MG Operator	Motor Grader			1.00	4.00			$ 83.99	$ 335.94	$ 70.25	281.00	$ 616.94	1.00	$ -
PC Material	0.35 GAL / SY		9,856.00	GAL	-	-		$ 18,796.21					$ 18,796.21	-	$ -
SC Material	0.35 GAL / SY		9,856.00	GAL	-	-		$ 15,714.41					$ 31,428.81	-	$ -
Type 4 Aggregate	1 CY / 110 SY		128.00	CY	-	-		$ 8,969.23					$ 17,938.45	-	$ -
Striping					-	-		$ 4,224.00					$ 4,224.00	-	$ -
													$ 112,933.23		

$ 99,750.24	$ 909.57	$ 511.85	
Material Cost	Equipment Cost	Labor Cost	Conversion Cost
$/Mile	$/HOUR	$/HOUR	$/Mile
$ -	$ -	$ -	$ 704.00
$ -	$ 8.70	$ 36.35	$ 360.40
$ 27,267.29	$ -	$ -	$ 27,267.29
$ -	$ 83.99	$ 70.25	$ 154.24
$ -	$ 83.99	$ 70.25	$ 154.24
$ -	$ 41.03	$ 54.00	$ 1,209.73
$ 95.48	$ -	$ -	$ 95.48
$ -	$ 435.88	$ 70.25	$ 2,864.01
$ -	$ 83.99	$ 70.25	$ 154.24
$ -	$ 88.03	$ 70.25	$ 677.43
$ -	$ 83.99	$ 70.25	$ 154.24
$ 18,796.21			$ 18,796.21
$ 31,428.81			$ 31,428.81
$ 17,938.45			$ 17,938.45
$ 4,224.00			$ 4,224.00
			$ 106,182.75

Unsurfaced to Surfaced Schedule

						Act. WH's / Mile		Day 1								5280		
Day worked	Description	Labor Description	Equipment Description	Amt of Equip / Day	Hours Worked / Day	HOURS/ Mile	LF / Hour	1	2	3	4	5	6	7	8		1	2
All Days	Traffic Control	Traffic Control Crew	Traffic Control Vehicle	1.00	8.00	8.00												
All Days	Foreman + Truck	Foreman	Foreman Truck	1.00	8.00	8.00												
Day 1	Truck-in Flex Base	Truck Driver	12 CY Haul Truck	13.00	8.00	104.00	660	660	660	660	660	660	660	660	660	5,280		
Day 1	Level New Material	Skilled MG Operator	Motor Grader	1.00	8.00	8.00	660	660	660	660	660	660	660	660	660	5,280		
Day 2&3	Rip	Skilled MG Operator	Motor Grader	1.00	0.50	1.00	5,280										2640	
Day 2&3	Add Water	Truck Driver	Water Truck	4.00	8.00	12.73	1,659										1659	981
Day 2&3	Mix	Skilled Mixer Operator	Mixer	1.00	8.00	5.66	933											933
Day 2&3	Level-off Fluff	Skilled MG Operator	Motor Grader	1.00	3.00	3.00	1,760											880
Day 2&3	Compact	Skilled Roller Operator	Compactor	1.00	8.00	4.28	1,234											
Day 2&3	Final Finish	Skilled MG Operator	Motor Grader	1.00	4.00	8.00	660											
Day 4	Prime Coat	Truck Driver	Asphalt Spreader	1.00	2.00	2.00	2,640											
Day 5	Seal Coat	Truck Driver	Asphalt Spreader	1.00	8.00	8.00	660											
Day 5	Aggregate	Rock Spreader Operator	Rock Spreader	1.00	8.00	8.00	660											
Day 5	Aggregate	Truck Driver	12 CY Haul Truck	10.00	8.00	80.00	660											
Day 6	Striping					1.00	5,280											

	Day 2						2640	Day 3								2640	Day 4							
Description	3	4	5	6	7	8		1	2	3	4	5	6	7	8		1	2	3	4	5	6	7	8
Traffic Control																								
Foreman + Truck																								
Truck-in Flex Base																								
Level New Material																								
Rip							2,640	2640								2,640								
Add Water							2,640	1659	981							2,640								
Mix	933	774					2,640		933	933	774					2,640								
Level-off Fluff	880	880					2,640		880	880	880					2,640								
Compact		1,234	1,234	173			2,640				1,234	1,234	173			2,640								
Final Finish			660	660	660	660	2,640					660	660	660	660	2,640								
Prime Coat																	2640	2640						
Seal Coat																								
Aggregate																								
Aggregate																								
Striping																								

	5280	Day 5								5280	Day 6								5280
Description		1	2	3	4	5	6	7	8		1	2	3	4	5	6	7	8	
Traffic Control																			
Foreman + Truck																			
Truck-in Flex Base																			
Level New Material																			
Rip																			
Add Water																			
Mix																			
Level-off Fluff																			
Compact																			
Final Finish																			
Prime Coat	5,280																		
Seal Coat		660	660	660	660	660	660	660	660	5280									
Aggregate		660	660	660	660	660	660	660	660	5280									
Aggregate		660	660	660	660	660	660	660	660	5280									
Striping											5280								5280

TxDOT Price Info by District & Climate Zone

Descriptions						Project Standard									
						Dimensions			Material					M	
											Tier II or III				
						Width	Length	Area			B.I. 316				B.I. 316
District Info			Climate Info		Geography	8.0	1760	14080	0.35	4928	Seal Coat Oil			Rate: 110 SY / CY	Grade 4 rock
District Order	Location	Location Description	Climate Zone	Climate Type	Geographic Region	YD	YD / Mile	SY / MILE	GAL / SY	GAL / MILE	$ / GAL	Courses	$ / Mile	CY / Mile	$ / CY
Z6	**Zone 6 Texas**	**State Average**	**0.0**	**All**	**State (Whole)**	**8.0**	**1,760**	**14,080**	**0.35**	**4,928**	**$ 3.19**	**2**	**$ 31,428.81**	**128.0**	**$ 70.07**
Z1	Zone 1	CZ Regional Average	0.1	Dry - Cold	North	8.0	1,760	14,080	0.35	4,928	$ 3.42	2	**$ 33,687.81**	128.0	$ 77.59
Z2	Zone 2	CZ Regional Average	0.2	Wet - Cold	North East	8.0	1,760	14,080	0.35	4,928	$ 3.21	2	**$ 31,598.34**	128.0	$ 63.34
Z3	Zone 3	CZ Regional Average	0.3	Dry - Warm	South West	8.0	1,760	14,080	0.35	4,928	$ 3.05	2	**$ 30,027.95**	128.0	$ 73.36
Z4	Zone 4	CZ Regional Average	0.4	Mixed	Central	8.0	1,760	14,080	0.35	4,928	$ 3.12	2	**$ 30,750.72**	128.0	$ 61.37
Z5	Zone 5	CZ Regional Average	0.5	Wet Warm	Coastal	8.0	1,760	14,080	0.35	4,928	$ 3.17	2	**$ 31,223.81**	128.0	$ 70.96
8	Abilene	District	1.0	Dry - Cold	North	8.0	1,760	14,080	0.35	4,928	$ 4.57	2	**$ 45,041.92**	128.0	$ 67.48
4	Amarillo	District	1.0	Dry - Cold	North	8.0	1,760	14,080	0.35	4,928	$ 2.94	2	**$ 28,976.64**	128.0	$ 68.00
25	Childress	District	1.0	Dry - Cold	North	8.0	1,760	14,080	0.35	4,928	$ 2.76	2	**$ 27,202.56**	128.0	$ 59.65
5	Lubbock	District	1.0	Dry - Cold	North	8.0	1,760	14,080	0.35	4,928	$ 3.57	2	**$ 35,185.92**	128.0	$ 118.80
3	W. Falls	District	1.0	Dry - Cold	North	8.0	1,760	14,080	0.35	4,928	$ 3.25	2	**$ 32,032.00**	128.0	$ 74.00
19	Atlanta	District	2.0	Wet - Cold	North East	8.0	1,760	14,080	0.35	4,928	$ 3.60	2	**$ 35,481.60**	128.0	$ 55.00
18	Dallas	District	2.0	Wet - Cold	North East	8.0	1,760	14,080	0.35	4,928	$ 3.65	2	**$ 35,974.40**	128.0	$ 63.34
2	FT Worth	District	2.0	Wet - Cold	North East	8.0	1,760	14,080	0.35	4,928	$ 2.66	2	**$ 26,216.96**	128.0	$ 53.00
1	Paris	District	2.0	Wet - Cold	North East	8.0	1,760	14,080	0.35	4,928	$ 3.43	2	**$ 33,806.08**	128.0	$ 77.00
10	Tyler	District	2.0	Wet - Cold	North East	8.0	1,760	14,080	0.35	4,928	$ 2.69	2	**$ 26,512.64**	128.0	$ 68.35
24	El Paso	District	3.0	Dry - Warm	South West	8.0	1,760	14,080	0.35	4,928	$ 4.11	2	**$ 40,508.16**	128.0	$ 128.50
22	Laredo	District	3.0	Dry - Warm	South West	8.0	1,760	14,080	0.35	4,928	$ 2.20	2	**$ 21,683.20**	128.0	$ 71.00
6	Odessa	District	3.0	Dry - Warm	South West	8.0	1,760	14,080	0.35	4,928	$ 3.12	2	**$ 30,750.72**	128.0	$ 59.77
21	Pharr	District	3.0	Dry - Warm	South West	8.0	1,760	14,080	0.35	4,928	$ 2.90	2	**$ 28,582.40**	128.0	$ 56.47
7	San Angelo	District	3.0	Dry - Warm	South West	8.0	1,760	14,080	0.35	4,928	$ 2.77	2	**$ 27,301.12**	128.0	$ 60.76
15	San Antonio	District	3.0	Dry - Warm	South West	8.0	1,760	14,080	0.35	4,928	$ 3.18	2	**$ 31,342.08**	128.0	$ 63.67
14	Austin	District	4.0	Mixed	Central	8.0	1,760	14,080	0.35	4,928	$ 3.35	2	**$ 33,017.60**	128.0	$ 60.00
23	Brownwood	District	4.0	Mixed	Central	8.0	1,760	14,080	0.35	4,928	$ 3.40	2	**$ 33,510.40**	128.0	$ 75.00
17	Bryan	District	4.0	Mixed	Central	8.0	1,760	14,080	0.35	4,928	$ 3.03	2	**$ 29,863.68**	128.0	$ 77.88
9	Waco	District	4.0	Mixed	Central	8.0	1,760	14,080	0.35	4,928	$ 2.70	2	**$ 26,611.20**	128.0	$ 32.60
20	Beaumont	District	5.0	Wet Warm	Coastal	8.0	1,760	14,080	0.35	4,928	$ 3.25	2	**$ 32,032.00**	128.0	$ 90.90
16	Corpus	District	5.0	Wet Warm	Coastal	8.0	1,760	14,080	0.35	4,928	$ 3.02	2	**$ 29,765.12**	128.0	$ 79.29
12	Houston	District	5.0	Wet Warm	Coastal	8.0	1,760	14,080	0.35	4,928	$ 3.10	2	**$ 30,553.60**	128.0	$ 66.00
11	Lufkin	District	5.0	Wet Warm	Coastal	8.0	1,760	14,080	0.35	4,928	$ 3.50	2	**$ 34,496.00**	128.0	$ 68.00
13	Yokum	District	5.0	Wet Warm	Coastal	8.0	1,760	14,080	0.35	4,928	$ 2.97	2	**$ 29,272.32**	128.0	$ 50.61

TxDOT's Price Info x Dist&CZ

TxDOT Average Bid Unit Prices

Material		Material					Material Delivered			
								CY- TY D or A		
				B.I. 310				B.I. 247		
		0.35	4928	Prime			14080	Flex Base	Depth @ 2"	Depth @ 6"
Courses	$ / Mile	GAL / SY	GAL / MILE	$ / GAL	Type	$ / Mile	SY / MILE	$ / CY	$ / Mile	$ / Mile
2	$ 17,938.45	0.35	4,928	$ 3.81		$ 18,796.21	14,080	$ 34.86	$ 27,267.29	$ 81,801.87
2	$ 19,862.02	0.35	4,928	$ 4.36		$ 21,461.44	14,080	$ 38.26	$ 29,930.95	$ 89,792.85
2	$ 16,214.40	0.35	4,928	$ 4.38		$ 21,594.50	14,080	$ 22.33	$ 17,465.07	$ 52,395.20
2	$ 18,780.59	0.35	4,928	$ 3.37		$ 16,599.15	14,080	$ 28.13	$ 22,003.91	$ 66,011.73
2	$ 15,710.72	0.35	4,928	$ 3.80		$ 18,701.76	14,080	$ 34.20	$ 26,748.09	$ 80,244.27
2	$ 18,165.76	0.35	4,928	$ 3.36		$ 16,577.79	14,080	$ 50.08	$ 39,176.82	$ 117,530.45
2	$ 17,274.88	0.35	4,928	$ 4.87		$ 23,999.36	14,080	$ 30.50	$ 23,857.78	$ 71,573.33
2	$ 17,408.00	0.35	4,928	$ 4.36		$ 21,461.44	14,080	$ 26.80	$ 20,963.56	$ 62,890.67
2	$ 15,270.40	0.35	4,928	$ 4.53	CSS1-H	$ 22,323.84	14,080	$ 38.04	$ 29,755.73	$ 89,267.20
2	$ 30,412.80	0.35	4,928	$ 3.96	MC-30	$ 19,514.88	14,080	$ 51.75	$ 40,480.00	$ 121,440.00
2	$ 18,944.00	0.35	4,928	$ 4.06	MC-30	$ 20,007.68	14,080	$ 44.23	$ 34,597.69	$ 103,793.07
2	$ 14,080.00	0.35	4,928	$ 4.24		$ 20,894.72	14,080	$ 12.00	$ 9,386.67	$ 28,160.00
2	$ 16,214.40	0.35	4,928	$ 3.54	MC-30	$ 17,445.12	14,080	$ 26.20	$ 20,494.22	$ 61,482.67
2	$ 13,568.00	0.35	4,928	$ 5.00	RC-250	$ 24,640.00	14,080	$ 25.11	$ 19,641.60	$ 58,924.80
2	$ 19,712.00	0.35	4,928	$ 4.53	MC-30	$ 22,323.84	14,080	$ 26.00	$ 20,337.78	$ 61,013.33
2	$ 17,497.60	0.35	4,928	$ 4.60	MC-30	$ 22,668.80	14,080	$ 22.33	$ 17,465.07	$ 52,395.20
2	$ 32,896.00	0.35	4,928	$ 1.32	CSS1	$ 6,504.96	14,080	$ 45.00	$ 35,200.00	$ 105,600.00
2	$ 18,176.00	0.35	4,928	$ 3.78	MC-30	$ 18,627.84	14,080	$ 23.00	$ 17,991.11	$ 53,973.33
2	$ 15,301.12	0.35	4,928	$ 3.49	AE-P	$ 17,198.72	14,080	$ 29.50	$ 23,075.56	$ 69,226.67
2	$ 14,456.32	0.35	4,928	$ 4.01	MC-30	$ 19,761.28	14,080	$ 16.38	$ 12,812.80	$ 38,438.40
2	$ 15,554.56	0.35	4,928	$ 4.94	MC-30	$ 24,344.32	14,080	$ 28.65	$ 22,410.67	$ 67,232.00
2	$ 16,299.52	0.35	4,928	$ 2.67	AE-P	$ 13,157.76	14,080	$ 26.25	$ 20,533.33	$ 61,600.00
2	$ 15,360.00	0.35	4,928	$ 3.40	MC-30	$ 16,755.20	14,080	$ 26.11	$ 20,423.82	$ 61,271.47
2	$ 19,200.00	0.35	4,928	$ 4.08	MC-30	$ 20,106.24	14,080	$ 27.00	$ 21,120.00	$ 63,360.00
2	$ 19,937.28	0.35	4,928	$ 3.95		$ 19,465.60	14,080	$ 54.00	$ 42,240.00	$ 126,720.00
2	$ 8,345.60	0.35	4,928	$ 3.75	MC-30	$ 18,480.00	14,080	$ 29.67	$ 23,208.53	$ 69,625.60
2	$ 23,270.40	0.35	4,928	$ 4.01		$ 19,761.28	14,080	$ 44.00	$ 34,417.78	$ 103,253.33
2	$ 20,298.24	0.35	4,928	$ 2.75		$ 13,552.00	14,080	$ 38.40	$ 30,037.33	$ 90,112.00
2	$ 16,896.00	0.35	4,928	$ 1.65	MC-30	$ 8,131.20	14,080	$ 31.00	$ 24,248.89	$ 72,746.67
2	$ 17,408.00	0.35	4,928	$ 4.50	RC-250	$ 22,176.00	14,080	$ 69.15	$ 54,090.67	$ 162,272.00
2	$ 12,956.16	0.35	4,928	$ 3.91	RC-250	$ 19,268.48	14,080	$ 67.87	$ 53,089.42	$ 159,268.27

Simulations

Descriptions						Environmental Inputs		Unpaved Routine Maintenance							Paved Maintanence
District Info			Climate Info		Geography	Soil Info	Rainfall	Unpaved Grading			Gravel Resurfaceing				Seal Coat
District Order	Location	Location Description	Climate Zone	Climate Type	Geographic Region	Average PI	Month Average (m/month)	$/Mile	Km / Mile	$/Km	$/Mile	$ / Mile / YEAR @ 5yr Int.	Km / Mile	Routine Maint $/km/yr	Routine Maint $/km/yr
Z6	**Zone 6 Texas**	**State Average**	**0.0**	**All**	**State (Whole)**	**37.8**	**0.0679**	**$ 137.34**	**1.609**	**$ 85.34**	**$ 28,366.00**	**$ 5,673.2**	**1.609**	**$ 3,525.2**	**$ 3,853.39**
Z1	Zone 1	CZ Regional Average	0.1	Dry - Cold	North	32.6	0.0460	$ 136.31	1.609	$ 84.70	$ 31,021.41	$ 6,204.3	1.609	$ 3,855.2	$ 4,039.03
Z2	Zone 2	CZ Regional Average	0.2	Wet - Cold	North East	43.3	0.0856	$ 138.35	1.609	$ 85.97	$ 18,571.90	$ 3,714.4	1.609	$ 2,308.0	$ 3,784.40
Z3	Zone 3	CZ Regional Average	0.3	Dry - Warm	South West	34.4	0.0455	$ 137.00	1.609	$ 85.13	$ 23,099.92	$ 4,620.0	1.609	$ 2,870.7	$ 3,828.59
Z4	Zone 4	CZ Regional Average	0.4	Mixed	Central	35.1	0.0714	$ 135.30	1.609	$ 84.07	$ 27,830.53	$ 5,566.1	1.609	$ 3,458.6	$ 3,724.42
Z5	Zone 5	CZ Regional Average	0.5	Wet Warm	Coastal	43.4	0.0912	$ 139.39	1.609	$ 86.61	$ 40,291.93	$ 8,058.4	1.609	$ 5,007.2	$ 3,854.38
8	Abilene	District	1.0	Dry - Cold	North	18.5	0.0460	$ 134.87	1.609	$ 83.81	$ 24,936.75	$ 4,987.3	1.609	$ 3,099.0	$ 4,428.14
4	Amarillo	District	1.0	Dry - Cold	North	33.8	0.0460	$ 135.85	1.609	$ 84.42	$ 22,050.39	$ 4,410.1	1.609	$ 2,740.3	$ 3,721.01
25	Childress	District	1.0	Dry - Cold	North	23.1	0.0460	$ 135.01	1.609	$ 83.89	$ 30,835.83	$ 6,167.2	1.609	$ 3,832.1	$ 3,547.40
5	Lubbock	District	1.0	Dry - Cold	North	41.5	0.0460	$ 140.86	1.609	$ 87.53	$ 41,606.87	$ 8,321.4	1.609	$ 5,170.7	$ 4,573.80
3	W. Falls	District	1.0	Dry - Cold	North	46.0	0.0460	$ 134.94	1.609	$ 83.85	$ 35,677.22	$ 7,135.4	1.609	$ 4,433.8	$ 3,924.79
19	Atlanta	District	2.0	Wet - Cold	North East	41.5	0.0856	$ 139.03	1.609	$ 86.39	$ 10,498.87	$ 2,099.8	1.609	$ 1,304.7	$ 3,862.02
18	Dallas	District	2.0	Wet - Cold	North East	48.3	0.0856	$ 140.30	1.609	$ 87.18	$ 21,616.66	$ 4,323.3	1.609	$ 2,686.4	$ 3,978.65
2	FT Worth	District	2.0	Wet - Cold	North East	36.9	0.0856	$ 135.09	1.609	$ 83.94	$ 20,722.35	$ 4,144.5	1.609	$ 2,575.3	$ 3,428.09
1	Paris	District	2.0	Wet - Cold	North East	48.3	0.0856	$ 138.04	1.609	$ 85.77	$ 21,442.10	$ 4,288.4	1.609	$ 2,664.7	$ 4,037.62
10	Tyler	District	2.0	Wet - Cold	North East	41.5	0.0856	$ 139.31	1.609	$ 86.56	$ 18,579.52	$ 3,715.9	1.609	$ 2,309.0	$ 3,615.63
24	El Paso	District	3.0	Dry - Warm	South West	17.5	0.0455	$ 134.66	1.609	$ 83.67	$ 36,277.28	$ 7,255.5	1.609	$ 4,508.3	$ 4,920.24
22	Laredo	District	3.0	Dry - Warm	South West	43.8	0.0455	$ 134.72	1.609	$ 83.71	$ 19,068.91	$ 3,813.8	1.609	$ 2,369.8	$ 3,431.39
6	Odessa	District	3.0	Dry - Warm	South West	33.8	0.0455	$ 138.08	1.609	$ 85.80	$ 24,180.16	$ 4,836.0	1.609	$ 3,005.0	$ 3,706.24
21	Pharr	District	3.0	Dry - Warm	South West	29.6	0.0455	$ 138.33	1.609	$ 85.96	$ 13,919.48	$ 2,783.9	1.609	$ 1,729.8	$ 3,572.51
7	San Angelo	District	3.0	Dry - Warm	South West	37.7	0.0455	$ 135.64	1.609	$ 84.29	$ 23,495.82	$ 4,699.2	1.609	$ 2,919.9	$ 3,564.38
15	San Antonio	District	3.0	Dry - Warm	South West	44.2	0.0455	$ 140.57	1.609	$ 87.35	$ 21,657.89	$ 4,331.6	1.609	$ 2,691.5	$ 3,776.80
14	Austin	District	4.0	Mixed	Central	35.8	0.0714	$ 134.90	1.609	$ 83.82	$ 21,503.03	$ 4,300.6	1.609	$ 2,672.3	$ 3,809.47
23	Brownwood	District	4.0	Mixed	Central	30.0	0.0714	$ 134.73	1.609	$ 83.72	$ 22,197.85	$ 4,439.6	1.609	$ 2,758.6	$ 4,001.77
17	Bryan	District	4.0	Mixed	Central	44.2	0.0714	$ 136.51	1.609	$ 84.82	$ 43,332.04	$ 8,666.4	1.609	$ 5,385.1	$ 3,872.64
9	Waco	District	4.0	Mixed	Central	30.4	0.0714	$ 135.08	1.609	$ 83.94	$ 24,289.19	$ 4,857.8	1.609	$ 3,018.5	$ 3,213.80
20	Beaumont	District	5.0	Wet Warm	Coastal	41.5	0.0912	$ 136.05	1.609	$ 84.54	$ 35,506.17	$ 7,101.2	1.609	$ 4,412.5	$ 4,116.81
16	Corpus	District	5.0	Wet Warm	Coastal	43.8	0.0912	$ 138.40	1.609	$ 86.00	$ 31,144.57	$ 6,228.9	1.609	$ 3,870.5	$ 3,884.29
12	Houston	District	5.0	Wet Warm	Coastal	41.5	0.0912	$ 142.82	1.609	$ 88.75	$ 25,391.47	$ 5,078.3	1.609	$ 3,155.5	$ 3,768.28
11	Lufkin	District	5.0	Wet Warm	Coastal	46.0	0.0912	$ 139.45	1.609	$ 86.65	$ 55,206.24	$ 11,041.2	1.609	$ 6,860.7	$ 3,965.98
13	Yokum	District	5.0	Wet Warm	Coastal	44.2	0.0912	$ 140.22	1.609	$ 87.13	$ 54,211.22	$ 10,842.2	1.609	$ 6,737.1	$ 3,536.55

	Control	$ / Mile Simulation Analysis						Control	$ / Mile Simulation Analysis					Control	$ / I	
	Control	Unpaved					Paved	Control	Unpaved - Paved					Control		
	ADT @ 0	ADT @ 100	ADT @ 200	ADT @ 300	ADT @ 400	ADT @ 500	PVD	ADT @ 0	UNPVD 100 - PVD	UNPVD 200 - PVD	UNPVD 300 - PVD	UNPVD 400 - PVD	UNPVD 500 - PVD	ADT @ 0	ADT @ 100	ADT @ 200
1.609344	**$ 5,632.70**	**$ 6,115.51**	**$ 6,437.38**	**$ 6,920.18**	**$ 7,402.98**	**$ 7,724.85**	**$ 6,276.44**	**$ (643.74)**	**$ (160.93)**	**$160.93**	**$643.74**	**$1,126.54**	**$1,448.41**	**$ 3,500.00**	**$ 3,800.00**	**$ 4,000.00**
1.609344	$ 6,276.44	$ 6,598.31	$ 7,081.11	$ 7,402.98	$ 7,885.79	$ 8,207.65	$ 6,437.38	($160.93)	$160.93	$643.74	$965.61	$1,448.41	$1,770.28	$ 3,900.00	$ 4,100.00	$ 4,400.00
1.609344	$ 3,701.49	$ 4,184.29	$ 4,506.16	$ 4,988.97	$ 5,471.77	$ 5,793.64	$ 6,115.51	($2,414.02)	($1,931.21)	($1,609.34)	($1,126.54)	($643.74)	($321.87)	$ 2,300.00	$ 2,600.00	$ 2,800.00
1.609344	$ 4,667.10	$ 4,988.97	$ 5,471.77	$ 5,793.64	$ 6,276.44	$ 6,759.24	$ 6,115.51	($1,448.41)	($1,126.54)	($643.74)	($321.87)	$160.93	$643.74	$ 2,900.00	$ 3,100.00	$ 3,400.00
1.609344	$ 5,632.70	$ 5,954.57	$ 6,437.38	$ 6,759.24	$ 7,242.05	$ 7,563.92	$ 5,954.57	($321.87)	$0.00	$482.80	$804.67	$1,287.48	$1,609.34	$ 3,500.00	$ 3,700.00	$ 4,000.00
1.609344	$ 8,046.72	$ 8,529.52	$ 8,851.39	$ 9,334.20	$ 9,817.00	$ 10,138.87	$ 6,276.44	$1,770.28	$2,253.08	$2,574.95	$3,057.75	$3,540.56	$3,862.43	$ 5,000.00	$ 5,300.00	$ 5,500.00
1.609344	$ 4,988.97	$ 5,471.77	$ 5,793.64	$ 6,276.44	$ 6,598.31	$ 7,081.11	$ 7,081.11	($2,092.15)	($1,609.34)	($1,287.48)	($804.67)	($482.80)	$0.00	$ 3,100.00	$ 3,400.00	$ 3,600.00
1.609344	$ 4,345.23	$ 4,828.03	$ 5,310.84	$ 5,632.70	$ 6,115.51	$ 6,437.38	$ 5,954.57	($1,609.34)	($1,126.54)	($643.74)	($321.87)	$160.93	$482.80	$ 2,700.00	$ 3,000.00	$ 3,300.00
1.609344	$ 6,115.51	$ 6,598.31	$ 6,920.18	$ 7,402.98	$ 7,885.79	$ 8,207.65	$ 5,632.70	$482.80	$965.61	$1,287.48	$1,770.28	$2,253.08	$2,574.95	$ 3,800.00	$ 4,100.00	$ 4,300.00
1.609344	$ 8,368.59	$ 8,690.46	$ 9,173.26	$ 9,656.06	$ 9,977.93	$ 10,460.74	$ 7,402.98	$965.61	$1,287.48	$1,770.28	$2,253.08	$2,574.95	$3,057.75	$ 5,200.00	$ 5,400.00	$ 5,700.00
1.609344	$ 7,081.11	$ 7,563.92	$ 7,885.79	$ 8,368.59	$ 8,851.39	$ 9,173.26	$ 6,276.44	$804.67	$1,287.48	$1,609.34	$2,092.15	$2,574.95	$2,896.82	$ 4,400.00	$ 4,700.00	$ 4,900.00
1.609344	$ 2,092.15	$ 2,574.95	$ 2,896.82	$ 3,379.62	$ 3,701.49	$ 4,184.29	$ 6,276.44	($4,184.29)	($3,701.49)	($3,379.62)	($2,896.82)	($2,574.95)	($2,092.15)	$ 1,300.00	$ 1,600.00	$ 1,800.00
1.609344	$ 4,345.23	$ 4,828.03	$ 5,149.90	$ 5,632.70	$ 5,954.57	$ 6,437.38	$ 6,437.38	($2,092.15)	($1,609.34)	($1,287.48)	($804.67)	($482.80)	$0.00	$ 2,700.00	$ 3,000.00	$ 3,200.00
1.609344	$ 4,184.29	$ 4,506.16	$ 4,988.97	$ 5,310.84	$ 5,793.64	$ 6,276.44	$ 5,471.77	($1,287.48)	($965.61)	($482.80)	($160.93)	$321.87	$804.67	$ 2,600.00	$ 2,800.00	$ 3,100.00
1.609344	$ 4,345.23	$ 4,667.10	$ 5,149.90	$ 5,471.77	$ 5,954.57	$ 6,437.38	$ 6,437.38	($2,092.15)	($1,770.28)	($1,287.48)	($965.61)	($482.80)	$0.00	$ 2,700.00	$ 2,900.00	$ 3,200.00
1.609344	$ 3,701.49	$ 4,184.29	$ 4,506.16	$ 4,988.97	$ 5,471.77	$ 5,793.64	$ 5,793.64	($2,092.15)	($1,609.34)	($1,287.48)	($804.67)	($321.87)	$0.00	$ 2,300.00	$ 2,600.00	$ 2,800.00
1.609344	$ 7,242.05	$ 7,724.85	$ 8,046.72	$ 8,529.52	$ 8,851.39	$ 9,334.20	$ 7,885.79	($643.74)	($160.93)	$160.93	$643.74	$965.61	$1,448.41	$ 4,500.00	$ 4,800.00	$ 5,000.00
1.609344	$ 3,862.43	$ 4,184.29	$ 4,667.10	$ 4,988.97	$ 5,471.77	$ 5,793.64	$ 5,471.77	($1,609.34)	($1,287.48)	($804.67)	($482.80)	$0.00	$321.87	$ 2,400.00	$ 2,600.00	$ 2,900.00
1.609344	$ 4,828.03	$ 5,310.84	$ 5,632.70	$ 6,115.51	$ 6,437.38	$ 6,920.18	$ 5,954.57	($1,126.54)	($643.74)	($321.87)	$160.93	$482.80	$965.61	$ 3,000.00	$ 3,300.00	$ 3,500.00
1.609344	$ 2,735.88	$ 3,218.69	$ 3,701.49	$ 4,023.36	$ 4,506.16	$ 4,828.03	$ 5,793.64	($3,057.75)	($2,574.95)	($2,092.15)	($1,770.28)	($1,287.48)	($965.61)	$ 1,700.00	$ 2,000.00	$ 2,300.00
1.609344	$ 4,667.10	$ 5,149.90	$ 5,471.77	$ 5,954.57	$ 6,276.44	$ 6,759.24	$ 5,793.64	($1,126.54)	($643.74)	($321.87)	$160.93	$482.80	$965.61	$ 2,900.00	$ 3,200.00	$ 3,400.00
1.609344	$ 4,345.23	$ 4,828.03	$ 5,149.90	$ 5,632.70	$ 6,115.51	$ 6,437.38	$ 6,115.51	($1,770.28)	($1,287.48)	($965.61)	($482.80)	$0.00	$321.87	$ 2,700.00	$ 3,000.00	$ 3,200.00
1.609344	$ 4,345.23	$ 4,667.10	$ 5,149.90	$ 5,471.77	$ 5,954.57	$ 6,276.44	$ 6,115.51	($1,770.28)	($1,448.41)	($965.61)	($643.74)	($160.93)	$160.93	$ 2,700.00	$ 2,900.00	$ 3,200.00
1.609344	$ 4,506.16	$ 4,828.03	$ 5,310.84	$ 5,632.70	$ 6,115.51	$ 6,437.38	$ 6,437.38	($1,931.21)	($1,609.34)	($1,126.54)	($804.67)	($321.87)	$0.00	$ 2,800.00	$ 3,000.00	$ 3,300.00
1.609344	$ 8,690.46	$ 9,012.33	$ 9,495.13	$ 9,977.93	$ 10,299.80	$ 10,782.60	$ 6,276.44	$2,414.02	$2,735.88	$3,218.69	$3,701.49	$4,023.36	$4,506.16	$ 5,400.00	$ 5,600.00	$ 5,900.00
1.609344	$ 4,828.03	$ 5,310.84	$ 5,632.70	$ 6,115.51	$ 6,437.38	$ 6,920.18	$ 5,149.90	($321.87)	$160.93	$482.80	$965.61	$1,287.48	$1,770.28	$ 3,000.00	$ 3,300.00	$ 3,500.00
1.609344	$ 7,081.11	$ 7,563.92	$ 7,885.79	$ 8,368.59	$ 8,690.46	$ 9,173.26	$ 6,598.31	$482.80	$965.61	$1,287.48	$1,770.28	$2,092.15	$2,574.95	$ 4,400.00	$ 4,700.00	$ 4,900.00
1.609344	$ 6,276.44	$ 6,598.31	$ 7,081.11	$ 7,563.92	$ 7,885.79	$ 8,368.59	$ 6,276.44	$0.00	$321.87	$804.67	$1,287.48	$1,609.34	$2,092.15	$ 3,900.00	$ 4,100.00	$ 4,400.00
1.609344	$ 5,149.90	$ 5,471.77	$ 5,954.57	$ 6,437.38	$ 6,759.24	$ 7,242.05	$ 6,115.51	($965.61)	($643.74)	($160.93)	$321.87	$643.74	$1,126.54	$ 3,200.00	$ 3,400.00	$ 3,700.00
1.609344	$ 11,104.47	$ 11,426.34	$ 11,909.15	$ 12,391.95	$ 12,713.82	$ 13,196.62	$ 6,437.38	$4,667.10	$4,988.97	$5,471.77	$5,954.57	$6,276.44	$6,759.24	$ 6,900.00	$ 7,100.00	$ 7,400.00
1.609344	$ 10,782.60	$ 11,265.41	$ 11,748.21	$ 12,070.08	$ 12,552.88	$ 13,035.69	$ 5,632.70	$5,149.90	$5,632.70	$6,115.51	$6,437.38	$6,920.18	$7,402.98	$ 6,700.00	$ 7,000.00	$ 7,300.00

SIMULATIONS

Km Simulation Results					$ / Km Simulation Analysis					
Unpaved			Paved	Control	Unpaved - Paved					
ADT @ 300	ADT @ 400	ADT @ 500	PVD	ADT @ 0	UNPVD 100 - PVD	UNPVD 200 - PVD	UNPVD 300 - PVD	UNPVD 400 - PVD	UNPVD 500 - PVD
$ 4,300.00	**$ 4,600.00**	**$ 4,800.00**	**$ 3,900.00**	**$ (400.00)**	**$ (100.00)**	**$100.00**	**$400.00**	**$700.00**	**$900.00**
$ 4,600.00	$ 4,900.00	$ 5,100.00	$ 4,000.00	($100.00)	$100.00	$400.00	$600.00	$900.00	$1,100.00
$ 3,100.00	$ 3,400.00	$ 3,600.00	$ 3,800.00	($1,500.00)	($1,200.00)	($1,000.00)	($700.00)	($400.00)	($200.00)
$ 3,600.00	$ 3,900.00	$ 4,200.00	$ 3,800.00	($900.00)	($700.00)	($400.00)	($200.00)	$100.00	$400.00
$ 4,200.00	$ 4,500.00	$ 4,700.00	$ 3,700.00	($200.00)	$0.00	$300.00	$500.00	$800.00	$1,000.00
$ 5,800.00	$ 6,100.00	$ 6,300.00	$ 3,900.00	$1,100.00	$1,400.00	$1,600.00	$1,900.00	$2,200.00	$2,400.00
$ 3,900.00	$ 4,100.00	$ 4,400.00	$ 4,400.00	($1,300.00)	($1,000.00)	($800.00)	($500.00)	($300.00)	$0.00
$ 3,500.00	$ 3,800.00	$ 4,000.00	$ 3,700.00	($1,000.00)	($700.00)	($400.00)	($200.00)	$100.00	$300.00
$ 4,600.00	$ 4,900.00	$ 5,100.00	$ 3,500.00	$300.00	$600.00	$800.00	$1,100.00	$1,400.00	$1,600.00
$ 6,000.00	$ 6,200.00	$ 6,500.00	$ 4,600.00	$600.00	$800.00	$1,100.00	$1,400.00	$1,600.00	$1,900.00
$ 5,200.00	$ 5,500.00	$ 5,700.00	$ 3,900.00	$500.00	$800.00	$1,000.00	$1,300.00	$1,600.00	$1,800.00
$ 2,100.00	$ 2,300.00	$ 2,600.00	$ 3,900.00	($2,600.00)	($2,300.00)	($2,100.00)	($1,800.00)	($1,600.00)	($1,300.00)
$ 3,500.00	$ 3,700.00	$ 4,000.00	$ 4,000.00	($1,300.00)	($1,000.00)	($800.00)	($500.00)	($300.00)	$0.00
$ 3,300.00	$ 3,600.00	$ 3,900.00	$ 3,400.00	($800.00)	($600.00)	($300.00)	($100.00)	$200.00	$500.00
$ 3,400.00	$ 3,700.00	$ 4,000.00	$ 4,000.00	($1,300.00)	($1,100.00)	($800.00)	($600.00)	($300.00)	$0.00
$ 3,100.00	$ 3,400.00	$ 3,600.00	$ 3,600.00	($1,300.00)	($1,000.00)	($800.00)	($500.00)	($200.00)	$0.00
$ 5,300.00	$ 5,500.00	$ 5,800.00	$ 4,900.00	($400.00)	($100.00)	$100.00	$400.00	$600.00	$900.00
$ 3,100.00	$ 3,400.00	$ 3,600.00	$ 3,400.00	($1,000.00)	($800.00)	($500.00)	($300.00)	$0.00	$200.00
$ 3,800.00	$ 4,000.00	$ 4,300.00	$ 3,700.00	($700.00)	($400.00)	($200.00)	$100.00	$300.00	$600.00
$ 2,500.00	$ 2,800.00	$ 3,000.00	$ 3,600.00	($1,900.00)	($1,600.00)	($1,300.00)	($1,100.00)	($800.00)	($600.00)
$ 3,700.00	$ 3,900.00	$ 4,200.00	$ 3,600.00	($700.00)	($400.00)	($200.00)	$100.00	$300.00	$600.00
$ 3,500.00	$ 3,800.00	$ 4,000.00	$ 3,800.00	($1,100.00)	($800.00)	($600.00)	($300.00)	$0.00	$200.00
$ 3,400.00	$ 3,700.00	$ 3,900.00	$ 3,800.00	($1,100.00)	($900.00)	($600.00)	($400.00)	($100.00)	$100.00
$ 3,500.00	$ 3,800.00	$ 4,000.00	$ 4,000.00	($1,200.00)	($1,000.00)	($700.00)	($500.00)	($200.00)	$0.00
$ 6,200.00	$ 6,400.00	$ 6,700.00	$ 3,900.00	$1,500.00	$1,700.00	$2,000.00	$2,300.00	$2,500.00	$2,800.00
$ 3,800.00	$ 4,000.00	$ 4,300.00	$ 3,200.00	($200.00)	$100.00	$300.00	$600.00	$800.00	$1,100.00
$ 5,200.00	$ 5,400.00	$ 5,700.00	$ 4,100.00	$300.00	$600.00	$800.00	$1,100.00	$1,300.00	$1,600.00
$ 4,700.00	$ 4,900.00	$ 5,200.00	$ 3,900.00	$0.00	$200.00	$500.00	$800.00	$1,000.00	$1,300.00
$ 4,000.00	$ 4,200.00	$ 4,500.00	$ 3,800.00	($600.00)	($400.00)	($100.00)	$200.00	$400.00	$700.00
$ 7,700.00	$ 7,900.00	$ 8,200.00	$ 4,000.00	$2,900.00	$3,100.00	$3,400.00	$3,700.00	$3,900.00	$4,200.00
$ 7,500.00	$ 7,800.00	$ 8,100.00	$ 3,500.00	$3,200.00	$3,500.00	$3,800.00	$4,000.00	$4,300.00	$4,600.00

TxDOT Average Bid Unit Price Analysis

District Order	Location	Location Description	Climate Zone	Climate Type	Geographic Region	Tier II or III B.I. 316 Seal Coat Oil $ / GAL	Average $ - Actual $	SD's away from Average	B.I. 316 Grade 4 rock $ / CY	Average $ - Actual $	SD's away from Average	B.I. 310 Prime $ / GAL	Average $ - Actual $	SD's away from Average	Type	CY- TY D or A B.I. 247 Flex Base $ / CY	Average $ - Actual $	SD's away from Average
Z6	Zone 6 Texas	State Average	0.0	All	State (Whole)	$ 3.19			$ 70.07			$ 3.81				$ 34.86		
Z1	Zone 1	CZ Regional Average	0.1	Dry - Cold	North	$ 3.42	$ (0.23)	(0.46)	$ 77.59	$ (7.51)	$ (0.35)	$ 4.36	$ (0.54)	(0.59)		$ 38.26	$ (3.41)	(0.24)
Z2	Zone 2	CZ Regional Average	0.2	Wet - Cold	North East	$ 3.21	$ (0.02)	(0.03)	$ 63.34	$ 6.73	$ 0.32	$ 4.38	$ (0.57)	(0.62)		$ 22.33	$ 12.53	0.87
Z3	Zone 3	CZ Regional Average	0.3	Dry - Warm	South West	$ 3.05	$ 0.14	0.29	$ 73.36	$ (3.29)	$ (0.15)	$ 3.37	$ 0.45	0.48		$ 28.13	$ 6.73	0.47
Z4	Zone 4	CZ Regional Average	0.4	Mixed	Central	$ 3.12	$ 0.07	0.14	$ 61.37	$ 8.70	$ 0.41	$ 3.80	$ 0.02	0.02		$ 34.20	$ 0.66	0.05
Z5	Zone 5	CZ Regional Average	0.5	Wet Warm	Coastal	$ 3.17	$ 0.02	0.04	$ 70.96	$ (0.89)	$ (0.04)	$ 3.36	$ 0.45	0.49		$ 50.08	$ (15.23)	(1.05)
8	Abilene	District	1.0	Dry - Cold	North	$ 4.57	$ (1.38)	(2.79)	$ 67.48	$ 2.59	$ 0.12	$ 4.87	$ (1.06)	(1.15)		$ 30.50	$ 4.36	0.30
4	Amarillo	District	1.0	Dry - Cold	North	$ 2.94	$ 0.25	0.50	$ 68.00	$ 2.07	$ 0.10	$ 4.36	$ (0.54)	(0.59)		$ 26.80	$ 8.06	0.56
25	Childress	District	1.0	Dry - Cold	North	$ 2.76	$ 0.43	0.87	$ 59.65	$ 10.42	$ 0.49	$ 4.53	$ (0.72)	(0.78)	CSS1-H	$ 38.04	$ (3.18)	(0.22)
5	Lubbock	District	1.0	Dry - Cold	North	$ 3.57	$ (0.38)	(0.77)	$ 118.80	$ (48.73)	$ (2.28)	$ 3.96	$ (0.15)	(0.16)	MC-30	$ 51.75	$ (16.89)	(1.17)
3	W. Falls	District	1.0	Dry - Cold	North	$ 3.25	$ (0.06)	(0.12)	$ 74.00	$ (3.93)	$ (0.18)	$ 4.06	$ (0.25)	(0.27)	MC-30	$ 44.23	$ (9.37)	(0.65)
19	Atlanta	District	2.0	Wet - Cold	North East	$ 3.60	$ (0.41)	(0.83)	$ 55.00	$ 15.07	$ 0.71	$ 4.24	$ (0.43)	(0.46)		$ 12.00	$ 22.86	1.58
18	Dallas	District	2.0	Wet - Cold	North East	$ 3.65	$ (0.46)	(0.93)	$ 63.34	$ 6.73	$ 0.32	$ 3.54	$ 0.27	0.30	MC-30	$ 26.20	$ 8.66	0.60
2	FT Worth	District	2.0	Wet - Cold	North East	$ 2.66	$ 0.53	1.07	$ 53.00	$ 17.07	$ 0.80	$ 5.00	$ (1.19)	(1.29)	RC-250	$ 25.11	$ 9.75	0.67
1	Paris	District	2.0	Wet - Cold	North East	$ 3.43	$ (0.24)	(0.49)	$ 77.00	$ (6.93)	$ (0.32)	$ 4.53	$ (0.72)	(0.78)	MC-30	$ 26.00	$ 8.86	0.61
10	Tyler	District	2.0	Wet - Cold	North East	$ 2.69	$ 0.50	1.01	$ 68.35	$ 1.72	$ 0.08	$ 4.60	$ (0.79)	(0.85)	MC-30	$ 22.33	$ 12.53	0.87
24	El Paso	District	3.0	Dry - Warm	South West	$ 4.11	$ (0.92)	(1.86)	$ 128.50	$ (58.43)	$ (2.74)	$ 1.32	$ 2.49	2.71	CSS1	$ 45.00	$ (10.14)	(0.70)
22	Laredo	District	3.0	Dry - Warm	South West	$ 2.20	$ 0.99	2.00	$ 71.00	$ (0.93)	$ (0.04)	$ 3.78	$ 0.03	0.04	MC-30	$ 23.00	$ 11.86	0.82
6	Odessa	District	3.0	Dry - Warm	South West	$ 3.12	$ 0.07	0.14	$ 59.77	$ 10.30	$ 0.48	$ 3.49	$ 0.32	0.35	AE-P	$ 29.50	$ 5.36	0.37
21	Pharr	District	3.0	Dry - Warm	South West	$ 2.90	$ 0.29	0.58	$ 56.47	$ 13.60	$ 0.64	$ 4.01	$ (0.20)	(0.21)	MC-30	$ 16.38	$ 18.48	1.28
7	San Angelo	District	3.0	Dry - Warm	South West	$ 2.77	$ 0.42	0.85	$ 60.76	$ 9.31	$ 0.44	$ 4.94	$ (1.13)	(1.22)	MC-30	$ 28.65	$ 6.21	0.43
15	San Antonio	District	3.0	Dry - Warm	South West	$ 3.18	$ 0.01	0.02	$ 63.67	$ 6.40	$ 0.30	$ 2.67	$ 1.14	1.24	AE-P	$ 26.25	$ 8.61	0.60
14	Austin	District	4.0	Mixed	Central	$ 3.35	$ (0.16)	(0.33)	$ 60.00	$ 10.07	$ 0.47	$ 3.40	$ 0.41	0.45	MC-30	$ 26.11	$ 8.75	0.60
23	Brownwood	District	4.0	Mixed	Central	$ 3.40	$ (0.21)	(0.43)	$ 75.00	$ (4.93)	$ (0.23)	$ 4.08	$ (0.27)	(0.29)	MC-30	$ 27.00	$ 7.86	0.54
17	Bryan	District	4.0	Mixed	Central	$ 3.03	$ 0.16	0.32	$ 77.88	$ (7.81)	$ (0.37)	$ 3.95	$ (0.14)	(0.15)		$ 54.00	$ (19.14)	(1.32)
9	Waco	District	4.0	Mixed	Central	$ 2.70	$ 0.49	0.99	$ 32.60	$ 37.47	$ 1.76	$ 3.75	$ 0.06	0.07	MC-30	$ 29.67	$ 5.19	0.36
20	Beaumont	District	5.0	Wet Warm	Coastal	$ 3.25	$ (0.06)	(0.12)	$ 90.90	$ (20.83)	$ (0.98)	$ 4.01	$ (0.20)	(0.21)		$ 44.00	$ (9.14)	(0.63)
16	Corpus	District	5.0	Wet Warm	Coastal	$ 3.02	$ 0.17	0.34	$ 79.29	$ (9.22)	$ (0.43)	$ 2.75	$ 1.06	1.16		$ 38.40	$ (3.54)	(0.24)
12	Houston	District	5.0	Wet Warm	Coastal	$ 3.10	$ 0.09	0.18	$ 66.00	$ 4.07	$ 0.19	$ 1.65	$ 2.16	2.35	MC-30	$ 31.00	$ 3.86	0.27
11	Lufkin	District	5.0	Wet Warm	Coastal	$ 3.50	$ (0.31)	(0.63)	$ 68.00	$ 2.07	$ 0.10	$ 4.50	$ (0.69)	(0.75)	RC-250	$ 69.15	$ (34.29)	(2.37)
13	Yokum	District	5.0	Wet Warm	Coastal	$ 2.97	$ 0.22	0.44	$ 50.61	$ 19.46	$ 0.91	$ 3.91	$ (0.10)	(0.10)	RC-250	$ 67.87	$ (33.01)	(2.28)
						SD	*$ 0.49*		*SD*	*$ 21.33*		*SD*	*$ 0.92*			*SD*	*$ 14.47*	
						Var	*$ 0.25*		*Var*	*$ 454.90*		*Var*	*$ 0.85*			*Var*	*$ 209.31*	
						Pop SD	*$ 0.48*		*Pop SD*	*$ 20.90*		*Pop SD*	*$ 0.90*			*Pop SD*	*$ 14.18*	
						Pop Var	*$ 0.24*		*Pop Var*	*$ 436.70*		*Pop Var*	*$ 0.81*			*Pop Var*	*$ 200.94*	

RSMeans Multipliers		Equipment		Labor	
TxDOT Districts	**RSM Cities**	**Individual Multiplier**	**Average Multiplier**	**Individual Multiplier**	**Average Multiplier**
Abilene			**88.90%**		**85.70%**
	Abilene	88.9%		86.00%	
	Eastland	88.9%		85.40%	
Amarillo			**88.90%**		**87.10%**
	Amarillo	88.9%		87.10%	
Atlanta			**90.50%**		**89.70%**
	Longview	90.5%		89.30%	
	Texarkana	90.5%		90.10%	
Austin			**88.60%**		**86.10%**
	Austin	88.6%		86.80%	
	Giddings	88.6%		85.40%	
Beaumont			**89.80%**		**86.30%**
	Beaumont	89.8%		86.30%	
Brownwood			**88.90%**		**85.50%**
	Brownwood	88.9%		85.50%	
Bryan			**89.80%**		**86.95%**
	Bryan	89.8%		87.90%	
	Huntsville	89.8%		86.00%	
Childress			**88.90%**		**85.90%**
	Childress	88.9%		85.90%	
Corpus Christi			**95.70%**		**82.60%**
	Corpus Christi	95.7%		82.60%	
Dallas			**96.40%**		**84.47%**
	Dallas	98.0%		87.30%	
	McKinney	95.6%		82.80%	
	Waxahachie	95.6%		83.30%	
El Paso			**88.90%**		**85.40%**
	El Paso	88.9%		85.40%	
Fort Worth			**91.80%**		**82.55%**
	Denton	94.7%		78.70%	
	Fort Worth	88.9%		86.40%	
Houston			**98.45%**		**85.60%**
	Galveston	98.5%		85.70%	
	Houston	98.4%		85.50%	
Laredo			**88.60%**		**85.85%**
	Del Rio	88.6%		85.10%	
	Laredo	88.6%		86.60%	

RSM Multiplier Table

Lubbock			**97.20%**		**84.30%**
	Lubbock	97.2%		84.30%	
Lufkin			**90.50%**		**90.30%**
	Lufkin	90.5%		90.30%	
Odessa			**93.05%**		**85.30%**
	Midland	97.2%		84.30%	
	Odessa	88.9%		86.30%	
Paris			**95.60%**		**82.20%**
	Greenville	95.6%		82.20%	
Pharr			**95.70%**		**82.50%**
	McAllen	95.7%		82.50%	
San Angelo			**88.90%**		**86.80%**
	San Angelo	88.9%		86.80%	
San Antonio			**91.00%**		**91.30%**
	San Antonio	91.0%		91.30%	
Tyler			**90.50%**		**90.10%**
	Palestine	90.5%		90.10%	
	Tyler	90.5%		90.10%	
Waco			**88.90%**		**85.80%**
	Temple	88.9%		85.20%	
	Waco	88.9%		86.40%	
Wichita Falls			**88.90%**		**86.00%**
	Wichita Falls	88.9%		86.00%	
Yoakum			**97.95%**		**82.50%**
	Victoria	97.4%		81.10%	
	Wharton	98.5%		83.90%	

Appendix B

SUMMARY OF HDM3 INPUTS

Screen	Page	Category	Input Description	Optional Input	Current Input Value	Constant Input	Zero Range	Low Range	Medium Range	High Range	Unit
Analysis Control	1		Description	Name		Sensitivity					
Analysis Control	1		Run Date	Date		16/1/12					D/M/Y
Analysis Control	1		Discount Rate		12	12	0	6	12	18	%
Analysis Control	1		Analysis Period		20	20	0	10	20	30	Year
Analysis Control	1		Calendar Year of Initial Year		2011	2012					Year
Analysis Control	1		Input Currency Name		Dollars	Dollars					Dollars
Analysis Control	1		Output Currency Name		Dollars	Dollars					Dollars
Analysis Control	1		Output Currency Conversion Multiplier		1	1	0	0.5	1	1.5	Ratio
Road Characteristics	1		Description	Name		Sensitivity A					
Road Characteristics	1		Paved or Unpaved	P or U		P	U		P		P or U
Road Characteristics	1	Geometry	Road Length		10	66	0	33	66	99	km
Road Characteristics	1	Geometry	Road Width		10	14	2.5	7	14	21	m
Road Characteristics	1	Geometry	One Should Width		0.4	2	0	1	2	3	m
Road Characteristics	1	Geometry	Effective Number of Lanes								
Road Characteristics	1	Geometry	Rise & Fall		0	40	0	20	40	60	m/km
Road Characteristics	1	Geometry	Curvature		0	40	0	20	40	60	deg/km
Road Characteristics	1	Geometry	Superelevation								%
Road Characteristics	1	Environment	Altitude		518	500	0	250	500	750	m
Road Characteristics	1	Environment	Rainfall		0.0635	0.0635	0	0.03175	0.0635	0.09525	m/month
Road Characteristics *Paved*	2	Surface	Surface Type		1	1	4	5	1	2	(Table)
Road Characteristics *Paved*	2	Surface	Thickness: New Layers		51	50	0	25	50	75	mm
Road Characteristics *Paved*	2	Surface	Old Surfacing Layers		0	0	0	25	50	75	mm
Road Characteristics *Paved*	2	Base/Subgrade	Base Type		1	1			1		(Table)
Road Characteristics *Paved*	2	Base/Subgrade	Subgrade CBR		2	10	0	5	10	15	%
Road Characteristics *Paved*	2	Base/Subgrade	If Base Type=2 Thickness of base latyers								mm
Road Characteristics *Paved*	2	Base/Subgrade	If Base Type=2 Resilent Modulus of Soil								Gpa
Road Characteristics *Paved*	2	Strength	Structural Number								
Road Characteristics *Paved*	2	Strength	Benkelman Beam Deflection								mm
Road Characteristics *Paved*	2	Condition	Roughness		6	3	0	3	6	9	IRI
Road Characteristics *Paved*	2	Condition	Construction Fault Code		0	0	1		0		
Road Characteristics *Paved*	2	Condition	Area All Cracks		0	10	0	5	10	15	%
Road Characteristics *Paved*	2	Condition	Wide Cracks		0	10	0	5	10	15	%
Road Characteristics *Paved*	2	Condition	Potholes		0	10	0	5	10	15	%
Road Characteristics *Paved*	2	Condition	Ravelled		0	10	0	5	10	15	%
Road Characteristics *Paved*	2	Condition	Rut Depth		0	50	0	25	50	75	mm
Road Characteristics *Paved*	2	Condition	Rut Depth St. Deviation		0	20	0	10	20	30	mm
Road Characteristics *Paved*	2	History	<ALL INPUTS>		0	0			0		
Road Characteristics *Paved*	2	Deterioration Factors	<ALL INPUTS>		1	1			1		
Road Characteristics *Unpaved*	2	Condition	Gravel Thickness		152.4		0	75	150	225	mm
Road Characteristics *Unpaved*	2	Condition	Gravel Age		0		0	2.5	5	7.5	y
Road Characteristics *Unpaved*	2	Condition	Road Roughness				0	1.5	3	4.5	IRI
Road Characteristics *Unpaved*	2	Condition	Compaction Code		1		0			1	
Road Characteristics *Unpaved*	2	Surface	Minimum Roughness				0	1.5	3	4.5	IRI
Road Characteristics *Unpaved*	2	Surface	Maximum Roughness				0	1.5	3	4.5	IRI
Road Characteristics *Unpaved*	2	Surface	Maximum Particle Size		22.2		0	10	20	30	mm
Road Characteristics *Unpaved*	2	Surface	Plasticity Index		10		0	5	10	15	%
Road Characteristics *Unpaved*	2	Surface	Material Passing 2.00mm Sieve		70		0	35	70	105	%
Road Characteristics *Unpaved*	2	Surface	Material Passing 0.425mm Sieve		30		0	15	30	45	%
Road Characteristics *Unpaved*	2	Surface	Material Passing 0.0075mm Sieve		10		0	5	10	15	%
Road Characteristics *Unpaved*	2	Base/Subgrade	Minimum Roughness				0	1.5	3	4.5	IRI
Road Characteristics *Unpaved*	2	Base/Subgrade	Maximum Roughness				0	1.5	3	4.5	IRI
Road Characteristics *Unpaved*	2	Base/Subgrade	Maximum Particle Size		100		0	150	100	200	mm
Road Characteristics *Unpaved*	2	Base/Subgrade	Plasticity Index		20		0	10	20	30	%
Road Characteristics *Unpaved*	2	Base/Subgrade	Material Passing 2.00mm Sieve		35		0	15	30	45	%
Road Characteristics *Unpaved*	2	Base/Subgrade	Material Passing 0.425mm Sieve		20		0	10	20	30	%
Road Characteristics *Unpaved*	2	Base/Subgrade	Material Passing 0.0075mm Sieve		12		0	6	12	18	%
Road Characteristics	3	Traffic	Average Daily Traffic (Car)			250	0	125	250	375	ADT
Road Characteristics	3	Traffic	Average Daily Traffic (Heavy Truck)			24	0	12	24	36	ADT
Road Characteristics	3	Traffic	Traffic Growth (Car)		0	10	0	5	10	15	%
Road Characteristics	3	Traffic	Traffic Growth (Heavy Truck)		0	10	0	5	10	15	%
Road Characteristics	3	Congestion	Include Congestion Effects		N	N					
Road Characteristics	3	Congestion	Road Type		N/A						
Road Characteristics	3	Congestion	Road Use		N/A						
Road Characteristics	3	Congestion	Roadside Friction		1	1					
Operations Unit Cost	1		Description	Name							
Operations Unit Cost	1	Operation	Grading Cost		621.4	100	0	50	100	150	km
Operations Unit Cost	1	Operation	Spot Regraveling Cost		15.29	15	0	7.5	15	22.5	m^3
Operations Unit Cost	1	Operation	Gravel Resurfacing Cost		25.41	25	0	12.5	25	37.5	m^3
Operations Unit Cost	1	Operation	Unpaved Routine Maintenance Cost		1604	1600	0	800	1600	2400	km/year
Operations Unit Cost	1	Operation	Patching Cost		38	40	0	20	40	60	m^2
Operations Unit Cost	1	Operation	Resealing Cost		2.78	3	0	1.5	3	4.5	m^2
Operations Unit Cost	1	Operation	Overlay Cost		4.46	5	0	2.5	5	7.5	m^2
Operations Unit Cost	1	Operation	Reconstruction Cost		7	7	0	3.5	7	10.5	m^2
Operations Unit Cost	1	Operation	Pave Routine Maintenance Cost		4828	5000	0	2500	5000	7500	km/year
Operations Unit Cost	1	Operation	Construction Cost		37.2	40	0	20	40	60	Thousands/km
Paved Maintenance Policy	1		Description	Name		Sensivity					
Paved Maintenance Policy	1	Routine Maintenance	Yes or No	Y or N	Y	Y	N		Y		Y or N
Paved Maintenance Policy	1	Routine Maintenance	Cost Factor		1	1	0	0.5	1	1.5	Ratio
Paved Maintenance Policy	1	Patching	Yes or No	Y or N	Y	Y	N		Y		Y or N
Paved Maintenance Policy	1	Patching	Scheduled or Responsive	S or R		S	R		S		S or R
Paved Maintenance Policy	1	Patching	Area to be Patched	S		20	0	10	20	30	m^2/km/y
Paved Maintenance Policy	1	Patching	Percent of pothole are to be patched	R		66	0	33	66	99	%
Paved Maintenance Policy	1	Patching	Maximum applicable area	R		20	0	10	20	30	m^2/km/y
Paved Maintenance Policy	1	Patching	Cost Factor		1	1	0	0.5	1	1.5	Ratio
Paved Maintenance Policy	1	Patching	Last application year								year
Paved Maintenance Policy	1	Patching	Maximum applicable roughness								IRI
Paved Maintenance Policy	1	Resealing	Yes or No	Y or N	Y	Y	N		Y		Y or N
Paved Maintenance Policy	1	Resealing	Scheduled or Responsive	S or R		S	R		S		S or R
Paved Maintenance Policy	1	Resealing	Resealing Interval	S		10	0	5	10	15	year
Paved Maintenance Policy	1	Resealing	Maximum allowable total damaged area	R			0	10	20	30	%
Paved Maintenance Policy	1	Resealing	Minimum applicable resealing interval	R			0	5	10	15	year
Paved Maintenance Policy	1	Resealing	Maximum applicable resealing interval	R			0	5	10	15	year
Paved Maintenance Policy	2	Resealing	Cost Factor		1	1	0	0.5	1	1.5	Ratio
Paved Maintenance Policy	2	Resealing	Resealing Type		1	1			1		?
Paved Maintenance Policy	2	Resealing	Resealing Strength coefficient		0.25	0.25			0.25		
Paved Maintenance Policy	2	Resealing	Reasealing thickness		12	12	0	6	12	18	mm
Paved Maintenance Policy	2	Resealing	Last application year								year
Paved Maintenance Policy	2	Resealing	Maximum applicable roughness			6	0	3	6	9	IRI
Paved Maintenance Policy	2	Overlay	Yes or No	Y or N	Y	Y	N		Y		Y or N
Paved Maintenance Policy	2	Overlay	Scheduled or Responsive	S or R	S	S	R		S		S or R
Paved Maintenance Policy	2	Overlay	Overlay Interval	S		10	0	5	10	15	year
Paved Maintenance Policy	2	Overlay	Maximum allowable roughness	R			0	1.5	3	4.5	IRI
Paved Maintenance Policy	2	Overlay	Minimum applicable overlay interval	R			0	5	10	15	year
Paved Maintenance Policy	2	Overlay	Maximum applicable overlay interval	R			0	5	10	15	year
Paved Maintenance Policy	2	Overlay	Cost factor		1	1	0	0.5	1	1.5	Ratio
Paved Maintenance Policy	2	Overlay	Overlay type		2	2	3		2		(Table)
Paved Maintenance Policy	2	Overlay	Overlay strength coefficient		0.4	0.4			0.04		?
Paved Maintenance Policy	2	Overlay	Overlay thickness		50.8	50	0	25	50	75	mm
Paved Maintenance Policy	2	Overlay	Last application year								year
Paved Maintenance Policy	2	Overlay	Roughness after overlay			6	0	3	6	9	IRI
Paved Maintenance Policy	3	Reconstruction	Yes or No	Y or N	Y	Y	N		Y		Y or N
Paved Maintenance Policy	3	Reconstruction	Scheduled or Responsive	S or R		S	R		S		S or R
Paved Maintenance Policy	3	Reconstruction	Reconstruction Interval	S	20	20	0	10	20	30	year
Paved Maintenance Policy	3	Reconstruction	Maximum allowable roughness	R			0	1.5	3	4.5	IRI
Paved Maintenance Policy	3	Reconstruction	Minimum applicable overlay interval	R			0	5	10	15	year
Paved Maintenance Policy	3	Reconstruction	Maximum applicable overlay interval	R			0	5	10	15	
Paved Maintenance Policy	3	Reconstruction	Cost Factor		1	1	0	0.5	1	1.5	Ratio
Paved Maintenance Policy	3	Reconstruction	New structural number		3	3	0	1	3	5	
Paved Maintenance Policy	3	Reconstruction	Surface Type		1	1	4	5	1	2	(Table)
Paved Maintenance Policy	3	Reconstruction	Total new surfacing layer thickness		76.2	66	0	33	66	99	mm

Paved Maintenance Policy	3	Reconstruction	Base Type		1	1			1		(Table)
Paved Maintenance Policy	3	Reconstruction	Construction fault code		0	0	1		0		
Paved Maintenance Policy	4	Reconstruction	Last application year								year
Paved Maintenance Policy	4	Reconstruction	Roughness after reconstruction			6	0	3	6	9	IRI
Unpaved Maintenance Policy	1		Description	Name							
Unpaved Maintenance Policy	1	Routine Maintenance P	Yes or No	Y or N	Y	Y	N		Y		Y or N
Unpaved Maintenance Policy	1	Routine Maintenance P	Cost Factor		1	1	0	0.5	1	1.5	Ratio
Unpaved Maintenance Policy	1	Grading	Yes or No	Y or N	Y	Y	N		Y		Y or N
Unpaved Maintenance Policy	1	Grading	Scheduled or Responsive	S or R		S	R		S		S or R
Unpaved Maintenance Policy	1	Grading	Time interval between grading	S			0	30	60	90	days
Unpaved Maintenance Policy	1	Grading	Traffic interval between grading	R							veh
Unpaved Maintenance Policy	1	Grading	Minimum applicable time interval	R			0	30	60	90	days
Unpaved Maintenance Policy	1	Grading	Maximum applicable time interval	R			0	30	60	90	days
Unpaved Maintenance Policy	2	Grading	Cost Factor		1		0	0.5	1	1.5	Ratio
Unpaved Maintenance Policy	2	Spot Regravelling	Yes or No	Y or N	Y	Y	N		Y		Y or N
Unpaved Maintenance Policy	2	Spot Regravelling	Scheduled or Responsive	S or R		S	R		S		S or R
Unpaved Maintenance Policy	2	Spot Regravelling	Gravel volume	S			0	10	20	30	m^3/km/y
Unpaved Maintenance Policy	2	Spot Regravelling	Percent annual material loss replaced	R			0	33	66	99	%
Unpaved Maintenance Policy	2	Spot Regravelling	Maximum applicable gravel volume	R			0	10	20	30	m^3/km/y
Unpaved Maintenance Policy	2	Spot Regravelling	Cost Factor		1		0	0.5	1	1.5	Ratio
Unpaved Maintenance Policy	2	Resurfacing	Yes or No	Y or N	Y	Y	N		Y		Y or N
Unpaved Maintenance Policy	2	Resurfacing	Scheduled or Responsive	S or R		S	R		S		S or R
Unpaved Maintenance Policy	3	Resurfacing	Resurfacing Interval	S							year
Unpaved Maintenance Policy	3	Resurfacing	Minimum allowable thickness	R			0	10	20	30	mm
Unpaved Maintenance Policy	3	Resurfacing	Minimum applicable resurfacing interval	R							year
Unpaved Maintenance Policy	3	Resurfacing	Maximum applicable resurfacning interval	R							year
Unpaved Maintenance Policy	3	Resurfacing	Cost factor		1		0	0.5	1	1.5	Ratio
Unpaved Maintenance Policy	3	Resurfacing	Increase in gravel thickness		25.1		0	15	30	45	mm
Unpaved Maintenance Policy	3	Resurfacing	Last applicable year								year
Unpaved Maintenance Policy	3	Resurfacing	Initial roughness				0	1.5	3	4.5	IRI
Unpaved Maintenance Policy	3	Resurfacing	Compaction code		1	1	0		1		
Unpaved Maintenance Policy	3	Resurfacing	Maximum Particle Size		22.2		0	15	30	45	mm
Unpaved Maintenance Policy	4	Resurfacing	Plasticity Index		10		0	5	10	15	%
Unpaved Maintenance Policy	4	Resurfacing	Material Passing 2.00mm Sieve		70		0	33	66	99	%
Unpaved Maintenance Policy	4	Resurfacing	Material Passing 0.425mm Sieve		30		0	33	66	99	%
Unpaved Maintenance Policy	4	Resurfacing	Material Passing 0.0075mm Sieve		10		0	33	66	99	%
Unpaved Maintenance Policy	4	Resurfacing	Minimum Roughness				0	1.5	3	4.5	IRI
Unpaved Maintenance Policy	4	Resurfacing	Maximum Roughness				0	1.5	3	4.5	IRI

SUMMARY OF HDM3 INPUTS

Screen	Page	Category	Input Description	Optional Input	Current Input Value	Constant Input	Zero Range	Low Range	Medium Range	High Range	Unit	Comments	Ignore (5)	Constant (19)	Known (6)	Unknown (13)
													Y / -	Y / -	Y / -	Y / -
Paved Maintenance Policy	3	Reconstruction	Scheduled or Responsive	S or R		S	R		S		S or R	*Scheduled or Responcive for patching?*		Y		Y
Paved Maintenance Policy	3	Reconstruction	Maximum applicable overlay interval	R			1.00	5.00	10.00	15.00		*not in scope therefore Scheduled only*	Y			
Paved Maintenance Policy	3	Reconstruction	Minimum applicable overlay interval	R			1.00	5.00	10.00	15.00	year	*not in scope therefore Scheduled only*	Y			
Paved Maintenance Policy	3	Reconstruction	Maximum allowable roughness	R			5.00	7.00	3.00	9.00	IRI	*not in scope therefore Scheduled only*	Y			
Paved Maintenance Policy	3	Reconstruction	Reconstruction Interval	S	20.00	20.00	1.00	10.00	20.00	30.00	year	*interval for resconstruciton of paved surface*		Y		Y
Paved Maintenance Policy	1	Patching	Maximum applicable area	R		20.00	-	10.00	20.00	30.00	m^2/km/y	*optional, not in scope if Responsive*	Y			
Paved Maintenance Policy	1	Patching	Scheduled or Responsive	S or R		S	R				S or R	*Scheduled or Responcive for patching?*		Y		Y
Paved Maintenance Policy	1	Resealing	Yes or No	Y or N	Y	Y	N		Y		Y or N	*Resealing included in maint policy?*		Y	Y	
Operations Unit Cost	1	Operation	Patching Cost		38.00	40.00	-	20.00	40.00	60.00	m^2	*Inputs from survey, Surface Patching cost per square meter*		Y		Y
Paved Maintenance Policy	1	Patching		S		20.00	-	10.00	20.00	30.00	m^2/km/y	*Area to be Patch*		Y		Y
Paved Maintenance Policy	1	Patching	Percent of pothole are to be patched	R		66.00	-	33.00	66.00	99.00	%	*Percent of pothole are to be patched*		Y		Y
Paved Maintenance Policy	1	Patching	Cost Factor	R	1.00	1.00	-	0.50	1.00	1.50	Ratio	*can be used for regional cost difference*		Y		Y
Paved Maintenance Policy	1	Patching	Yes or No	Y or N	Y	Y	N		Y		Y or N	*Patching Included in policy*		Y	Y	
Paved Maintenance Policy	2	Overlay	Yes or No	Y or N	Y	Y	N		Y		Y or N	*Overlay included in policy*		Y	Y	
Analysis Control	1		Analysis Period		20.00	20.00	10.00	15.00	20.00	25.00	Year	*(Life-cycle financial evaluation)*		Y	Y	
Paved Maintenance Policy	2	Overlay		S		10.00	1.00	5.00	10.00	15.00	year	*If (S) - Interval per year for overlay operation*		Y		Y
Paved Maintenance Policy	1	Resealing		S		10.00	1.00	5.00	10.00	15.00	year	*Interval per year for resealing.*		Y		Y
Paved Maintenance Policy	2	Overlay	Maximum allowable roughness	R			2.30	6.00	3.00	9.00	IRI	*not in scope therefore Scheduled only*	Y			
Operations Unit Cost	1	Operation	Pave Routine Maintenance Cost		4,828.00	5,000.00	-	2,500.00	5,000.00	7,500.00	km/year	*Inputs from survey, All inclusive cost of paved maintenance per km per year*		Y		Y
Paved Maintenance Policy	1	Routine Maintenance	Cost Factor		1.00	1.00	-	0.50	1.00	1.50	Ratio	*Routine Maintenance cost factor*		Y		Y
Road Characteristics	1	Geometry	Road Width		10.00	14.00	2.50	7.00	14.00	21.00	m	*(establishing modeling)*		Y	Y	
Operations Unit Cost	1	Operation	Overlay Cost		4.46	5.00	-	2.50	5.00	7.50	m^2	*Inputs from survey, Bituminious overlay placed by paver <125mm*		Y		Y
Paved Maintenance Policy	2	Overlay	Cost factor		1.00	1.00	-	0.50	1.00	1.50	Ratio	*can be used for regional cost difference*		Y		Y
Analysis Control	1		Output Currency Conversion Multiplier		1.00	1.00	0.10	0.50	1.00	1.50	Ratio	*(used from exchange rate, when input currency varies from output)*		Y	Y	

Verify in Research (6)			HDM3 Actual Outputs				Percent Difference				
Y / -	Base Line	Variable #	Zero Output Range	Low Output Range	Medium Output Range	High Output Range	Zero Output Range	Low Output Range	Medium Output Range	High Output Range	Aveage
	$ 12,522.00		$ 151,161.00		$ 12,522.00		8%		100%		54%
	$ 12,522.00		$ 15,161.00	$ 15,161.00	$ 15,161.00	$ 15,161.00	83%	83%	83%	83%	83%
	$ 12,522.00		$ 15,161.00	$ 15,161.00	$ 15,161.00	$ 15,161.00	83%	83%	83%	83%	83%
	$ 12,522.00		$ 15,161.00	$ 15,161.00	$ 15,161.00	$ 12,522.00	83%	83%	83%	100%	87%
	$ 12,522.00		$ 15,161.00	$ 15,161.00	$ 12,522.00	$ 12,522.00	83%	83%	100%	100%	91%
	$ 12,522.00	44	$ 14,916.00	$ 12,177.00	$ 12,361.00	$ 12,539.00	84%	103%	101%	100%	97%
	$ 12,522.00		$ 12,361.00		$ 12,522.00		101%		100%		101%
	$ 12,522.00	46	$ 12,361.00		$ 12,522.00		101%		100%		101%
Y	$ 12,522.00	34	$ 12,000.00	$ 12,256.00	$ 12,522.00	$ 12,778.00	104%	102%	100%	98%	101%
	$ 12,522.00	42	$ 12,000.00	$ 12,256.00	$ 12,522.00	$ 12,778.00	104%	102%	100%	98%	101%
	$ 12,522.00	43	$ 12,000.00	$ 12,361.00	$ 12,361.00	$ 12,361.00	104%	101%	101%	101%	102%
Y	$ 12,522.00	45	$ 12,000.00	$ 12,177.00	$ 12,361.00	$ 12,539.00	104%	103%	101%	100%	102%
	$ 12,522.00	41	$ 12,000.00		$ 12,522.00		104%		100%		102%
	$ 12,522.00	53	$ 10,663.00		$ 12,522.00		117%		100%		109%
	$ 12,522.00	2	$ 12,723.00	$ 10,149.00	$ 12,522.00	$ 11,018.00	98%	123%	100%	114%	109%
	$ 12,522.00		$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 9,062.00	100%	100%	100%	138%	110%
	$ 12,522.00	47	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 9,062.00	100%	100%	100%	138%	110%
	$ 12,522.00		ERROR	$ 12,622.00	$ 12,522.00	$ 9,062.00		99%	100%	138%	112%
Y	$ 12,522.00	38	$ 7,522.00	$ 10,022.00	$ 12,522.00	$ 15,022.00	166%	125%	100%	83%	119%
Y	$ 12,522.00	40	$ 7,522.00	$ 10,022.00	$ 12,522.00	$ 15,022.00	166%	125%	100%	83%	119%
	$ 12,522.00	6	$ 6,772.00	$ 9,022.00	$ 12,522.00	$ 16,022.00	185%	139%	100%	78%	125%
Y	$ 12,522.00	36	$ 5,522.00	$ 9,022.00	$ 12,522.00	$ 16,022.00	227%	139%	100%	78%	136%
Y	$ 12,522.00		$ 5,522.00	$ 9,022.00	$ 12,522.00	$ 16,022.00	227%	139%	100%	78%	136%
	$ 12,522.00	3	$ 1,249.00	$ 6,256.00	$ 12,522.00	$ 18,778.00	1003%	200%	100%	67%	342%

SUMMARY OF HDM3 INPUTS

Screen	Page	Category	Input Description	Optional Input	Current Input Value	Constant Input	Zero Range	Low Range	Medium Range	High Range	Unit	Comments	Base Line	HDM3 Actual Outputs: Zero Output Range	HDM3 Actual Outputs: Low Output Range	HDM3 Actual Outputs: Medium Output Range	HDM3 Actual Outputs: High Output Range	Percent Difference: Zero Output Range	Percent Difference: Low Output Range	Percent Difference: Medium Output Range	Percent Difference: High Output Range	Percent Difference: Average
Analysis Control	1		Description	Name		Sensitivity							$ 12,522.00									
Analysis Control	1		Run Date	Date		16/1/12					D/M/Y	Day/Month/Year	$ 12,522.00									
Analysis Control	1		Discount Rate		12	12	1	6	12	18	%	(used to compute	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Analysis Control	1		Analysis Period		20	20	10	15	20	25	Year	(Life-cycle financi	$ 12,522.00	$ 12,723.00	$ 10,149.00	$ 12,522.00	$ 11,018.00	98%	123%	100%	114%	109%
Analysis Control	1		Calendar Year of Initial Year		2011	2012					Year	(first year in the a	$ 12,522.00									
Analysis Control	1		Input Currency Name		Dollars	Dollars					Dollars		$ 12,522.00									
Analysis Control	1		Output Currency Name		Dollars	Dollars					Dollars		$ 12,522.00									
Analysis Control	1		Output Currency Conversion Multiplier		1	1	0.1	0.5	1	1.5	Ratio	(used from exchai	$ 12,522.00	$ 1,249.00	$ 6,256.00	$ 12,522.00	$ 18,778.00	1003%	200%	100%	67%	342%
Road Characteristics	1		Description	Name		Sensitivity A							$ 12,522.00									
Road Characteristics	1		Paved or Unpaved	P or U		P	U		P		P or U	Optional input de	$ 12,522.00			$ 12,522.00				100%		100%
Road Characteristics	1	Geometry	Road Length		10	66	1	33	66	99	km	(constants were u	$ 12,522.00	$ 12,650.00	$ 12,512.00	$ 12,522.00	$ 12,519.00	99%	100%	100%	100%	100%
Road Characteristics	1	Geometry	Road Width		10	14	2.5	7	14	21	m	(establishing mod	$ 12,522.00	$ 6,772.00	$ 9,022.00	$ 12,522.00	$ 16,022.00	185%	139%	100%	78%	125%
Road Characteristics	1	Geometry	One Should Width		0.4	2	0	1	2	3	m	(establishing mod	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics	1	Geometry	Effective Number of Lanes										$ 12,522.00									
Road Characteristics	1	Geometry	Rise & Fall		0	40	0	20	40	60	m/km	assumed flat	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics	1	Geometry	Curvature		0	40	0	20	40	60	deg/km	assumed straight	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics	1	Geometry	Superelevation								%		$ 12,522.00									
Road Characteristics	1	Environment	Altitude		518	500	0	250	500	750	m	USDA? Average fr	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics	1	Environment	Rainfall		0.0635	0.0635	0	0.0317	0.0635	0.0952	m/month	USDA? Average fr	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics Paved	2	Surface	Surface Type		1	1	4	5	1	2	(Table)	1=Surface Treatm	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics Paved	2	Surface	Thickness: New Layers		51	50	5	25	50	75	mm	2"	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics Paved	2	Surface	Old Surfacing Layers		0	0	0	25	50	75	mm	optional, out of sc	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics Paved	2	Base/Subgrade	Base Type		1	1			1		(Table)	1=Granular	$ 12,522.00			$ 12,522.00				100%		100%
Road Characteristics Paved	2	Base/Subgrade	Subgrade CBR		2	10	2	6	10	14	%	Not in scope, set t	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics Paved	2	Base/Subgrade	If Base Type=2 Thickness of base latyers								mm		$ 12,522.00									
Road Characteristics Paved	2	Base/Subgrade	If Base Type=2 Resilent Modulus of Soil								Gpa		$ 12,522.00									
Road Characteristics Paved	2	Strength	Structural Number										$ 12,522.00									
Road Characteristics Paved	2	Strength	Benkelman Beam Deflection								mm		$ 12,522.00									
Road Characteristics Paved	2	Condition	Roughness		6	6	1	3	6	9	IRI	(2=smooth, assun	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics Paved	2	Condition	Construction Fault Code		0	0	1		0			0=Good Construct	$ 12,522.00	$ 12,522.00		$ 12,522.00		100%		100%		100%
Road Characteristics Paved	2	Condition	Area All Cracks		0	10	0	5	10	15	%	(assumed mainte	$ 12,522.00	ERROR	ERROR	$ 12,522.00	$ 12,522.00			100%	100%	100%
Road Characteristics Paved	2	Condition	Wide Cracks		0	10	0	5	10	15	%	(assumed mainte	$ 12,522.00	$ 12,361.00	$ 12,522.00	$ 12,522.00		101%	100%	100%		100%
Road Characteristics Paved	2	Condition	Potholes		0	10	0	5	10	15	%	(assumed mainte	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics Paved	2	Condition	Ravelled		0	10	0	5	10	15	%	(assumed mainte	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics Paved	2	Condition	Rut Depth		0	50	0	25	50	75	mm	(assumed mainte	$ 12,522.00	ERROR	$ 12,522.00	$ 12,522.00	ERROR		100%	100%		100%
Road Characteristics Paved	2	Condition	Rut Depth St. Deviation		0	20	0	10	20	30	mm	(assumed mainte	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics Paved	2	History	<ALL INPUTS>		0	0			0			(assumed mainte	$ 12,522.00			$ 12,522.00				100%		100%
Road Characteristics Paved	2	Deterioration Factors	<ALL INPUTS>		1	1			1			(assumed all equ	$ 12,522.00			$ 12,522.00				100%		100%
Road Characteristics	3	Traffic	Average Daily Traffic (Car)			250	0	125	250	375	ADT	Car & Heavy Truc	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics	3	Traffic	Average Daily Traffic (Heavy Truck)			24	0	12	24	36	ADT	Car & Heavy Truc	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics	3	Traffic	Traffic Growth (Car)		0	10	0	5	10	15	%	optional, not in sc	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics	3	Traffic	Traffic Growth (Heavy Truck)		0	10	0	5	10	15	%	optional, not in sc	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Road Characteristics	3	Congestion	Include Congestion Effects		N	N						optional, not in sc	$ 12,522.00									
Road Characteristics	3	Congestion	Road Type		N/A							optional, not in sc	$ 12,522.00									
Road Characteristics	3	Congestion	Road Use		N/A							optional, not in sc	$ 12,522.00									
Road Characteristics	3	Congestion	Roadside Friction		1	1						optional, not in sc	$ 12,522.00									
Operations Unit Cost	1		Description	Name								Description of ope	$ 12,522.00									
Operations Unit Cost	1	Operation	Grading Cost		621.4	100	0	50	100	150	km	Inputs from surve	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Operations Unit Cost	1	Operation	Spot Regraveling Cost		15.29	15	0	7.5	15	22.5	m^3	Inputs from surve	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Operations Unit Cost	1	Operation	Gravel Resurfacing Cost		25.41	25	0	12.5	25	37.5	m^3	Inputs from surve	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Operations Unit Cost	1	Operation	Unpaved Routine Maintenance Cost		1604	1600	0	800	1600	2400	km/year	Inputs from surve	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Operations Unit Cost	1	Operation	Patching Cost		38	40	0	20	40	60	m^2	Inputs from surve	$ 12,522.00	$ 12,000.00	$ 12,256.00	$ 12,522.00	$ 12,778.00	104%	102%	100%	98%	101%
Operations Unit Cost	1	Operation	Resealing Cost		2.78	3	0	1.5	3	4.5	m^2	Inputs from surve	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Operations Unit Cost	1	Operation	Overlay Cost		4.46	5	0	2.5	5	7.5	m^2	Inputs from surve	$ 12,522.00	$ 5,522.00	$ 9,022.00	$ 12,522.00	$ 16,022.00	227%	139%	100%	78%	136%
Operations Unit Cost	1	Operation	Reconstruction Cost		7	7	0	3.5	7	10.5	m^2	Inputs from surve	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Operations Unit Cost	1	Operation	Pave Routine Maintenance Cost		4828	5000	0	2500	5000	7500	km/year	Inputs from surve	$ 12,522.00	$ 7,522.00	$ 10,022.00	$ 12,522.00	$ 15,022.00	166%	125%	100%	83%	119%
Operations Unit Cost	1	Operation	Construction Cost		37.2	40	0	20	40	60	Thousands/km	Inputs from surve	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	1		Description	Name		Sensivity						Description of the	$ 12,522.00									
Paved Maintenance Policy	1	Routine Maintenance	Yes or No	Y or N	Y	Y			Y		Y or N	Routine Maintenc	$ 12,522.00			$ 12,522.00				100%		100%
Paved Maintenance Policy	1	Routine Maintenance	Cost Factor		1	1	0	0.5	1	1.5	Ratio	Routine Mainten	$ 12,522.00	$ 7,522.00	$ 10,022.00	$ 12,522.00	$ 15,022.00	166%	125%	100%	83%	119%
Paved Maintenance Policy	1	Patching	Yes or No	Y or N	Y	Y	N		Y		Y or N	Patching Included	$ 12,522.00	$ 12,000.00		$ 12,522.00		104%		100%		102%
Paved Maintenance Policy	1	Patching	Scheduled or Responsive	S or R		S	R				S or R	Scheduled or Resp	$ 12,522.00	$ 12,361.00		$ 12,522.00		101%		100%		101%
Paved Maintenance Policy	1	Patching		S		20	0	10	20	30	$m^2/km/y$	Area to be Patch	$ 12,522.00	$ 12,000.00	$ 12,256.00	$ 12,522.00	$ 12,778.00	104%	102%	100%	98%	101%
Paved Maintenance Policy	1	Patching	[illegible]	R		66	0	33	66	99	%	Percent of pothol	$ 12,522.00	$ 12,000.00	$ 12,361.00	$ 12,361.00	$ 12,361.00	104%	101%	101%	101%	102%
Paved Maintenance Policy	1	Patching	Maximum applicable area	R		20	0	10	20	30	$m^2/km/y$	optional, not in sc	$ 12,522.00	$ 14,916.00	$ 12,177.00	$ 12,361.00	$ 12,539.00	84%	103%	101%	100%	97%
Paved Maintenance Policy	1	Patching	Cost Factor	R	1	1	0	0.5	1	1.5	Ratio	can be used for re	$ 12,522.00	$ 12,000.00	$ 12,177.00	$ 12,361.00	$ 12,539.00	104%	103%	101%	100%	102%
Paved Maintenance Policy	1	Patching	Last application year								year	optional, not in sc	$ 12,522.00									
Paved Maintenance Policy	1	Patching	Maximum applicable roughness								IRI	optional, not in sc	$ 12,522.00									
Paved Maintenance Policy	1	Resealing	Yes or No	Y or N	Y	Y	N		Y		Y or N	Resealing include	$ 12,522.00	$ 12,361.00		$ 12,522.00		101%		100%		101%
Paved Maintenance Policy	1	Resealing	Scheduled or Responsive	S or R		S	R		S		S or R	Scheduled or Resp	$ 12,522.00			$ 12,522.00				100%		100%
Paved Maintenance Policy	1	Resealing		S		10	1	5	10	15	year	Interval per year	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 9,062.00	100%	100%	100%	138%	110%
Paved Maintenance Policy	1	Resealing	Maximum allowable total damaged area	R		20	0	10	20	30	%	Maximum percer	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	1	Resealing	Minimum applicable resealing interval	R		10	1	5	10	15	year	optinal, not if sco	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	1	Resealing	Maximum applicable resealing interval	R		10	1	5	10	15	year	optinal, not if sco	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	2	Resealing	Cost Factor		1	1	0	0.5	1	1.5	Ratio	can be used for re	$ 12,522.00									
Paved Maintenance Policy	2	Resealing	Resealing Type	S	1	1			1			Surface treatmen	$ 12,522.00			$ 12,522.00				100%		100%
Paved Maintenance Policy	2	Resealing	Resealing Strength coefficient	S	0.25	0.25			0.25			Suggest value is .	$ 12,522.00			$ 12,522.00				100%		100%
Paved Maintenance Policy	2	Resealing	Reasealing thickness	S	12	12	4	8	12	16	mm	.5" to resealing o	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	2	Resealing	Last application year								year	optional, not in sc	$ 12,522.00									
Paved Maintenance Policy	2	Resealing	Maximum applicable roughness			8	4	6	8	10	IRI	optional, not in sc	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	2	Overlay	Yes or No	Y or N	Y	Y	N		Y		Y or N	Overlay included	$ 12,522.00	$ 10,663.00		$ 12,522.00		117%		100%		109%
Paved Maintenance Policy	2	Overlay	Scheduled or Responsive	S or R	S	S	R		S		S or R	Scheduled or Resp	$ 12,522.00	$ 12,522.00		$ 12,522.00		100%		100%		100%

Paved Maintenance Policy	2	Overlay		S		10	1	5	10	15	year	If (S) - Interval pe	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 9,062.00	100%	100%	100%	138%	110%
Paved Maintenance Policy	2	Overlay	Maximum allowable roughness	R			2.3	6	3	9	IRI	not in scope there	$ 12,522.00	ERROR	$ 12,622.00	$ 12,522.00	$ 9,062.00		99%	100%	138%	112%
Paved Maintenance Policy	2	Overlay	Minimum applicable overlay interval	R			1	5	10	15	year	not in scope there	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	2	Overlay	Maximum applicable overlay interval	R			1	5	10	15	year	not in scope there	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	2	Overlay	Cost factor		1	1	0	0.5	1	1.5	Ratio	can be used for re	$ 12,522.00	$ 5,522.00	$ 9,022.00	$ 12,522.00	$ 16,022.00	227%	139%	100%	78%	136%
Paved Maintenance Policy	2	Overlay	Overlay type		2	2	3		2		(Table)	Asphalt concrete	$ 12,522.00	$ 12,522.00		$ 12,522.00		100%		100%		100%
Paved Maintenance Policy	2	Overlay	Overlay strength coefficient		0.4	0.4			0.04			Suggest value is .4	$ 12,522.00			$ 12,522.00				100%		100%
Paved Maintenance Policy	2	Overlay	Overlay thickness		50.8	50	20	35	50	65	mm	2"	$ 12,522.00	$ 12,562.00	$ 12,562.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	2	Overlay	Last application year								year	optional, not in sc	$ 12,522.00									
Paved Maintenance Policy	2	Overlay	Roughness after overlay			6	2	4	6	8	IRI	optional, not in sc	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	3	Reconstruction	Yes or No	Y or N	Y	Y	N		Y		Y or N	Patching Included	$ 12,522.00	$ 12,522.00		$ 12,522.00		100%		100%		100%
Paved Maintenance Policy	3	Reconstruction	Scheduled or Responsive	S or R		S	R		S		S or R	Scheduled or Resp	$ 12,522.00	$ 151,161.00		$ 12,522.00		8%		100%		54%
Paved Maintenance Policy	3	Reconstruction	Reconstruction Interval	S	20	20	1	10	20	30	year	interval for recon	$ 12,522.00	$ 15,161.00	$ 15,161.00	$ 12,522.00	$ 12,522.00	83%	83%	100%	100%	91%
Paved Maintenance Policy	3	Reconstruction	Maximum allowable roughness	R			5	7	3	9	IRI	not in scope there	$ 12,522.00	$ 15,161.00	$ 15,161.00	$ 15,161.00	$ 12,522.00	83%	83%	83%	100%	87%
Paved Maintenance Policy	3	Reconstruction	Minimum applicable overlay interval	R			1	5	10	15	year	not in scope there	$ 12,522.00	$ 15,161.00	$ 15,161.00	$ 15,161.00	$ 15,161.00	83%	83%	83%	83%	83%
Paved Maintenance Policy	3	Reconstruction	Maximum applicable overlay interval	R			1	5	10	15		not in scope there	$ 12,522.00	$ 15,161.00	$ 15,161.00	$ 15,161.00	$ 15,161.00	83%	83%	83%	83%	83%
Paved Maintenance Policy	3	Reconstruction	Cost Factor		1	1	0	0.5	1	1.5	Ratio	can be used for re	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	3	Reconstruction	New structural number		3	3	0	1	3	5		unknown	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	3	Reconstruction	Surface Type		1	1	4	5	1	2	(Table)	Surface treateme	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	3	Reconstruction	Total new surfacing layer thickness		76.2	66	0	33	66	99	mm	3"	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%
Paved Maintenance Policy	3	Reconstruction	Base Type		1	1			1		(Table)	Granular	$ 12,522.00			$ 12,522.00				100%		100%
Paved Maintenance Policy	3	Reconstruction	Construction fault code		0	0	1		0			0 for Good Constr	$ 12,522.00	$ 12,522.00		$ 12,522.00		100%		100%		100%
Paved Maintenance Policy	4	Reconstruction	Last application year								year	optional, not in sc	$ 12,522.00									
Paved Maintenance Policy	4	Reconstruction	Roughness after reconstruction			6	0	3	6	9	IRI	optional, not in sc	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	$ 12,522.00	100%	100%	100%	100%	100%

SUMMARY OF HDM3 INPUTS

Screen	Page	Category	Input Description	Optional Input	Current Input Value	Constant Input	Zero Range	Low Range	Medium Range	High Range	Unit	Comments	Base Line	HDM3 Ac Zero Output Range	 Low Output Range
Unpaved Maintenance Policy	3	Resurfacing	Maximum applicable resurfacning interval	R			1.00	10.00	19.00	28.00	year	*Max. time interval*	**$ 4,155.00**	ERROR	$ 18,909.00
Unpaved Maintenance Policy	3	Resurfacing	Minimum allowable thickness	R			10.00	80.00	150.00	220.00	mm	*Minimum thickness of gravel*	**$ 4,155.00**	$ 15,630.00	$ 17,270.00
Unpaved Maintenance Policy	1	Grading	Traffic interval between grading	R		600.00	100.00	350.00	600.00	850.00	veh	*Vehicle count between grading*	**$ 4,155.00**	$ 10,836.00	$ 10,836.00
Unpaved Maintenance Policy	1	Grading	Maximum applicable time interval	R			5.00	35.00	65.00	95.00	days	*Max. time interval*	**$ 4,155.00**	$ 10,836.00	$ 10,836.00
Unpaved Maintenance Policy	1	Grading	Scheduled or Responsive	S or R		S	R		S		S or R	*Scheduled or Responcive for grading?*	**$ 4,155.00**	$ 10,836.00	
Unpaved Maintenance Policy	2	Spot Regravelling	Percent annual material loss replaced	R			-	33.00	66.00	99.00	%	*Percentage of loss material replaced*	**$ 4,155.00**	$ 3,852.00	$ 6,614.00
Unpaved Maintenance Policy	3	Resurfacing	Resurfacing Interval	S		10.00	1.00	5.00	10.00	15.00	year	*Years bewteen resurfacing*	**$ 4,155.00**	$ 18,909.00	$ 5,794.00
Unpaved Maintenance Policy	2	Spot Regravelling	Scheduled or Responsive	S or R		S	R		S		S or R	*Scheduled or Responcive for spot regraveling?*	**$ 4,155.00**	$ 6,852.00	
Unpaved Maintenance Policy	1	Grading	Time interval between grading	S		60.00	5.00	30.00	60.00	90.00	days	*Days between grading*	**$ 4,155.00**	$ 10,836.00	$ 4,761.00
Unpaved Maintenance Policy	1	Grading	Minimum applicable time interval	R			5.00	35.00	65.00	95.00	days	*Min. time interval*	**$ 4,155.00**	$ 10,836.00	$ 4,579.00
Unpaved Maintenance Policy	2	Spot Regravelling	Maximum applicable gravel volume	R			-	10.00	20.00	30.00	m^3/km/y	*Max. Volume/length/year to be filled.*	**$ 4,155.00**	$ 6,852.00	$ 4,003.00
Road Characteristics	1	Geometry	One Should Width		0.40	2.00	-	1.00	2.00	3.00	m	*(establishing modeling)*	**$ 4,155.00**	$ 3,950.00	$ 4,053.00
Operations Unit Cost	1	Operation	Spot Regraveling Cost		15.29	15.00	-	7.50	15.00	22.50	m^3	*Inputs from survey, Spot regraveling cost per cubic*	**$ 4,155.00**	$ 3,852.00	$ 4,003.00
Unpaved Maintenance Policy	2	Spot Regravelling		S			-	10.00	20.00	30.00	m^3/km/y	*Volume/length/year to be filled.*	**$ 4,155.00**	$ 3,852.00	$ 4,003.00
Unpaved Maintenance Policy	2	Spot Regravelling	Cost Factor		1.00		-	0.50	1.00	1.50	Ratio	*can be used for regional cost difference*	**$ 4,155.00**	$ 3,852.00	$ 4,003.00
Unpaved Maintenance Policy	2	Spot Regravelling	Yes or No	Y or N	Y	Y	N		Y		Y or N	*Spot Regraveling Included in policy*	**$ 4,155.00**	$ 3,852.00	
Operations Unit Cost	1	Operation	Grading Cost		621.40	100.00	-	50.00	100.00	150.00	km	*Inputs from survey, Grading cost per km of road gr*	**$ 4,155.00**	$ 3,533.00	$ 3,836.00
Unpaved Maintenance Policy	2	Grading	Cost Factor		1.00		-	0.50	1.00	1.50	Ratio	*can be used for regional cost difference*	**$ 4,155.00**	$ 3,533.00	$ 3,836.00
Unpaved Maintenance Policy	1	Grading	Yes or No	Y or N	Y	Y	N		Y		Y or N	*Grading Included in policy*	**$ 4,155.00**	$ 3,533.00	
Analysis Control	1		Analysis Period		20.00	20.00	10.00	15.00	20.00	25.00	Year	*(Life-cycle financial evaluation)*	**$ 4,155.00**	$ 4,155.00	$ 3,068.00
Road Characteristics	1	Geometry	Road Width		10.00	14.00	2.50	7.00	14.00	21.00	m	*(establishing modeling)*	**$ 4,155.00**	$ 2,976.00	$ 3,438.00
Unpaved Maintenance Policy	3	Resurfacing	Increase in gravel thickness		25.10	41.00	1.00	21.00	41.00	61.00	mm	*1" of material added to unpaved surface*	**$ 4,155.00**	$ 2,555.00	$ 3,355.00
Operations Unit Cost	1	Operation	Unpaved Routine Maintenance Cost		1,604.00	1,600.00	-	800.00	1,600.00	2,400.00	km/year	*Inputs from survey, All inclusive cost of unpaved m*	**$ 4,155.00**	$ 2,549.00	$ 3,352.00
Unpaved Maintenance Policy	1	Routine Maintenance Policy	Cost Factor		1.00	1.00	-	0.50	1.00	1.50	Ratio	*Routine Maintenance cost factor*	**$ 4,155.00**	$ 2,549.00	$ 3,352.00
Operations Unit Cost	1	Operation	Gravel Resurfacing Cost		25.41	25.00	-	12.50	25.00	37.50	m^3	*Inputs from survey, Gravel Resurfacing per cubic m*	**$ 4,155.00**	$ 2,515.00	$ 3,335.00
Unpaved Maintenance Policy	3	Resurfacing	Cost factor		1.00		-	0.50	1.00	1.50	Ratio	*can be used for regional cost difference*	**$ 4,155.00**	$ 2,515.00	$ 3,335.00
Unpaved Maintenance Policy	3	Resurfacing	Minimum applicable resurfacing interval	R			1.00	11.00	21.00	30.00	year	*Min. time interval*	**$ 4,155.00**	$ 18,909.00	$ 3,335.00
Unpaved Maintenance Policy	2	Resurfacing	Yes or No	Y or N	Y	Y	N		Y		Y or N	*Grading Included in policy*	**$ 4,155.00**	$ 2,515.00	
Analysis Control	1		Output Currency Conversion Multiplier		1.00	1.00	0.01	0.50	1.00	1.50	Ratio	*(used from exchange rate, when input currency va*	**$ 4,155.00**	$ 47.00	$ 2,077.00

ctual Outputs		Percent Difference				
Medium Output Range	High Output Range	Zero Output Range	Low Output Range	Medium Output Range	High Output Range	**Aveage**
$ 18,909.00	$ 18,909.00		22%	22%	22%	**22%**
$ 18,909.00	$ 18,909.00	27%	24%	22%	22%	**24%**
$ 10,836.00	$ 10,836.00	38%	38%	38%	38%	**38%**
$ 10,836.00	$ 10,836.00	38%	38%	38%	38%	**38%**
$ 4,155.00		38%		100%		**69%**
$ 6,852.00	$ 6,852.00	108%	63%	61%	61%	**73%**
$ 4,155.00	$ 3,335.00	22%	72%	100%	125%	**80%**
$ 4,155.00		61%		100%		**80%**
$ 4,155.00	$ 3,942.00	38%	87%	100%	105%	**83%**
$ 4,094.00	$ 3,937.00	38%	91%	101%	106%	**84%**
$ 4,155.00	$ 4,291.00	61%	104%	100%	97%	**90%**
$ 4,155.00	$ 4,258.00	105%	103%	100%	98%	**101%**
$ 4,155.00	$ 4,291.00	108%	104%	100%	97%	**102%**
$ 4,155.00	$ 4,291.00	108%	104%	100%	97%	**102%**
$ 4,155.00	$ 4,291.00	108%	104%	100%	97%	**102%**
$ 4,155.00		108%		100%		**104%**
$ 4,155.00	$ 4,458.00	118%	108%	100%	93%	**105%**
$ 4,155.00	$ 4,458.00	118%	108%	100%	93%	**105%**
$ 4,155.00		118%		100%		**109%**
$ 4,155.00	$ 3,827.00	100%	135%	100%	109%	**111%**
$ 4,155.00	$ 4,873.00	140%	121%	100%	85%	**111%**
$ 4,155.00	$ 4,955.00	163%	124%	100%	84%	**118%**
$ 4,155.00	$ 4,942.00	163%	124%	100%	84%	**118%**
$ 4,155.00	$ 4,942.00	163%	124%	100%	84%	**118%**
$ 4,155.00	$ 4,976.00	165%	125%	100%	84%	**118%**
$ 4,155.00	$ 4,976.00	165%	125%	100%	84%	**118%**
$ 2,515.00	$ 2,515.00	22%	125%	165%	165%	**119%**
$ 4,155.00		165%		100%		**133%**
$ 4,155.00	$ 6,218.00	8840%	200%	100%	67%	**2302%**

UNPAVED Analysis

SUMMARY OF HDM3 INPUTS

Screen	Page	Category	Input Description	Optional Input	Current Input Value	Constant Input	Zero Range	Low Range	Medium Range	High Range	Unit	Comments	Base Line	HDM3 Actual Outputs: Zero Output Range	HDM3 Actual Outputs: Low Output Range	HDM3 Actual Outputs: Medium Output Range	HDM3 Actual Outputs: High Output Range	Percent Difference: Zero Output Range	Percent Difference: Low Output Range	Percent Difference: Medium Output Range	Percent Difference: High Output Range	Percent Difference: Aveage
Analysis Control	1		Description	Name		Sensitivity							4155									
Analysis Control	1		Run Date	Date		16/1/12					D/M/Y	Day/Month/Year	4155									
Analysis Control	1		Discount Rate		12	12	0	6	12	18	%	(used to computed pre	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Analysis Control	1		Analysis Period		20	20	10	15	20	25	Year	(Life-cycle financial eva	4155	4155	3068	4155	3827	100%	135%	100%	109%	111%
Analysis Control	1		Calendar Year of Initial Year		2011	2012					Year	(first year in the analys	4155									
Analysis Control	1		Input Currency Name		Dollars	Dollars					Dollars		4155									
Analysis Control	1		Output Currency Name		Dollars	Dollars					Dollars		4155									
Analysis Control	1		Output Currency Conversion Multiplier		1	1	0.01	0.5	1	1.5	Ratio	(used from exchange r	4155	47	2077	4155	6218	8840%	200%	100%	67%	2302%
Road Characteristics	1		Description	Name		Sensitivity A							4155									
Road Characteristics	1		Paved or Unpaved	P or U		P	U		P		P or U	Optional input determ	4155	4155				100%				100%
Road Characteristics	1	Geometry	Road Length		10	66	1	33	66	99	km	(constants were used f	4155	4600	4155	4155	4146	90%	100%	100%	100%	98%
Road Characteristics	1	Geometry	Road Width		10	14	2.5	7	14	21	m	(establishing modeling	4155	2976	3438	4155	4873	140%	121%	100%	85%	111%
Road Characteristics	1	Geometry	One Should Width		0.4	2	0	1	2	3	m	(establishing modeling	4155	3950	4053	4155	4258	105%	103%	100%	98%	101%
Road Characteristics	1	Geometry	Effective Number of Lanes										4155									
Road Characteristics	1	Geometry	Rise & Fall		0	40	0	20	40	60	m/km	assumed flat	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics	1	Geometry	Curvature		0	40	0	20	40	60	deg/km	assumed straight	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics	1	Geometry	Superelevation								%		4155									
Road Characteristics	1	Environment	Altitude		518	500	0	250	500	750	m	USDA? Average from E	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics	1	Environment	Rainfall		0.0635	0.0635	0	0.03175	0.0635	0.09525	m/month	USDA? Average from E	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics Unpaved	2	Condition	Gravel Thickness		152.4	150	0	75	150	225	mm	6"	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics Unpaved	2	Condition	Gravel Age		0	5	0	3	6	9	y	assumed for new cons	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics Unpaved	2	Condition	Road Roughness				2	12	22	32	IRI	not in scope	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics Unpaved	2	Condition	Compaction Code		1		0		1			1=Mechnical Compacti	4155	4155		4155		100%		100%		100%
Road Characteristics Unpaved	2	Surface	Minimum Roughness				0	1.5	3	4.5	IRI	not in scope	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics Unpaved	2	Surface	Maximum Roughness				0	1.5	3	4.5	IRI	not in scope	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics Unpaved	2	Surface	Maximum Particle Size		22.2	20	0	10	20	30	mm	Type II Flex Base (TxDo	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics Unpaved	2	Surface	Plasticity Index		10	10	0	5	10	15	%	Type II Flex Base (TxDo	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics Unpaved	2	Surface	Material Passing 2.00mm Sieve		70	70	0	35	70	100	%	Type II Flex Base (TxDo	4155	ERROR	4155	4155	4155		100%	100%	100%	100%
Road Characteristics Unpaved	2	Surface	Material Passing 0.425mm Sieve		30	30	0	15	30	45	%	Type II Flex Base (TxDo	4155	ERROR	4155	4155	4155		100%	100%	100%	100%
Road Characteristics Unpaved	2	Surface	Material Passing 0.0075mm Sieve		10	10	0	5	10	15	%	Type II Flex Base (TxDo	4155	ERROR	4155	4155	4155		100%	100%	100%	100%
Road Characteristics Unpaved	2	Base/Subgrade	Minimum Roughness				2	4	6	8	IRI	optional not in scope	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics Unpaved	2	Base/Subgrade	Maximum Roughness				2	4	6	8	IRI	optional not in scope	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics Unpaved	2	Base/Subgrade	Maximum Particle Size		100	100	0	50	100	150	mm	USDA? Average from E	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics Unpaved	2	Base/Subgrade	Plasticity Index		20	20	0	10	20	30	%	USDA? Average from E	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics Unpaved	2	Base/Subgrade	Material Passing 2.00mm Sieve		35	30	0	15	30	45	%	USDA? Average from E	4155	ERROR	4155	4155	4155		100%	100%	100%	100%
Road Characteristics Unpaved	2	Base/Subgrade	Material Passing 0.425mm Sieve		20	20	0	10	20	30	%	USDA? Average from E	4155	ERROR	ERROR	4155	4155			100%	100%	100%
Road Characteristics Unpaved	2	Base/Subgrade	Material Passing 0.0075mm Sieve		12	12	0	6	12	18	%	USDA? Average from E	4155	ERROR	4155	4155	4155		100%	100%	100%	100%
Road Characteristics	3	Traffic	Average Daily Traffic (Car)			250	0	125	250	375	ADT	Car & Heavy Truck onl	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics	3	Traffic	Average Daily Traffic (Heavy Truck)			24	0	12	24	36	ADT	Car & Heavy Truck onl	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics	3	Traffic	Traffic Growth (Car)		0	10	0	5	10	15	%	optional, not in scope	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics	3	Traffic	Traffic Growth (Heavy Truck)		0	10	0	5	10	15	%	optional, not in scope	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Road Characteristics	3	Congestion	Include Congestion Effects		N	N						optional, not in scope	4155									
Road Characteristics	3	Congestion	Road Type		N/A							optional, not in scope	4155									
Road Characteristics	3	Congestion	Road Use		N/A							optional, not in scope	4155									
Road Characteristics	3	Congestion	Roadside Friction		1	1						optional, not in scope	4155									
Operations Unit Cost	1		Description	Name								Description of operatio	4155									
Operations Unit Cost	1	Operation	Grading Cost		621.4	100	0	50	100	150	km	Inputs from survey, Gr	4155	3533	3836	4155	4458	118%	108%	100%	93%	105%
Operations Unit Cost	1	Operation	Spot Regraveling Cost		15.29	15	0	7.5	15	22.5	m^3	Inputs from survey, Sp	4155	3852	4003	4155	4291	108%	104%	100%	97%	102%
Operations Unit Cost	1	Operation	Gravel Resurfacing Cost		25.41	25	0	12.5	25	37.5	m^3	Inputs from survey, Gr	4155	2515	3335	4155	4976	165%	125%	100%	84%	118%
Operations Unit Cost	1	Operation	Unpaved Routine Maintenance Cost		1604	1600	0	800	1600	2400	km/year	Inputs from survey, All	4155	2549	3352	4155	4942	163%	124%	100%	84%	118%
Operations Unit Cost	1	Operation	Patching Cost		38	40	0	20	40	60	m^2	Inputs from survey, Su	4155									
Operations Unit Cost	1	Operation	Resealing Cost		2.78	3	0	1.5	3	4.5	m^2	Inputs from survey, Ch	4155		Chris:							
Operations Unit Cost	1	Operation	Overlay Cost		4.46	5	0	2.5	5	7.5	m^2	Inputs from survey, Bit	4155	applies to paved not unpaved								
Operations Unit Cost	1	Operation	Reconstruction Cost		7	7	0	3.5	7	10.5	m^2	Inputs from survey, All	4155									
Operations Unit Cost	1	Operation	Pave Routine Maintenance Cost		4828	5000	0	2500	5000	7500	km/year	Inputs from survey, All	4155									
Operations Unit Cost	1	Operation	Construction Cost		37.2	40	0	20	40	60	Thousands/km	Inputs from survey, Co	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Unpaved Maintenance Policy	1		Description	Name								Description of mainten	4155									
Unpaved Maintenance Policy	1	Routine Maintenance Policy	Yes or No	Y or N	Y	Y			Y		Y or N	Routine Maintenance i	4155			4155				100%		100%
Unpaved Maintenance Policy	1	Routine Maintenance Policy	Cost Factor		1	1	0	0.5	1	1.5	Ratio	Routine Maintenance c	4155	2549	3352	4155	4942	163%	124%	100%	84%	118%
Unpaved Maintenance Policy	1	Grading	Yes or No	Y or N	Y	Y	N		Y		Y or N	Grading Included in po	4155	3533		4155		118%		100%		109%
Unpaved Maintenance Policy	1	Grading	Scheduled or Responsive	S or R		S	R		S		S or R	Scheduled or Responci	4155	10836		4155		38%		100%		69%
Unpaved Maintenance Policy	1	Grading	Time interval between grading	S		60	5	30	60	90	days	Days between grading	4155	10836	4761	4155	3942	38%	87%	100%	105%	83%
Unpaved Maintenance Policy	1	Grading	Traffic interval between grading	R		600	100	350	600	850	veh	Vehicle count between	4155	10836	10836	10836	10836	38%	38%	38%	38%	38%
Unpaved Maintenance Policy	1	Grading	Minimum applicable time interval	R			5	35	65	95	days	Min. time interval	4155	10836	4579	4094	3937	38%	91%	101%	106%	84%
Unpaved Maintenance Policy	1	Grading	Maximum applicable time interval	R			5	35	65	95	days	Max. time interval	4155	10836	10836	10836	10836	38%	38%	38%	38%	38%
Unpaved Maintenance Policy	2	Grading	Cost Factor		1		0	0.5	1	1.5	Ratio	can be used for region	4155	3533	3836	4155	4458	118%	108%	100%	93%	105%
Unpaved Maintenance Policy	2	Spot Regravelling	Yes or No	Y or N	Y	Y	N		Y		Y or N	Spot Regraveling Inclu	4155	3852		4155		108%		100%		104%
Unpaved Maintenance Policy	2	Spot Regravelling	Scheduled or Responsive	S or R		S	R		S		S or R	Scheduled or Responci	4155	6852		4155		61%		100%		80%
Unpaved Maintenance Policy	2	Spot Regravelling		S			0	10	20	30	$m^3/km/y$	Volume/length/year to	4155	3852	4003	4155	4291	108%	104%	100%	97%	102%
Unpaved Maintenance Policy	2	Spot Regravelling	Percent annual material loss replaced	R			0	33	66	99	%	Percentage of loss mat	4155	3852	6614	6852	6852	108%	63%	61%	61%	73%
Unpaved Maintenance Policy	2	Spot Regravelling	Maximum applicable gravel volume	R			0	10	20	30	$m^3/km/y$	Max. Volume/length/y	4155	6852	4003	4155	4291	61%	104%	100%	97%	90%
Unpaved Maintenance Policy	2	Spot Regravelling	Cost Factor		1		0	0.5	1	1.5	Ratio	can be used for region	4155	3852	4003	4155	4291	108%	104%	100%	97%	102%
Unpaved Maintenance Policy	2	Resurfacing	Yes or No	Y or N	Y	Y	N		Y		Y or N	Grading Included in po	4155	2515		4155		165%		100%		133%
Unpaved Maintenance Policy	2	Resurfacing	Scheduled or Responsive	S or R		S	R		S		S or R	Scheduled or Responci	4155			4155				100%		100%
Unpaved Maintenance Policy	3	Resurfacing	Resurfacing Interval	S		10	1	5	10	15	year	Years bewteen resurfa	4155	18909	5794	4155	3335	22%	72%	100%	125%	80%
Unpaved Maintenance Policy	3	Resurfacing	Minimum allowable thickness	R			10	80	150	220	mm	Minimum thickness of	4155	15630	17270	18909	18909	27%	24%	22%	22%	24%
Unpaved Maintenance Policy	3	Resurfacing	Minimum applicable resurfacing interval	R			1	11	21	30	year	Min. time interval	4155	18909	3335	2515	2515	22%	125%	165%	165%	119%
Unpaved Maintenance Policy	3	Resurfacing	Maximum applicable resurfacning interval	R			1	10	19	28	year	Max. time interval	4155	ERROR	18909	18909	18909		22%	22%	22%	22%
Unpaved Maintenance Policy	3	Resurfacing	Cost factor		1		0	0.5	1	1.5	Ratio	can be used for region	4155	2515	3335	4155	4976	165%	125%	100%	84%	118%
Unpaved Maintenance Policy	3	Resurfacing	Increase in gravel thickness		25.1	41	1	21	41	61	mm	1" of material added t	4155	2555	3355	4155	4955	163%	124%	100%	84%	118%
Unpaved Maintenance Policy	3	Resurfacing	Last applicable year								year	optional not in scope	4155									
Unpaved Maintenance Policy	3	Resurfacing	Initial roughness			8	2	5	8	11	IRI	optional not in scope	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Unpaved Maintenance Policy	3	Resurfacing	Compaction code		1	1	0		1			optional, 1 for mechnic	4155	4155		4155		100%		100%		100%
Unpaved Maintenance Policy	3	Resurfacing	Maximum Particle Size		22.2	30	0	15	30	45	mm	Type II Flex Base (TxDo	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Unpaved Maintenance Policy	4	Resurfacing	Material Passing 2.00mm Sieve		70	66	0	33	66	99	%	Type II Flex Base (TxDo	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Unpaved Maintenance Policy	4	Resurfacing	Material Passing 0.425mm Sieve		30	66	0	33	66	99	%	Type II Flex Base (TxDo	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Unpaved Maintenance Policy	4	Resurfacing	Material Passing 0.0075mm Sieve		10	66	0	33	66	99	%	Type II Flex Base (TxDo	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Unpaved Maintenance Policy	4	Resurfacing	Plasticity Index		10	66	0	5	10	15	%	Average (brady's equa	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Unpaved Maintenance Policy	4	Resurfacing	Minimum Roughness				2	5	8	11	IRI	optional not in scope	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%
Unpaved Maintenance Policy	4	Resurfacing	Maximum Roughness				4	8	12	16	IRI	optional not in scope	4155	4155	4155	4155	4155	100%	100%	100%	100%	100%

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