



STATE OF ILLINOIS

OFFICE OF THE AUDITOR GENERAL

**MANAGEMENT AUDIT OF THE
ILLINOIS DEPARTMENT OF TRANSPORTATION'S
LIFE-CYCLE COST ANALYSIS
FOR ROAD CONSTRUCTION CONTRACTS**

MAY 2012

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*To the Legislative Audit Commission, the
Speaker and Minority Leader of the House
of Representatives, the President and
Minority Leader of the Senate, the members
of the General Assembly, and
the Governor:*

This is our report of the management audit of the Illinois Department of Transportation's implementation of life-cycle cost analysis required by Section 2705-590 of the Department of Transportation Law (20 ILCS 2705/2705-590) for road construction contracts awarded in calendar year 2010.

The audit was conducted pursuant to Legislative Audit Commission Resolution Number 140. This audit was conducted in accordance with generally accepted government auditing standards and the audit standards promulgated by the Office of the Auditor General at 74 Ill. Adm. Code 420.310.

The audit report is transmitted in conformance with Section 3-14 of the Illinois State Auditing Act.

A handwritten signature in blue ink, appearing to read "William G. Holland".

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WILLIAM G. HOLLAND
Auditor General

Springfield, Illinois
May 2012



STATE OF ILLINOIS
OFFICE OF THE
AUDITOR GENERAL

William G. Holland, Auditor General

SUMMARY REPORT DIGEST

**IDOT'S LIFE-CYCLE COST ANALYSIS FOR ROAD CONSTRUCTION
CONTRACTS**

MANAGEMENT AUDIT

Release Date: May 2012

SYNOPSIS

Public Act 96-715, effective August 2009, required the Illinois Department of Transportation (IDOT) to *develop and implement a life-cycle cost analysis for each State road project under its jurisdiction for which the total pavement costs exceed \$500,000*. Legislative Audit Commission Resolution Number 140 required the Office of the Auditor General to conduct a management audit of the Illinois Department of Transportation's implementation of this Law.

Of the 313 road contracts under the State's jurisdiction awarded by IDOT in 2010 with pavement costs greater than \$500,000, 19 (6%) received a life-cycle cost analysis (LCCA), based on documentation provided by IDOT. While IDOT performs life-cycle cost analyses on new construction and reconstruction projects, it typically does not perform LCCAs on rehabilitation projects. **We concluded that given the requirements of Public Act 96-715 and the existence of pavement alternatives, IDOT should be performing LCCAs on rehabilitation projects involving structural overlays.**

Our audit also found that:

- **Eight of 15 contracts utilized LCCAs that were 3 or more years old** (at the time of project letting), ranging from 3 years to over 12 years old. Costs could have changed dramatically over the time period between when the LCCAs were prepared and when the projects were put out for bid.
- **Twelve of 15 contracts (80%) were missing unit cost support for one or more of the major pay items for concrete or asphalt.** Without the cost support, it would be difficult for IDOT's Central Office to perform its review and ensure that appropriate unit costs were used by each respective District.
- There were **21 instances** where costs were miscalculated in the LCCA. **Two of the errors resulted in a pavement being selected that actually had higher life-cycle costs than the alternative.**
- IDOT's maintenance and rehabilitation activity schedules in use during calendar year 2010 were based primarily on engineering judgment and not actual historical project schedules, and therefore, were not in compliance with the Act. They have since been updated and are based on historical schedules and actual pavement performance.
- **IDOT does not incorporate user costs into its life-cycle cost analyses.** Public Act 96-715 states that IDOT "may include estimates of user costs throughout the entire pavement life."
- IDOT's Central Office does not check to ensure that all eligible projects receive a LCCA.
- The Pavement Selection Committee was not functioning as required by IDOT policy.

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

BACKGROUND

Life-cycle cost analysis (LCCA) is a process for evaluating the financial impact of a project by analyzing initial costs and discounted future costs, such as maintenance, user, reconstruction, rehabilitation, restoring, and resurfacing costs, over the life of the project. By taking into account all of the costs that would occur throughout the life of each alternative, LCCA helps identify the lowest cost alternative to the State to carry out the project and provides other critical information vital for the overall decision-making process.

Public Act 96-715 required the Illinois Department of Transportation (IDOT) to develop and implement a life-cycle cost analysis for each State road project under its jurisdiction for which the total pavement costs exceed \$500,000.

Effective August 25, 2009, Public Act 96-715 required the Illinois Department of Transportation (IDOT) to *develop and implement a life-cycle cost analysis for each State road project under its jurisdiction for which the total pavement costs exceed \$500,000*. The Act requires IDOT to design and award these paving projects utilizing the material having the lowest life-cycle cost. However, at the discretion of the Department, interstate highways with high traffic volumes or experimental projects may be exempt from the requirement. According to IDOT officials, the Department has been conducting life-cycle cost analysis for over 25 years for some projects. IDOT's Bureau of Design and Environment (BDE) is responsible for developing standards, specifications, and policies for the State's highway system. It also reviews the life-cycle cost analyses prepared and submitted by the Department's nine Districts.

Legislative Audit Commission Resolution Number 140 required the Office of the Auditor General to conduct a management audit of the Illinois Department of Transportation's implementation of the Public Act. To provide assistance in the technical review of IDOT's LCCA process, we contracted with a Consultant with expertise in both pavement design, as well as life-cycle cost analysis practices. (pages 6-8,14)

REPORT CONCLUSIONS

Of the 313 road contracts under the State's jurisdiction awarded by IDOT in 2010 with pavement costs greater than \$500,000, 19 (6%) received a life-cycle cost analysis, based on documentation provided by IDOT.

Although Public Act 96-715 requires a life-cycle cost analysis when a project's "pavement costs exceed \$500,000", of the 313 road contracts under the State's jurisdiction awarded by IDOT in 2010 with pavement costs greater than \$500,000, 19 (6%) received a life-cycle cost analysis, based on documentation provided by IDOT.

There are two primary reasons why most projects awarded in 2010 with pavement costs greater than \$500,000 did not receive a life-cycle cost analysis by IDOT. The first is that

While IDOT performs life-cycle cost analyses on new construction and reconstruction projects, it typically does not perform LCCAs on rehabilitation projects, such as resurfacing.

while IDOT performs life-cycle cost analyses on new construction and reconstruction projects, it typically does not perform LCCAs on rehabilitation projects, such as resurfacing. The law does not exclude or exempt rehabilitation projects, such as resurfacing, from receiving a LCCA. According to IDOT officials: “Simple resurfacing, which constitutes the vast majority of our so-called “paving” projects, does not lend itself to the production of equivalent sections.” To conduct a life-cycle cost analysis, at least two equivalent designs of pavement alternatives (with equal analysis periods) are required.

While pavement alternatives necessary to conduct a LCCA may not be feasible for thin types of resurfacing overlays, alternatives may exist for thicker “structural overlays” (which are at least 3.75 inches of equivalent HMA (asphalt) pavement for non-interstate highways and at least 5 inches of equivalent HMA (asphalt) pavement for interstate highways according to IDOT’s Bureau of Design and Environment (BDE) Manual). Chapter 53 (Pavement Rehabilitation) of IDOT’s BDE Manual recommends life-cycle cost analysis on certain rehabilitation projects. Section 53-5 states, “This section provides guidance on conducting Life-Cycle Cost Analyses (LCCA) for pavement rehabilitation projects to assess the long-term cost effectiveness of alternative rehabilitation strategies.” However, IDOT officials stated they do not require LCCAs for structural overlays and that they are conducted only on rare, if any, occasions. **We concluded that given the requirements of Public Act 96-715 and the existence of pavement alternatives for structural overlays, IDOT should be performing LCCAs on projects involving structural overlays.** (pages 20-23)

We concluded that given the requirements of Public Act 96-715 and the existence of pavement alternatives for structural overlays, IDOT should be performing LCCAs on projects involving structural overlays.

The other primary reason why certain projects do not undergo a LCCA is because IDOT has determined that a “special design” is required or another IDOT policy exemption to a LCCA exists. Public Act 96-715 exempts “interstate highways with high traffic volumes or experimental projects” from the LCCA requirement. IDOT has established by policy other exemptions to the LCCA requirement, such as high stress intersections, a need to match surface type of small projects with those of abutting road sections, and widening projects.

To determine whether IDOT was conducting life-cycle cost analyses as required by State law and in accordance with its own policies, we reviewed a sample of nine road project contracts awarded in 2010 for which documentation provided by IDOT showed that no LCCA had been conducted. In compiling information related to our requests for these nine projects, IDOT determined that, in fact, two of the nine did have LCCAs conducted on them and provided us with the documentation.

For the remaining seven projects, we determined the following:

- **Three projects involved structural overlays and should have received a LCCA.** For one project, the rehabilitation of Interstate 39 in Lee County, 5 inches of pavement were laid. Regarding the second project, a rehabilitation of Interstate 80 in LaSalle and Grundy counties, when it was originally designed, the project called for a non-structural overlay of 3.75 inches of pavement. However, the pavement thickness was subsequently revised to 6 inches of overlay, which would be considered a structural rehabilitation. No LCCA was conducted on the revised design. On the third project, the resurfacing of US 51 in Macon County, the pavement overlay was 3.75 inches. Since this is a non-interstate highway, a 3.75 inch overlay is a structural overlay.
- Two projects, with design approvals prior to September 2010, involved a process called rubblization (breaking existing concrete into small pieces and compacting it to create a uniform base which can then be repaved over). Up until September 2010, IDOT considered rubblization projects to be “experimental” and not subject to LCCA requirements. Public Act 96-715 specifically exempts experimental projects from undergoing a LCCA. **However, with the 2010 update to IDOT’s BDE Manual, rubblization projects are no longer considered experimental and will be required to undergo a LCCA.**
- The remaining two projects involved resurfacing which was not structural in nature.

We subsequently submitted an additional 20 projects to IDOT and, based on IDOT’s responses, we determined that: 6 involved a structural overlay for at least part of the project; 2 projects involved an experimental process and were thus exempt from LCCA; 2 projects actually had received LCCAs which were previously unidentified by IDOT; and the remaining 10 projects did not involve a structural overlay. (pages 24-27)

LCCA Data Inputs

We reviewed the data IDOT uses to complete the life-cycle cost analysis. Public Act 96-715 requires that “Actual, relevant data, and not assumptions or estimates, shall be used to the extent such data has been collected.” There are three basic types of project-specific data that go into a LCCA: the initial project costs, the maintenance and rehabilitation activity schedules, and the maintenance and rehabilitation costs.

IDOT used actual cost data for its cost inputs. **However, IDOT’s maintenance and rehabilitation activity schedules**

IDOT used actual cost data for its cost inputs. However, IDOT’s maintenance and rehabilitation activity schedules in use during calendar year 2010 were based primarily on engineering judgment and not actual historical project schedules, and therefore, were not in compliance with the Act.

in use during calendar year 2010 were based primarily on engineering judgment and not actual historical project schedules, and therefore, were not in compliance with the Act. In April 2011, IDOT updated its maintenance and rehabilitation activity schedules and, unlike the activity schedules used for the 2010 projects, the updated schedules are based on historical schedules. IDOT officials noted that the changes were based on actual pavement performance. According to IDOT officials, the maintenance and rehabilitation activity schedule updates were based on pavement survey data and long-term efforts between IDOT and the paving/construction industry between 2003 and 2009. IDOT officials said these changes were confirmed by data collected by IDOT in 2010 (interim report released in March 2011), as well as a review of other states’ data. (pages 30-33)

We found both the analysis period and discount rate used by IDOT to be reasonable and in line with those used by other states.

We reviewed the analysis period used in the LCCA calculations, which is the time period for which IDOT evaluates the future costs to maintain and rehabilitate the roadway for each pavement alternative. In 2010, the analysis period was 40 years; IDOT increased it to 45 years in 2011. We also reviewed the discount rate (3%) used by IDOT in conducting the life-cycle cost analyses. We found both the analysis period and discount rate used by IDOT to be reasonable and in line with those used by other states. **We noted that IDOT does not incorporate user costs into its life-cycle cost analyses.** Some states include user costs while other states do not. **Public Act 96-715 states that IDOT “may include estimates of user costs throughout the entire pavement life.”** (pages 33-35)

We noted that IDOT does not incorporate user costs into its life-cycle cost analyses.

IDOT reported conducting LCCAs for 19 contracts awarded in calendar year 2010. IDOT initially provided LCCAs for 15 contracts; however, IDOT identified 4 additional contracts with LCCAs at the end of fieldwork after auditors inquired about several projects that did not receive a LCCA. Because we did not receive the 4 LCCAs until after our testing was completed, our detailed LCCA testing primarily focused on the initial 15 contracts with LCCAs we received. (page 38)

We found that IDOT’s pavement design spreadsheet is generally sufficient to address the core issues of pavement design in Illinois and therefore produces equivalent designs. To assess the adequacy of IDOT’s design outputs from its pavement design spreadsheet, our Consultant carried out an independent pavement design using the Mechanistic-Empirical Pavement Design Guide (MEPDG) software. MEPDG is a national-level software package for pavement design. The Consultant’s results using the MEPDG software indicated a general consistency with the designs obtained by IDOT. (page 39)

Lack of Unit Cost Documentation

Twelve of 15 contracts (80%) were missing unit cost support for one or more of the major pay items for concrete or asphalt.

When reviewing the 15 contracts with LCCAs, we found many did not contain unit cost documentation for all of the major pavement pay items as required by IDOT policy. Unit cost documentation provides support for the unit costs used to calculate the initial construction costs of a project. **Twelve of 15 contracts (80%) were missing unit cost support for one or more of the major pay items for concrete or asphalt.** Our Consultant reviewed the initial construction material costs for 8 contracts and concluded that the values used by IDOT were reasonable and generally consistent with the practice in other states; however, without all of the unit cost documentation, we can not have complete assurance that the unit costs used were appropriate and reflective of District costs. Likewise, it would be difficult for IDOT's BDE Central Office to perform its review and ensure appropriate unit costs are used for each respective District. (pages 39-40)

Age of LCCAs

We found that 8 of 15 contracts utilized LCCAs that were 3 or more years old (at the time of project letting), ranging from 3 years to over 12 years old.

In our review of 15 contracts with LCCAs, we found that 8 of 15 contracts utilized LCCAs that were 3 or more years old (at the time of project letting), ranging from 3 years to over 12 years old. The average age for the 15 LCCAs was 3.7 years old. We found projects let and awarded in calendar year 2010 that had LCCAs prepared as early as 1998 and 2003. **Costs could have changed dramatically** over the time period between when the LCCAs were prepared and when the project was put out for bid. Public Act 96-715 requires the data used to be actual and relevant which would require up-to-date traffic data, material prices, and pavement designs to be used in the LCCA. (pages 40-43)

LCCA Calculation Errors

We found 21 instances where the costs were miscalculated in the LCCA. Two of the errors resulted in a pavement being selected that actually had higher life-cycle costs than the alternative.

In 8 of 15 contracts reviewed, we found 21 instances where the costs were miscalculated in the LCCA. Fourteen of the 21 (67%) were errors of \$10,000 or more, and **two of the errors resulted in a pavement being selected that actually had higher life-cycle costs than the alternative.**

IDOT's Central Office does not check to ensure that all eligible projects receive a LCCA.

Furthermore, according to IDOT officials, IDOT's Central Office does not check to ensure that all eligible projects receive a LCCA. With the passage of Public Act 96-715, which now statutorily requires the completion of LCCAs, the recent revisions to the BDE Manual which will require a greater number of projects to undergo a LCCA, and the calculation errors identified by auditors in our review of LCCAs, IDOT's Central Office needs to strengthen its control and oversight to ensure that Districts are complying with State law and IDOT policy. (pages 43-46)

Pavement Selection Committee

We found the Pavement Selection Committee was not functioning as required by IDOT policy.

We found the Pavement Selection Committee was not functioning as required by IDOT policy. According to the BDE Manual, for projects awarded during calendar year 2010, if the difference in life-cycle costs between two equivalent designs was 10 percent or less, the pavement type and design selection was to be determined by the Pavement Selection Committee (comprised of one representative each from the Bureau of Design and Environment, the Bureau of Materials and Physical Research, and the Bureau of Construction and two from the respective IDOT District office). In response to a request from auditors for all Pavement Selection Committee decisions in 2010, IDOT officials responded that all LCCA projects went to the lowest cost alternative; therefore, the Pavement Selection Committee did not meet or make any pavement decisions in 2010. The IDOT officials also added that very few designs ever go to the Committee because Districts choose to accept most of the lowest life-cycle cost designs. The BDE Manual, however, gives the Pavement Selection Committee, not District staff, authority to formally make the pavement selection decision when the cost difference between the two alternatives is 10 percent or less. (pages 46-48)

Other States

IDOT's LCCA program compares similarly to other states' programs.

IDOT's LCCA program compares similarly to other states' programs. We surveyed the Illinois State Toll Highway Authority (ISTHA) and ten other states to determine their road construction life-cycle cost analysis practices for pavement type selection. Of those survey respondents regularly using LCCA as part of their pavement type selection, as few as 5 LCCAs (Pennsylvania) and as many as 100 LCCAs (Kentucky) were conducted in calendar year 2010.

Over half of the states' requirements to perform a LCCA are based on the type of project or work being done (i.e., new construction, reconstruction, pavement widening, etc.). Only two states (Michigan and Minnesota) are required by statute, like Illinois, to conduct LCCAs on road pavement projects. Also, only two states (Michigan and Pennsylvania) in addition to Illinois have a pavement cost threshold for projects to receive a LCCA. One state (Iowa) uses a square yard threshold that must be met before a LCCA will be conducted.

The types of projects required to have a LCCA as part of the pavement type selection process varied by survey respondent. Like Illinois, all survey respondents are required to conduct a LCCA for new construction and reconstruction projects; however, most require a LCCA for at least one other type of project in addition to new construction and reconstruction. (pages 52-54)

IDOT's LCCA program assumptions compare similarly to other states and the ISTHA. In CY10, IDOT used a 40-year analysis period when conducting the life-cycle cost analysis. The analysis period for other states and the ISTHA ranged between 35 and 50 years. IDOT uses a 3 percent discount rate. The discount rate used for other states and the ISTHA ranged between 2.7 and 5 percent. **IDOT does not include user costs in its analysis. Only three (Indiana, Michigan, and Pennsylvania) of the ten respondents reported including user costs in the analysis of life-cycle costs.** Like Illinois, eight of the survey respondents (ISTHA, Indiana, Iowa, Michigan, Minnesota, Ohio, Pennsylvania, and Wisconsin) reported using actual historical cost data in their LCCAs. (pages 54-55)

The process for pavement selection when competing alternatives have similar life-cycle costs varied by state. These different processes included pavement review committees, alternate bidding, alternate bidding with a bid adjustment factor, and letting other factors determine the pavement type (e.g., adjacent pavement type). (page 56)

Most other states surveyed, like Illinois, did not have a standard "shelf-life" defined in policy, or time after which a LCCA is no longer considered valid. However, responses indicated a maximum of 3 to 4 years prior to letting was a general practice. (page 57)

RECOMMENDATIONS

The audit report contains six recommendations directed towards the Department of Transportation. The Department of Transportation agreed with three recommendations, partially agreed with one recommendation, and disagreed with two recommendations. Appendix G to the report contains the agency responses.



WILLIAM G. HOLLAND
Auditor General

WGH:TEW

AUDITORS ASSIGNED: This Management Audit was performed by the Office of the Auditor General's staff with technical assistance from Kumares Sinha, Ph.D., P.E. and Samuel Labi, Ph.D., from Purdue University's School of Civil Engineering.

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GLOSSARY OF TERMS

Agency Costs - Agency costs are costs incurred directly by the owning agency over the life of the project. Items/costs common to all alternatives cancel one another out and are generally excluded from life-cycle cost analysis (LCCA) calculations. Agency costs typically include: preliminary engineering, contract administration, initial construction, construction supervision, as well as certain future maintenance and rehabilitation costs and the associated administrative costs.

Alternate Pavement Bidding Process - The opportunity for contractors to submit a bid to construct a designed pavement (two equivalent designs) as either an asphalt pavement or a portland cement concrete pavement in order to determine the most economical solution. Alternate bidding is only recommended when two or more alternatives have “equivalent designs” or designs that perform equally, and provide the same level of service over the same performance period, and have similar life-cycle costs.

Analysis Period - The time horizon over which future costs to maintain and rehabilitate the roadway are evaluated for each pavement alternative; it should be sufficient to reflect long-term cost differences associated with reasonable strategies.

Base Course - The layer or layers of specified or selected material (e.g., hot mix asphalt binder, cement aggregate mixture) of designed thickness placed on a subbase or a subgrade to support the surface course.

Composite Pavement - Combines elements of both flexible and rigid pavement systems, usually consisting of a hot mix asphalt (HMA) surface placed over a portland cement concrete (PCC) slab.

Continuously Reinforced Concrete Pavement (CRCP) - A rigid pavement structure having continuous longitudinal reinforcement achieved by overlapping the longitudinal steel reinforcing bars. The steel is intended to keep cracks from widening, keeping the aggregate interlock preserved and reducing stresses in the concrete slab due to traffic loading.

First-Cost Analysis - Using a summation of initial costs of construction with no consideration of future maintenance and rehabilitation costs.

Flexible Pavement - An asphalt pavement structure which maintains contact with and distributes loads to the subgrade which depends upon aggregate interlock, particle friction, and cohesion for stability; rely heavily on the strength and stiffness of the underlying unbound layers to supplement the load carrying capacity of the asphaltic surface layer.

Functional Overlay - A non-structural overlay which restores the riding surface quality and significantly extends the service life by correcting functional deficiencies, but which does not significantly increase the structural capacity of the pavement.

Hot Mix Asphalt (HMA) Pavement - Asphalt concrete pavement, or hot mix asphalt pavement as it is more commonly called, refers to the bound layers of a flexible pavement type/structure. For most applications, asphalt concrete is placed as HMA, which is a mixture of coarse and fine aggregate, and asphalt binder.

HMA Overlay - Resurfacing using hot mix asphalt (HMA) to create a new surface on the pavement.

HMA Overlay of Rubblized PCC Pavement - The use of a hot mix asphalt overlay over PCC pavement which has been broken and compacted (to create a uniform base).

IDOT - Illinois Department of Transportation

IRIS - Illinois Roadway Information System

Jointed Plain Concrete Pavement (JPCP) - A rigid pavement structure that uses doweled joints at 15 feet nominal intervals.

Jointed Reinforced Concrete Pavement (JRCP) - A rigid pavement structure that uses distributed steel reinforcement and transverse contraction joints.

Life-Cycle Cost Analysis (LCCA) - A process for evaluating the total economic worth among competing alternative investment strategies by incorporating initial costs and discounted future costs over the analysis period.

Mechanistic-Empirical Pavement Design Guide (MEPDG) - National level software package for pavement design. MEPDG models evaluate the impact of traffic, climate, materials, and subgrade stiffness on performance and account for the interactions among these components.

Mechanistic Pavement Design - A structural pavement design procedure used to determine fatigue life based on actual conditions, including stresses, strains, and deflections.

New Construction - The design and construction of a pavement on a previously unpaved alignment. All pavements start as new construction.

Pavement Management System (PMS) - A PMS is a set of tools or methods that assist decision-makers in finding optimum strategies for providing, evaluating, and maintaining pavements in serviceable condition over a period of time.

Portland Cement Concrete (PCC) - Rigid pavement type/structure that is a composite material consisting of coarse aggregate (crushed stone and gravel), fine aggregate (such as sand), portland cement, and water.

Reconstruction - Pavement reconstruction is the removal and replacement of the existing pavement structure. Reconstruction may utilize either new or recycled materials incorporated

into the materials used for the reconstruction of the complete pavement section. Reconstruction is required when a pavement has either failed or has become functionally obsolete.

Rehabilitation - Consists of structural enhancements that extend the service life of an existing pavement and/or improve the pavement's load carrying capacity. Rehabilitation techniques include restoration treatments and structural overlays. Rehabilitation projects extend the life of existing pavement structures either by restoring existing structural capacity through the elimination of age-related, environmental cracking of embrittled pavement surface or by increasing pavement thickness to strengthen existing pavement sections to accommodate existing or projected traffic loading conditions.

Resurfacing - Placing a new surface on an existing roadway to extend or renew the pavement life. Resurfacing can be structural or non-structural.

Rigid Pavement - A pavement structure whose surface and principal load distributing component is a portland cement concrete (PCC) slab of relatively high bending resistance.

Rubblizing - Part of a rehabilitation process in which existing PCC pavement is broken (in-place) into small pieces and compacted to create a uniform base.

Special Design - For IDOT, special designs include, but are not limited to, the following: high stress locations; high stress intersections; and roadways with heavily loaded vehicles and high truck volume.

Structural Overlay - A structural overlay is used to significantly extend the remaining service life by increasing the structural capacity and serviceability of the pavement, usually in combination with pre-overlay repair and/or recycling. A structural overlay also corrects any functional deficiencies present.

Subbase - The layer, or layers, of specified or selected material laid on the subgrade. Provides support to the base course or PCC slab which is placed on top of the subbase.

Surface Course - One or more layers of a pavement structure designed to accommodate the traffic load. The surface layer may consist of asphalt, resulting in "flexible" pavement, or concrete, resulting in "rigid" pavement. In addition to providing a significant fraction of the overall structural capacity of the pavement, the surface layer must minimize the infiltration of surface water, provide a smooth, uniform, and skid-resistant riding surface, and offer durability against traffic abrasion and the climate.

Traffic Factor - The total number of 18-kip equivalent single-axle load applications (ESALs) to the design lane anticipated during the design period, expressed in millions. It is used as an equivalency factor for mixed traffic loads (a combination of semi-trailer trucks, buses, passenger vehicles, etc.).

Unbonded Concrete Overlay - A rehabilitation alternative which consists of an existing concrete pavement, an interlayer (often HMA), and a concrete overlay.

User Costs - The vehicle operating costs, travel time costs, and crash costs incurred by highway users.

Whitetopping - A concrete overlay on an asphalt pavement usually done to increase structural capacity. There are three types of whitetopping: ultrathin (2 to 4 inches), thin (4 to 8 inches), and conventional (more than 8 inches).

INTRODUCTION AND BACKGROUND

REPORT CONCLUSIONS

Life-cycle cost analysis (LCCA) is a process for evaluating the financial impact of a project by analyzing initial costs and discounted future costs, such as maintenance, user, reconstruction, rehabilitation, restoring, and resurfacing costs, over the life of the project. By taking into account all of the costs that would occur throughout the life of each alternative, LCCA helps identify the lowest cost alternative to the State to carry out the project and provides other critical information vital for the overall decision-making process.

Effective August 25, 2009, Public Act 96-715 (Public Act) required the Illinois Department of Transportation (IDOT) to *develop and implement a life-cycle cost analysis for each State road project under its jurisdiction for which the total pavement costs exceed \$500,000*. The Public Act requires IDOT to design and award these paving projects using the material having the lowest life-cycle cost. However, at the discretion of the Department, interstate highways with high traffic volumes or experimental projects may be exempt from the requirement. According to IDOT officials, the Department has been conducting life-cycle cost analysis for over 25 years for some projects. IDOT's Bureau of Design and Environment (BDE) is responsible for developing standards, specifications, and policies for the State's highway system. It also reviews the life-cycle cost analyses prepared and submitted by the Department's nine Districts.

Although Public Act 96-715 requires a life-cycle cost analysis when a project's "pavement costs exceed \$500,000", of the 313 road contracts under the State's jurisdiction awarded by IDOT in 2010 with pavement costs greater than \$500,000, **19 (6%)** received a life-cycle cost analysis, based on documentation provided by IDOT.

There are two primary reasons why most projects awarded in 2010 with pavement costs greater than \$500,000 did not receive a life-cycle cost analysis by IDOT. The first is that while IDOT performs life-cycle cost analyses on new construction and reconstruction projects, it typically does not perform LCCAs on rehabilitation projects, such as resurfacing. The law does not exclude or exempt rehabilitation projects, such as resurfacing, from receiving a LCCA. According to IDOT officials: "Simple resurfacing, which constitutes the vast majority of our so-called "paving" projects, does not lend itself to the production of equivalent sections." To conduct a life-cycle cost analysis, at least two equivalent designs of pavement alternatives (with equal analysis periods) are required.

While pavement alternatives necessary to conduct a LCCA may not be feasible for thin types of resurfacing overlays, alternatives may exist for thicker "structural overlays" (which are at least 3.75 inches of equivalent HMA (asphalt) pavement for non-interstate highways and at

least 5 inches of equivalent HMA (asphalt) pavement for interstate highways according to IDOT's Bureau of Design and Environment (BDE) Manual). Chapter 53 (Pavement Rehabilitation) of IDOT's BDE Manual recommends life-cycle cost analysis on certain rehabilitation projects. Section 53-5 states, "This section provides guidance on conducting Life-Cycle Cost Analyses (LCCA) for pavement rehabilitation projects to assess the long-term cost effectiveness of alternative rehabilitation strategies." However, IDOT officials stated they do not require LCCAs for structural overlays and that they are conducted only on rare, if any, occasions. **We concluded that given the requirements of Public Act 96-715 and the existence of pavement alternatives for structural overlays, IDOT should be performing LCCAs on projects involving structural overlays.**

The other primary reason why certain projects do not undergo a LCCA is because IDOT has determined that a "special design" is required or another IDOT policy exemption to a LCCA exists. Public Act 96-715 exempts "interstate highways with high traffic volumes or experimental projects" from the LCCA requirement. IDOT has established by policy other exemptions to the LCCA requirement, such as high stress intersections, a need to match surface type of small projects with those of abutting road sections, and widening projects.

To determine whether IDOT was conducting life-cycle cost analyses as required by State law and in accordance with its own policies, we reviewed a sample of nine road project contracts awarded in 2010 for which documentation provided by IDOT showed that no LCCA had been conducted. In compiling information related to our requests for these nine projects, IDOT determined that, in fact, two of the nine did have LCCAs conducted on them and provided us with the documentation.

For the remaining seven projects, we determined the following:

- **Three projects involved structural overlays and should have received a LCCA.** For one project, the rehabilitation of Interstate 39 in Lee County, 5 inches of pavement were laid. Regarding the second project, a rehabilitation of Interstate 80 in LaSalle and Grundy counties, when it was originally designed, the project called for a non-structural overlay of 3.75 inches of pavement. However, the pavement thickness was subsequently revised to 6 inches of overlay, which would be considered a structural rehabilitation. No LCCA was conducted on the revised design. On the third project, the resurfacing of US 51 in Macon County, the pavement overlay was 3.75 inches. Since this is a non-interstate highway, a 3.75 inch overlay is a structural overlay.
- Two projects, with design approvals prior to September 2010, involved a process called rubblization (breaking existing concrete into small pieces and compacting it to create a uniform base which can then be repaved over). Up until September 2010, IDOT considered rubblization projects to be "experimental" and not subject to LCCA requirements. Public Act 96-715 specifically exempts experimental projects from undergoing a LCCA. **However, with the 2010 update to IDOT's BDE Manual, rubblization projects are no longer considered experimental and will be required to undergo a LCCA.**

- The remaining two projects involved resurfacing which was not structural in nature.

We subsequently submitted an additional 20 projects to IDOT and, based on IDOT's responses, we determined that: 6 involved a structural overlay for at least part of the project; 2 projects involved an experimental process and were thus exempt from LCCA; 2 projects actually had received a LCCA which was previously unidentified by IDOT; and the remaining 10 projects did not involve a structural overlay.

We reviewed the data IDOT uses to complete the life-cycle cost analysis. Public Act 96-715 requires that "Actual, relevant data, and not assumptions or estimates, shall be used to the extent such data has been collected." There are three basic types of project-specific data that go into a LCCA: the initial project costs, the maintenance and rehabilitation activity schedules, and the maintenance and rehabilitation costs.

IDOT used actual cost data for its cost inputs. **However, IDOT's maintenance and rehabilitation activity schedules in use during calendar year 2010 were based primarily on engineering judgment and not actual historical project schedules, and therefore, were not in compliance with the Public Act.** In April 2011, IDOT updated its maintenance and rehabilitation activity schedules and, unlike the activity schedules used for the 2010 projects, the updated schedules are based on historical schedules. IDOT officials noted that the changes were based on actual pavement performance. According to IDOT officials, the maintenance and rehabilitation activity schedule updates were based on pavement survey data and long-term efforts between IDOT and the paving/construction industry between 2003 and 2009. IDOT officials said these changes were confirmed by data collected by IDOT in 2010 (interim report released in March 2011), as well as a review of other states' data.

We reviewed the analysis period used in the LCCA calculations, which is the time period for which IDOT evaluates the future costs to maintain and rehabilitate the roadway for each pavement alternative. In 2010, the analysis period was 40 years; IDOT increased it to 45 years in 2011. We also reviewed the discount rate (3%) used by IDOT in conducting the life-cycle cost analyses. We found both the analysis period and discount rate used by IDOT to be reasonable and in line with those used by other states. **We noted that IDOT does not incorporate user costs into its life-cycle cost analyses.** Some states include user costs while other states do not. **Public Act 96-715 states that IDOT "may include estimates of user costs throughout the entire pavement life."**

IDOT reported conducting LCCAs for 19 contracts awarded in calendar year 2010. IDOT initially provided LCCAs for 15 contracts; however, IDOT identified 4 additional contracts with LCCAs at the end of fieldwork after auditors inquired about several projects that did not receive a LCCA. Because we did not receive the 4 LCCAs until after our testing was completed, our detailed LCCA testing primarily focused on the initial 15 contracts with LCCAs we received.

We found that IDOT's pavement design spreadsheet is generally sufficient to address the core issues of pavement design in Illinois and therefore produces equivalent designs. To assess the adequacy of IDOT's design outputs from its pavement design spreadsheet, our Consultant carried out an independent pavement design using the Mechanistic-

Empirical Pavement Design Guide (MEPDG) software. MEPDG is a national-level software package for pavement design. The Consultant's results using the MEPDG software indicated a general consistency with the designs obtained by IDOT.

When reviewing the 15 contracts with LCCAs, we found many did not contain unit cost documentation for all of the major pavement pay items as required by IDOT policy. Unit cost documentation provides support for the unit costs used to calculate the initial construction costs of a project. **Twelve of 15 contracts (80%) were missing unit cost support for one or more of the major pay items for concrete or asphalt.** Our Consultant reviewed the initial construction material costs for eight contracts and concluded that the values used by IDOT were reasonable and generally consistent with the practice in other states; however, without all of the unit cost documentation, we can not have complete assurance that the unit costs used were appropriate and reflective of District costs. Likewise, it would be difficult for IDOT's BDE Central Office to perform its review and ensure appropriate unit costs were used for each respective District.

In our review of 15 contracts with LCCAs, we found that 8 of 15 contracts utilized LCCAs that were 3 or more years old (at the time of project letting), ranging from 3 years to over 12 years old. The average age for the 15 LCCAs was 3.7 years old. We found projects let and awarded in calendar year 2010 that had LCCAs prepared as early as 1998 and 2003. **Costs could have changed dramatically** over the time period between when the LCCAs were prepared and when the project was put out for bid. Public Act 96-715 requires the data used to be actual and relevant which would require up-to-date traffic data, material prices, and pavement designs to be used in the LCCA.

In 8 of 15 contracts reviewed, we found 21 instances where the costs were miscalculated in the LCCA. Fourteen of the 21 (67%) were errors of \$10,000 or more, and **two of the errors resulted in a pavement being selected that actually had higher life-cycle costs than the alternative.**

Furthermore, according to IDOT officials, IDOT's Central Office does not check to ensure that all eligible projects receive a LCCA. With the passage of Public Act 96-715, which now statutorily requires the completion of LCCAs, the recent revisions to the BDE Manual which will require a greater number of projects to undergo a LCCA, and the calculation errors identified by auditors in our review of LCCAs, IDOT's Central Office needs to strengthen its control and oversight to ensure that Districts are complying with State law and IDOT policy.

We found the Pavement Selection Committee was not functioning as required by IDOT policy. According to the BDE Manual, for projects awarded during calendar year 2010, if the difference in life-cycle costs between two equivalent designs was 10 percent or less, the pavement type and design selection was to be determined by the Pavement Selection Committee (comprised of one representative each from the Bureau of Design and Environment, the Bureau of Materials and Physical Research, and the Bureau of Construction and two from the respective IDOT District office). In response to a request from auditors for all Pavement Selection Committee decisions in 2010, IDOT officials responded that all LCCA projects went to the lowest cost alternative; therefore, the Pavement Selection Committee did not meet or make any

pavement decisions in 2010. The IDOT officials also added that very few designs ever go to the Committee because Districts choose to accept most of the lowest life-cycle cost designs. The BDE Manual, however, gives the Pavement Selection Committee, not District staff, authority to formally make the pavement selection decision when the cost difference between the two alternatives is 10 percent or less (Section 54-7.05 of the BDE Manual).

Other States

IDOT's LCCA program compares similarly to other states' programs. We surveyed the Illinois State Toll Highway Authority (ISTHA) and ten other states to determine their road construction life-cycle cost analysis practices for pavement type selection. Of those survey respondents regularly using LCCA as part of their pavement type selection, as few as 5 LCCAs (Pennsylvania) and as many as 100 LCCAs (Kentucky) were conducted in calendar year 2010.

Over half of the states' requirements to perform a LCCA are based on the type of project or work being done (i.e., new construction, reconstruction, pavement widening, etc.). Only two states (Michigan and Minnesota) are required by statute, like Illinois, to conduct LCCAs on road pavement projects. Also, only two states (Michigan and Pennsylvania) in addition to Illinois have a pavement cost threshold for projects to receive a LCCA. One state (Iowa) uses a square yard threshold that must be met before a LCCA will be conducted.

The types of projects required to have a LCCA as part of the pavement type selection process varied by survey respondent. Like Illinois, all survey respondents are required to conduct a LCCA for new construction and reconstruction projects; however, most require a LCCA for at least one other type of project in addition to new construction and reconstruction.

IDOT's LCCA program assumptions compare similarly to other states and the ISTHA. In CY10, IDOT used a 40-year analysis period when conducting the life-cycle cost analysis. The analysis period for other states and the ISTHA ranged between 35 and 50 years. IDOT uses a 3 percent discount rate. The discount rate used for other states and the ISTHA ranged between 2.7 and 5 percent. **IDOT does not include user costs in its analysis. Only three (Indiana, Michigan, and Pennsylvania) of the ten respondents reported including user costs in the analysis of life-cycle costs.** Like Illinois, eight of the survey respondents (ISTHA, Indiana, Iowa, Michigan, Minnesota, Ohio, Pennsylvania, and Wisconsin) reported using actual historical cost data in their LCCAs.

The process for pavement selection when competing alternatives have similar life-cycle costs varied by state. These different processes included pavement review committees, alternate bidding, alternate bidding with a bid adjustment factor, and letting other factors determine the pavement type (e.g., adjacent pavement type).

Most other states surveyed, like Illinois, did not have a standard "shelf-life" defined in policy, or time after which a LCCA is no longer considered valid. However, responses indicated a maximum of 3 to 4 years prior to letting was a general practice.

BACKGROUND

On November 16, 2010, the Legislative Audit Commission (LAC) adopted Resolution Number 140 directing the Auditor General to conduct a management audit of the Illinois Department of Transportation's implementation of the life-cycle cost analysis (LCCA) required by Section 2705-590 of the Department of Transportation Law (20 ILCS 2705/2705-590) for road construction contracts awarded in calendar year 2010. See Appendix A for LAC Resolution Number 140 and Appendix B for 20 ILCS 2705/2705-590.

Specifically, the resolution asks the Auditor General to determine:

- Whether the Department has developed and implemented a life-cycle cost analysis which complies with the requirements of Section 2705-590 of the Department of Transportation Law, for each State road project under its jurisdiction for which the total pavement costs exceed \$500,000 funded, in whole, or in part, with State or State appropriated funds;
- Whether the Department has designed and awarded these projects utilizing material having the lowest life-cycle cost; and
- The frequency in which the Department has made a decision based on other criteria when alternative material options are substantially equivalent on a life-cycle cost basis.

INTRODUCTION

In the 1950s states began using life-cycle cost analysis (LCCA) for the evaluation of highway projects. Life-cycle cost analysis allows state agencies to evaluate different alternatives concerning proposed highway projects. The selection of different pavement types, the initial quality and strength of design, rehabilitation strategies, and the financial impact on the agency and the motoring public are all concerns that may be evaluated when performing a LCCA. The American Association of State Highway and Transportation Officials' (AASHTO) "Red Book" of 1960 introduced the concept of life-cycle cost analysis (or cost-benefit analysis) to the broader highway construction arena. The 1986 and the 1993 AASHTO Pavement Design Guides encouraged the concept of life-cycle costing, and gave detailed discussions about the various costs that should be considered in life-cycle cost analysis.

At the federal level, the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 specifically required consideration of "the use of life-cycle costs in the design and engineering of bridges, tunnels, or pavement" in both metropolitan and statewide transportation planning. The National Highway System (NHS) Designation Act of 1995 required states to conduct life-cycle cost analysis on NHS projects costing \$25 million or more. Implementing guidance was provided by the Federal Highway Administration (FHWA) in an April 1996 Memorandum to FHWA Regional Administrators. However, the implementing guidance did not recommend specific LCCA procedures, but rather it specified the use of good practice.

The 1998 Transportation Equity Act for the 21st Century (TEA-21) removed the LCCA requirements established in the NHS Act and directed the US Secretary of Transportation to

develop recommended procedures for conducting LCCAs on NHS projects. To meet this requirement, in September 1998, the Federal Highway Administration issued an *Interim Technical Bulletin* recommending procedures for conducting life-cycle cost analysis of pavements.

For the State of Illinois, effective August 25, 2009, Public Act 96-715 required the Illinois Department of Transportation (IDOT) to *develop and implement a life-cycle cost analysis for each State road project under its jurisdiction for which the total pavement costs exceed \$500,000* (see Exhibit 1-1). The Public Act requires IDOT to design and award these paving projects utilizing the material having the lowest life-cycle cost. However, at the discretion of the Department, interstate highways with high traffic volumes or experimental projects may be exempt from the requirement. According to IDOT officials, the Department has been conducting life-cycle cost analysis for over 25 years for some projects.

Exhibit 1-1
PUBLIC ACT 96-715

Sec. 2705-590. Roadbuilding criteria; life-cycle cost analysis.

- (a) As used in this Section, “life-cycle cost” means the total of the cost of the initial project plus all anticipated future costs over the life of the pavement. Actual, relevant data, and not assumptions or estimates, shall be used to the extent such data has been collected.
- (b) The Department shall develop and implement a life-cycle cost analysis for each State road project under its jurisdiction for which the total pavement costs exceed \$500,000 funded in whole, or in part, with State or State-appropriated funds. The Department shall design and award these paving projects utilizing material having the lowest life-cycle cost. All pavement design life shall ensure that State and State-appropriated funds are utilized as efficiently as possible. When alternative material options are substantially equivalent on a life-cycle cost basis, the Department may make a decision based on other criteria. At the discretion of the Department, interstate highways with high traffic volumes or experimental projects may be exempt from this requirement.
- (c) Except as otherwise provided in this Section, a life-cycle cost analysis shall compare equivalent designs based upon this State’s actual historic project schedules and costs as recorded by the pavement management system, and may include estimates of user costs throughout the entire pavement life.
- (d) For pavement projects for which this State has no actual historic project schedules and costs as recorded by the pavement management system, the Department may use actual historical and comparable data for equivalent designs from states with similar climates, soil structures, or vehicle traffic.

Source: 20 ILCS 2705/2705-590 (Effective date: 8/25/2009).

LIFE-CYCLE COST ANALYSIS (LCCA)

Life-cycle cost analysis (LCCA) is a process for evaluating the total economic worth of a usable project segment by analyzing initial costs and discounted future costs, such as maintenance, user, reconstruction, rehabilitation, restoring, and resurfacing costs, over the life of the project segment. By taking into account all of the costs that would occur throughout the life of each alternative, LCCA helps identify the lowest cost alternative to carry out the project and provides other critical information vital for the overall decision-making process. Performing a LCCA requires estimating future costs in constant dollars and discounting these costs to a “present” value using a real discount rate. The alternative with the lowest life-cycle cost is viewed as having the lowest financial impact to the State even if it has higher initial costs.

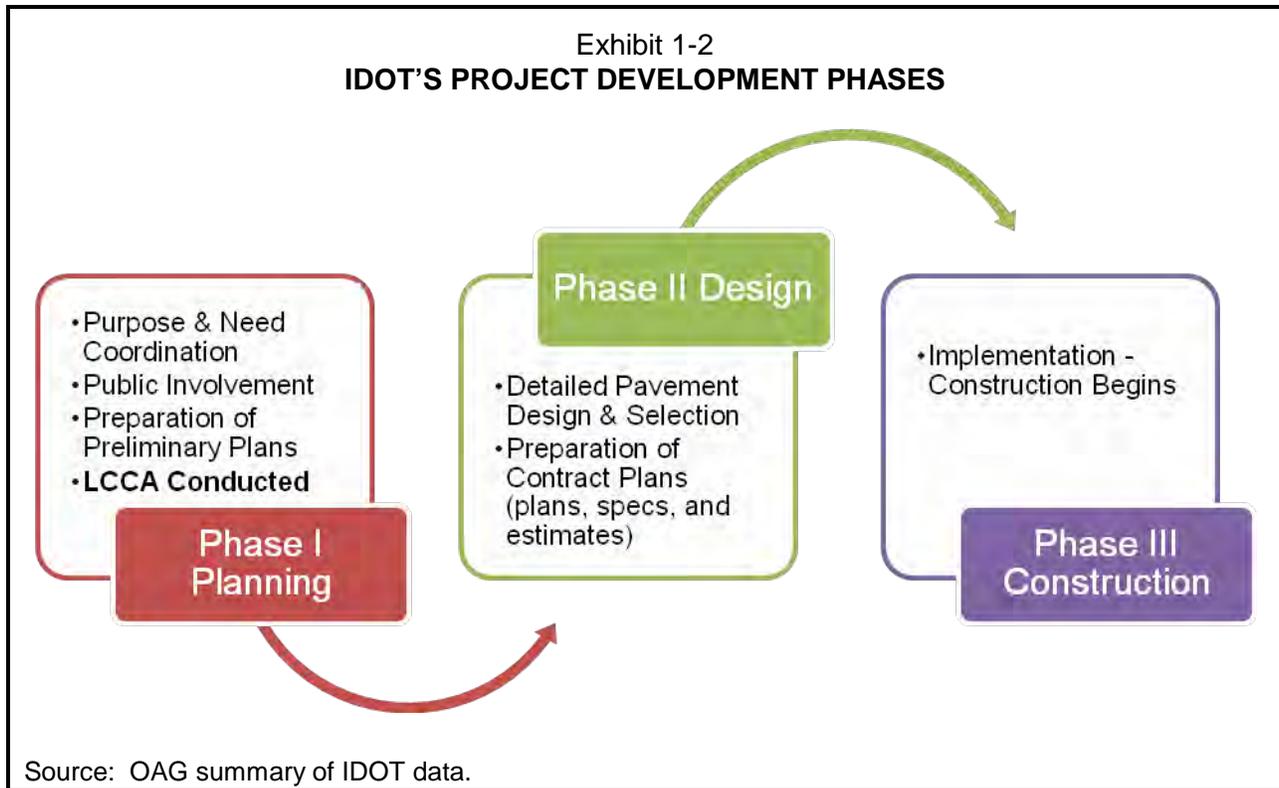
Life-Cycle Cost Analysis (LCCA)

LCCA is a process for evaluating the total economic worth of a usable project segment by analyzing initial costs and discounted future costs, such as maintenance, user, reconstruction, rehabilitation, restoring, and resurfacing costs, over the life of the project segment.

Source: *USDOT FHWA Technical Bulletin for Life-Cycle Cost Analysis in Pavement Design.*

LCCA can be applied to a wide variety of investment-related decision levels to evaluate the financial impact of various designs, projects, alternatives, or system investment strategies to get the best return on the dollar. The analysis period, or the time horizon over which alternatives are evaluated, should be sufficient to reflect long-term cost differences associated with reasonable design strategies.

LCCA should be conducted as early in the project development cycle as possible. IDOT has three phases to complete a project: Phase I Planning, Phase II Design, and Phase III Construction. Exhibit 1-2 shows the three phases of road construction projects. LCCAs are to be conducted in Phase I.



Alternative Pavement Designs

In order to perform a life-cycle cost analysis, there must be at least two competing alternative pavement designs for comparison. The two primary types of pavement used for road construction are hot mix asphalt (HMA) and portland cement concrete (PCC). Each type of pavement has advantages and disadvantages when considering the initial cost and maintenance that is required over the life of the pavement. Pavement conditions decline at different rates for each pavement design alternative, thereby creating a different maintenance and rehabilitation activity schedule for each pavement design. Typically, concrete requires less frequent maintenance, but is more expensive initially, while asphalt requires more frequent maintenance, but is less expensive initially.

These types of models and the assumptions used are at the center of life-cycle costs for pavements. Although one type of pavement may have a lower initial cost, maintenance and rehabilitation costs over the useful life of the pavement may cause the overall costs to be very different.

Life-Cycle Cost Analysis Components and Framework

LCCA takes into account factors such as pavement design, initial construction costs, maintenance costs, and rehabilitation strategies. LCCA may also factor in user costs and other external costs. User costs are those associated costs to the user of the roads such as vehicle operating costs, crash costs, and travel delay costs caused by construction. These factors are discounted to the present and totaled in order to compare alternative pavements.

According to the FHWA, the steps involved in conducting a life-cycle cost analysis include:

1. Establish design alternatives.
2. Determine activity timing.
3. Estimate costs (agency and user).
4. Compute life-cycle costs.
5. Analyze the results.

ILLINOIS DEPARTMENT OF TRANSPORTATION (IDOT)

The Illinois Department of Transportation (IDOT) is responsible for the planning, design, construction, operation and maintenance of an over 16,000 mile State highway system and for the administration of the local roads and streets program. The work related to these functions is performed through IDOT's Central Office and IDOT's Regional/District offices.

As is shown in Exhibit 1-3, annual expenditures for the Division of Highways at IDOT account for about 80 percent of the Department's expenditures. The Division of Highways is responsible for developing, maintaining, and operating the State highway system in a safe, timely, efficient, and economical manner. Highway construction projects are the responsibility of the Bureau of Design and Environment located within the Division of Highways (see organization chart in Appendix D).

| Exhibit 1-3 IDOT EXPENDITURES FY08 - FY11 | | | | |
|--|------------------------|------------------------|------------------------|------------------------|
| Division | FY08 | FY09 | FY10 | FY11 |
| Highways | \$3,120,006,784 | \$3,360,790,978 | \$4,103,355,421 | \$4,523,575,614 |
| Public Transportation | \$562,190,720 | \$597,964,765 | \$651,489,082 | \$810,652,645 |
| Rail | \$32,449,645 | \$26,474,705 | \$31,995,678 | \$125,645,943 |
| Aeronautics | \$116,080,945 | \$112,702,257 | \$95,522,062 | \$108,486,728 |
| Traffic Safety | \$50,315,744 | \$51,648,368 | \$53,301,415 | \$50,228,750 |
| Total | \$3,881,043,838 | \$4,149,581,073 | \$4,935,663,658 | \$5,618,589,680 |

Source: IDOT.

The Bureau of Design and Environment (BDE) is responsible for developing standards, specifications, and policies for the State highway system. BDE:

- Develops highway standards and provides support services for district highway design programs;
- Coordinates and prepares federal-aid program documents; and

- Processes plans and contract documents through the letting and contract award stage.

In addition, BDE is responsible for developing policies for the preparation, coordination, final review, and approval of project location studies and environmental documents. The Bureau also prepares road projects for letting, including reviewing the life-cycle cost analysis if applicable. During FY10, the Bureau of Design and Environment reviewed 1,899 projects, reviewed and processed 6,861 bid proposals, and awarded 1,642 contracts.

The Bureau of Materials and Physical Research (BMPR) is also involved in the pavement selection process. BMPR is responsible for oversight and review of pavement design and selection. BMPR is involved in numerous statewide materials issues, applied research studies, problem solving, new product evaluations, and special pavement management, design, and rehabilitation activities. BMPR is responsible for activities such as planning and conducting investigations of pavement design, pavement rehabilitation, and material-oriented problems. BMPR is also responsible for updating IDOT's Bureau of Design and Environment Manual (BDE Manual) and policies.

IDOT's District offices are involved in project selection, pavement design, and preparation of plans for letting and construction (see Exhibit 1-4 for map). They are responsible for preparing the LCCAs on the road projects. IDOT has adopted a "mechanistic" pavement design process which the District offices use to determine the required pavement thicknesses, and, in turn, design the projects and prepare LCCAs. IDOT's mechanistic procedures were developed using structural mechanical analysis, computer modeling, and actual performance and response of existing pavement sections. Essentially, the mechanistic procedure is a set of instructions to guide the District engineers based on project type and conditions. An electronic spreadsheet is available from BDE which automates these instructions.

Life-cycle cost analysis at IDOT is not a new initiative; however, it was not required by law until August 2009. Public Act 96-715 required IDOT to implement LCCA for road construction projects with pavement costs of over \$500,000. Floor debates for the Public Act discussed a decision that IDOT made with the industry over 20 years ago. The debates stated that IDOT has been collecting data and the University of Illinois was going to "massage that data and upgrade the policies." The House debate noted that Illinois will be shifting to using actual, real data as opposed to assumptions.

IDOT has established policies and procedures (Chapter 54 of the BDE Manual) to determine the type of pavements to use on certain types of projects. These policies were updated in September 2010 and also in April 2011, after the start of our audit. In many cases, the BDE Manual does not require the life-cycle cost of the pavement to be calculated for certain types of pavement projects. The types of projects on which IDOT performs a life-cycle cost analysis is examined in Chapter Two.

Exhibit 1-4
IDOT REGIONS AND DISTRICTS
 Calendar Year 2010

REGION 1
 Diane M. O'Keefe

District 1
 201 W. Center Court
 Schaumburg, IL 60196
 847-705-4000

REGION 2
 George F. Ryan

District 2
 819 Depot Ave.
 Dixon, IL 61021
 815-284-2271

District 3
 700 E. Norris Dr.
 Ottawa, IL 61350
 815-434-6131

REGION 3
 Joseph E. Crowe

District 4
 401 Main Street
 Peoria, IL 61602
 309-671-3333

District 5
 13473 IL Hwy. 133
 P.O. Box 610
 Paris, IL 61944
 217-465-4181

REGION 4
 Roger L. Driskell

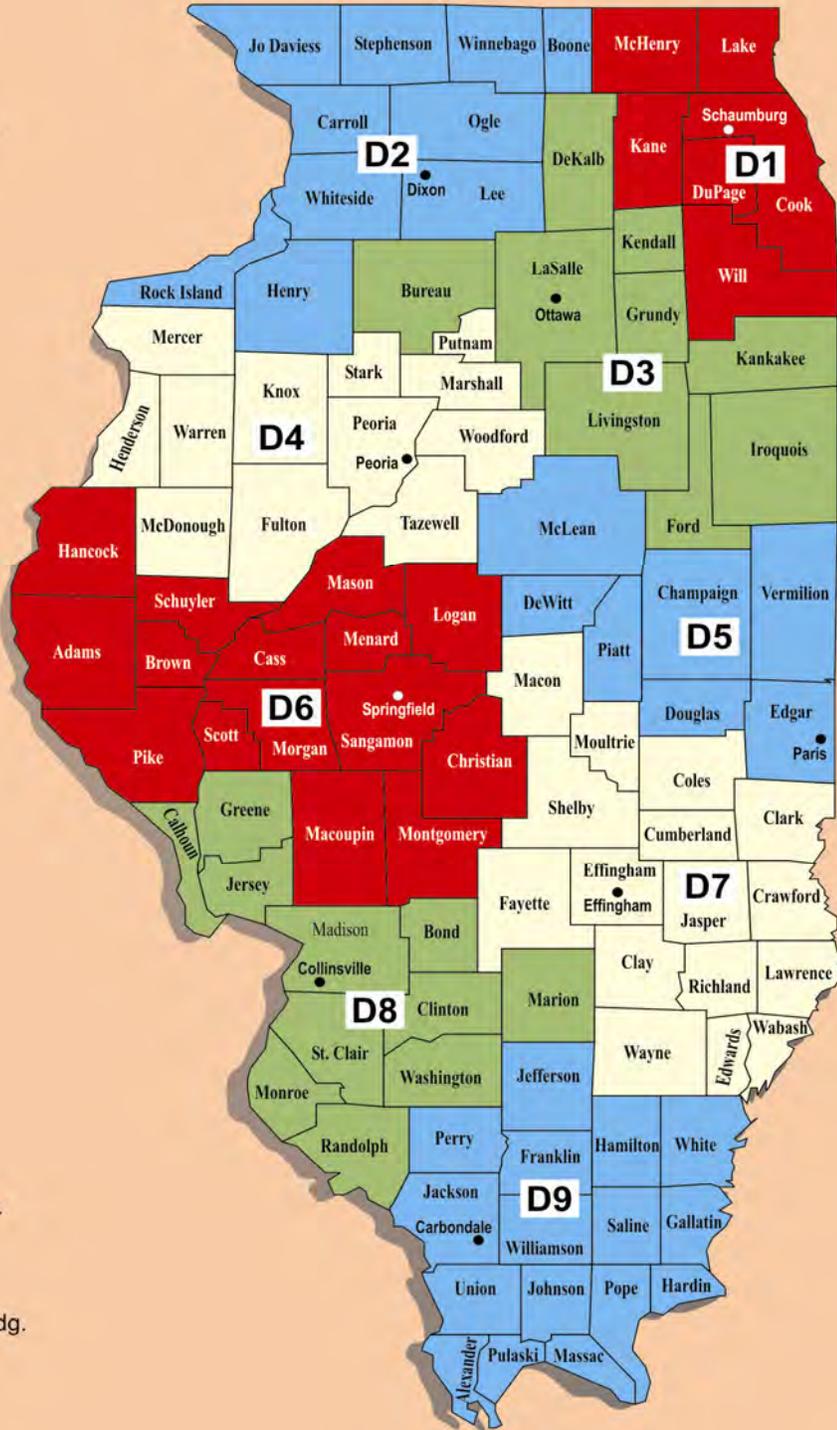
District 6
 126 E. Ash Street
 Springfield, IL 62704
 217-782-7301

District 7
 400 W. Wabash
 Effingham, IL 62401
 217-342-3951

REGION 5
 Mary C. Lamie

District 8
 1102 Eastport Plaza Dr.
 Collinsville, IL 62234
 618-346-3100

District 9
 State Transportation Bldg.
 P.O. Box 100
 Carbondale, IL 62903
 618-549-2171



Source: IDOT.

Even if a LCCA is conducted for the project, it does not ensure that the lowest cost alternative pavement will be selected. Public Act 96-715 allows IDOT to make a decision based on other criteria when “alternative material options are substantially equivalent on a life-cycle cost basis.” For projects awarded during our calendar year 2010 audit period, according to the BDE Manual, if the cost difference between project life-cycle costs is greater than 10 percent, the alternative with the lowest life-cycle cost is to be selected (or, for special cases, a waiver can be submitted to BDE for approval). If the cost difference is 10 percent or less, the pavement type and design selection is supposed to be determined by a Pavement Selection Committee (see Appendix E for IDOT’s flowchart of the process).

IDOT policies establish the Pavement Selection Committee which consists of three staff from the Central Office (one each from Bureau of Design and Environment, Bureau of Materials and Physical Research, and Bureau of Construction) and two from the respective IDOT District office. Regional Engineers, Deputy Directors, and other high ranking personnel are excluded from the Committee. The Pavement Selection Committee can choose any pavement option regardless of the lowest life-cycle cost. **According to IDOT policies, Committee deliberations are considered confidential and only the Committee’s recommendation as to the final pavement selection is recorded. According to an IDOT official, the extent of documentation for Committee decisions is a letter.**

As of April 2011, IDOT updated its Pavement Design chapter of the BDE Manual. These changes affect the function of the Pavement Selection Committee by making alternate bidding the first option when a project’s life-cycle cost difference is 10 percent or less. Alternate bidding is a process by which contractors are given the opportunity to submit a bid to construct a designed pavement as either asphalt pavement or portland cement concrete pavement. IDOT can then choose the lowest bid. If the project does not meet the alternate bidding criteria or if one pavement type is preferred over the other (for reasons such as existing adjacent sections or maintenance requirements), the pavement selection will be made by the Pavement Selection Committee. Chapter Three goes into more detail about our review of the LCCAs, the Pavement Selection Committee, and the process followed for each contract.

SCOPE AND METHODOLOGY

We conducted this management audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on the audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. This audit was also conducted in accordance with audit standards promulgated by the Office of the Auditor General at 74 Ill. Adm. Code 420.310.

The audit objectives for this audit were those as delineated in Legislative Audit Commission Resolution Number 140 (see Appendix A), which directed the Auditor General to conduct a management audit of the Illinois Department of Transportation’s implementation of

the life-cycle cost analysis required by Section 2705-590 of the Department of Transportation Law (20 ILCS 2705/2705-590) (see Appendix B) for road construction contracts awarded in calendar year 2010.

In conducting the audit, we reviewed applicable State statutes and rules. We reviewed compliance with those laws to the extent necessary to meet the audit's objectives. Any instances of non-compliance we identified are noted in this report.

We assessed risk by reviewing recommendations from previous IDOT audits, IDOT internal documents, policies and procedures, management controls, and IDOT's Bureau of Design and Environment (BDE) Manual. We reviewed management controls relating to the audit objectives that are identified in Section 2705-590 of the Department of Transportation Law (20 ILCS 2705/2705-590). This audit identified some weaknesses in those controls, which are included as recommendations in this report.

We interviewed representatives and obtained information and documentation from the Illinois Department of Transportation (IDOT) and the Federal Highway Administration. We examined the current IDOT organizational structure, policies and procedures, IDOT's LCCA process, including the Pavement Selection Committee process, federal requirements related to LCCA, documentation requirements, and changes to IDOT's Pavement Design chapter of the BDE Manual.

Given the technical nature of the life-cycle cost analysis process, we contracted with Consultants to provide assistance in reviewing IDOT's LCCA process. Our Consultants were Kumares Sinha, Ph.D., P.E. and Samuel Labi, Ph.D., from Purdue University's School of Civil Engineering. Both individuals have years of experience in transportation and pavement engineering and have been a part of an extensive number of research projects, transportation committees, and projects relevant to pavement evaluation and life-cycle cost analysis; however, the Consultants have not done any work for or with the Illinois Department of Transportation. The Consultants provided expertise in both pavement design, as well as life-cycle cost analysis practices.

IDOT conducted LCCAs for 19 contracts awarded in calendar year 2010. We requested a list of all projects from IDOT and received a list containing 1,481 awards. We found 313 State jurisdiction contracts awarded in calendar year 2010 that contained over \$500,000 in pavement costs. IDOT initially identified 24 contracts that received a LCCA, with a total award amount of \$375.8 million for calendar year 2010. After requesting and reviewing these 24 projects, we determined and confirmed with IDOT that only 15 of 24 actually received a LCCA. IDOT provided 4 additional LCCAs at the end of fieldwork after we inquired about samples of projects that did not receive a LCCA. Because we did not receive the 4 LCCAs until after our testing was completed, the detailed LCCA testing presented deals primarily with only the initial 15 contracts with LCCAs received.

We tested the LCCAs for these 15 contracts for the following: accuracy of LCCA calculations; documentation for unit costs utilized in the LCCA; whether the appropriate process

was followed for LCCAs with cost differences less than or greater than 10 percent; and the age of the LCCA at the contract's letting.

Our Consultant reviewed 8 of the 15 LCCAs judgmentally selected by the OAG. This included a review of IDOT processes pertaining to pavement design and pavement LCCA. The Consultant examined the specific procedures, input data, assumptions of IDOT's pavement design and pavement life-cycle cost analysis. The Consultant also carried out an independent pavement design and LCCA for each design to ensure the results were consistent with IDOT's. Results from the sample are presented in Chapter Three.

We judgmentally selected 29 contracts from the list of 313 State jurisdiction contracts with \$500,000 or more in paving costs that did not receive a LCCA. We ensured this sample contained projects from all Districts. Our Consultant also reviewed 9 of these. Results from the sample are presented in Chapter Two.

Auditors requested the decisions of the Pavement Selection Committee for 2010. IDOT's initial response was that the Committee did not meet formally in 2010; however, an IDOT official offered to provide decisions made via e-mail chains. IDOT officials responded that, after looking at the e-mail record, all LCCA projects for 2010 went to the lowest cost alternative; therefore, the Pavement Selection Committee did not meet or make any decisions. We reviewed the Pavement Selection Committee decisions from 2009 and 2008. We also reviewed any Pavement Selection Committee documentation provided for 15 of the contracts with LCCAs.

We surveyed the Illinois State Toll Highway Authority (ISTHA) and several other states to determine their road construction life-cycle cost analysis practices for pavement type selection. Surveyed states were: Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, and Wisconsin. Results of this survey are discussed in Chapter Four.

REPORT ORGANIZATION

The remainder of this report is organized into the following chapters:

- Chapter Two – LCCA Implementation;
- Chapter Three – Review of LCCAs; and
- Chapter Four – Other State LCCA Practices.

Chapter Two

LCCA IMPLEMENTATION

CHAPTER CONCLUSIONS

Public Act 96-715 requires a life-cycle cost analysis when a project's "pavement costs exceed \$500,000." Of the 313 road contracts awarded by IDOT in 2010 with pavement costs greater than \$500,000 and under the State's jurisdiction, **19 (6%)** received a life-cycle cost analysis, based on documentation provided by IDOT.

There are two primary reasons why most projects awarded in 2010 with pavement costs greater than \$500,000 did not receive a life-cycle cost analysis by IDOT. The first is that while IDOT performs life-cycle cost analyses on new construction and reconstruction projects, it typically does not perform LCCAs on rehabilitation projects, such as resurfacing. The law does not exclude or exempt rehabilitation projects, such as resurfacing, from receiving a LCCA. According to IDOT officials: "Simple resurfacing, which constitutes the vast majority of our so-called "paving" projects, does not lend itself to the production of equivalent sections." To conduct a life-cycle cost analysis, at least two equivalent designs of pavement alternatives (with equal analysis periods) are required.

While pavement alternatives necessary to conduct a LCCA may not be feasible for thin types of resurfacing overlays, alternatives may exist for thicker "structural overlays" (which are at least 3.75 inches of equivalent HMA (asphalt) pavement for non-interstate highways and at least 5 inches of equivalent HMA (asphalt) pavement for interstate highways according to IDOT's Bureau of Design and Environment (BDE) Manual). Chapter 53 (Pavement Rehabilitation) of IDOT's BDE Manual recommends life-cycle cost analysis on certain rehabilitation projects. Section 53-5 states, "This section provides guidance on conducting Life-Cycle Cost Analyses (LCCA) for pavement rehabilitation projects to assess the long-term cost effectiveness of alternative rehabilitation strategies." However, IDOT officials stated they do not require LCCAs for structural overlays and that they are conducted only on rare, if any, occasions. **We concluded that given the requirements of Public Act 96-715 and the existence of pavement alternatives for structural overlays, IDOT should be performing LCCAs on projects involving structural overlays.**

The other primary reason why certain projects do not undergo a LCCA is because IDOT has determined that a "special design" is required or another IDOT policy exemption to a LCCA exists. For these projects, IDOT has determined that a LCCA is not required. Public Act 96-715 exempts "interstate highways with high traffic volumes or experimental projects" from the LCCA requirement. IDOT has established by policy other exemptions to the LCCA requirement, such as high stress intersections, a need to match surface type of small projects with those of abutting road sections, and widening projects.

To determine whether IDOT was conducting life-cycle cost analyses as required by State law and in accordance with its own policies, we reviewed a sample of nine road project contracts

awarded in 2010 for which documentation provided by IDOT showed that no LCCA had been conducted. In compiling information related to our requests for these nine projects, IDOT determined that, in fact, two of the nine did have LCCAs conducted on them and provided us with the documentation.

For the remaining seven projects, we determined the following:

- **Three projects involved structural overlays and should have received a LCCA.** For one project, the rehabilitation of Interstate 39 in Lee County, 5 inches of pavement were laid. Regarding the second project, a rehabilitation of Interstate 80 in LaSalle and Grundy counties, when it was originally designed, the project called for a non-structural overlay of 3.75 inches of pavement. However, the pavement thickness was subsequently revised to 6 inches of overlay, which would be considered a structural rehabilitation. No LCCA was conducted on the revised design. On the third project, the resurfacing of US 51 in Macon County, the pavement overlay was 3.75 inches. Since this is a non-interstate highway, a 3.75 inch overlay is a structural overlay.
- Two projects, with design approvals prior to September 2010, involved a process called rubblization (breaking existing concrete into small pieces and compacting it to create a uniform base which can then be repaved over). Up until September 2010, IDOT considered rubblization projects to be “experimental” and not subject to LCCA requirements. Public Act 96-715 specifically exempts experimental projects from undergoing a LCCA. **However, with the 2010 update to IDOT’s BDE Manual, rubblization projects are no longer considered experimental and will be required to undergo a LCCA.**
- The remaining two projects involved resurfacing which was not structural in nature.

We subsequently submitted an additional 20 projects to IDOT and, based on IDOT’s responses, we determined that: 6 involved a structural overlay for at least part of the project; 2 projects involved an experimental process and were thus exempt from LCCA; 2 projects actually had received a LCCA which was previously unidentified by IDOT; and the remaining 10 projects did not involve a structural overlay.

We reviewed the data IDOT uses to complete the life-cycle cost analysis. Public Act 96-715 requires that “Actual, relevant data, and not assumptions or estimates, shall be used to the extent such data has been collected.” There are three basic types of project-specific data that go into a LCCA: the initial project costs, the maintenance and rehabilitation activity schedules, and the maintenance and rehabilitation costs.

IDOT used actual cost data for its cost inputs. **However, IDOT’s maintenance and rehabilitation activity schedules in use during calendar year 2010 were based primarily on engineering judgment and not actual historical project schedules, and therefore, were not in compliance with the Public Act.** In April 2011, IDOT updated its maintenance and rehabilitation activity schedules and, unlike the activity schedules used for the 2010 projects, the

updated schedules are based on historical schedules. IDOT officials noted that the changes were based on actual pavement performance. According to IDOT officials, the maintenance and rehabilitation activity schedule updates were based on pavement survey data and long-term efforts between IDOT and the paving/construction industry between 2003 and 2009. IDOT officials said these changes were confirmed by data collected by IDOT in 2010 (interim report released in March 2011), as well as a review of other states' data.

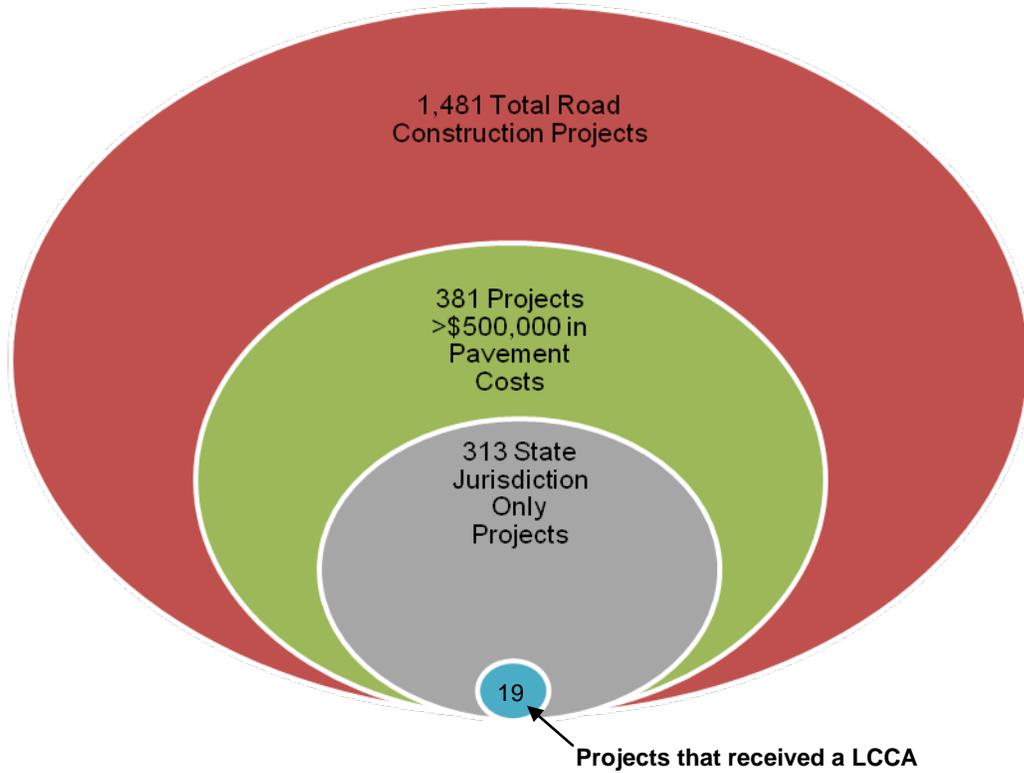
We reviewed the analysis period used in the LCCA calculations, which is the time period for which IDOT evaluates the future costs to maintain and rehabilitate the roadway for each pavement alternative. In 2010, the analysis period was 40 years; IDOT increased it to 45 years in 2011. We also reviewed the discount rate (3%) used by IDOT in conducting the life-cycle cost analyses. We found both the analysis period and discount rate used by IDOT to be reasonable and in line with those used by other states. **We noted that IDOT does not incorporate user costs into its life-cycle cost analyses.** Some states include user costs while other states do not. **Public Act 96-715 states that IDOT “may include estimates of user costs throughout the entire pavement life.”**

COMPLIANCE WITH PUBLIC ACT 96-715

Public Act 96-715 requires a life-cycle cost analysis for State road construction projects with pavement costs that exceed \$500,000. IDOT is required to design and award these paving projects utilizing material having the lowest life-cycle cost. The Public Act provides that in limited situations (interstate highways with high traffic volumes or experimental projects) certain projects may be exempt from this requirement.

The vast majority of IDOT's road construction contracts in 2010 with pavement costs exceeding \$500,000 did not receive a life-cycle cost analysis. Exhibit 2-1 graphically depicts the universe of road construction contracts awarded in calendar year 2010 and the number that received a life-cycle cost analysis.

Exhibit 2-1
ROAD CONSTRUCTION PROJECT BREAKDOWN
 Awarded in Calendar Year 2010



Source: OAG summary of IDOT data.

We reviewed each of the 1,481 contracts awarded by IDOT in 2010 and identified 381 contracts that had pavement costs that exceeded \$500,000. Our analysis consisted of capturing all of the pay items (such as road base, the actual pavement materials, any binders used, protective coats, fabric, and other items) that were directly related to pavement construction.

Of these 381 contracts, 68 were for roads that were under local jurisdiction, and thus were not required by State law to have a LCCA conducted. Public Act 96-715 only requires IDOT to conduct a LCCA on a “State road project under its jurisdiction.” Jurisdiction is defined by IDOT’s Highway Jurisdiction Guidelines for Highway and Street Systems as “the authority and obligation to administer, control, construct, maintain and operate a highway subject to the provisions of the Illinois Highway Code [605 ILCS 5].” IDOT reviews local jurisdiction projects to help ensure the projects’ estimates are reasonable and that the contracts contain all of the legal and practical requirements for letting and bidding. IDOT advertises these projects in the IDOT Transportation Bulletin and lets and awards these projects for the local agencies.

Of the remaining 313 contracts in 2010 with pavement costs greater than \$500,000 that were under IDOT’s jurisdiction, **19 (6%) received a LCCA**, based on information supplied by

IDOT. Exhibit 2-2 compares, by District, total contract award amounts for the 313 State jurisdiction projects with the 19 projects that received a LCCA.

| Exhibit 2-2 TOTAL AWARD AMOUNTS AND NUMBER OF CONTRACTS BY DISTRICT Contracts Awarded in Calendar Year 2010 | | | | |
|---|------------------------------|-----------------|--------------------------------|-----------------|
| District | State Jurisdiction Contracts | | Contracts that received a LCCA | |
| | Award Amount | Total Contracts | Award Amount | Total Contracts |
| 1 | \$329,559,182 | 51 | \$51,752,427 | 3 |
| 2 | \$157,908,612 | 34 | \$33,111,536 | 3 |
| 3 | \$105,880,814 | 23 | \$14,926,640 | 1 |
| 4 | \$166,299,592 | 57 | \$14,174,447 | 1 |
| 5 | \$110,616,054 | 25 | \$7,645,626 | 1 |
| 6 | \$212,292,175 | 45 | \$43,351,750 | 3 |
| 7 | \$117,771,878 | 19 | \$0 | 0 |
| 8 | \$222,889,577 | 39 | \$68,438,022 | 4 |
| 9 | \$104,955,645 | 20 | \$19,451,911 | 3 |
| Total | \$1,528,173,528 | 313 | \$252,852,359 | 19 |

Note: Numbers do not add due to rounding.
Source: OAG summary of IDOT data.

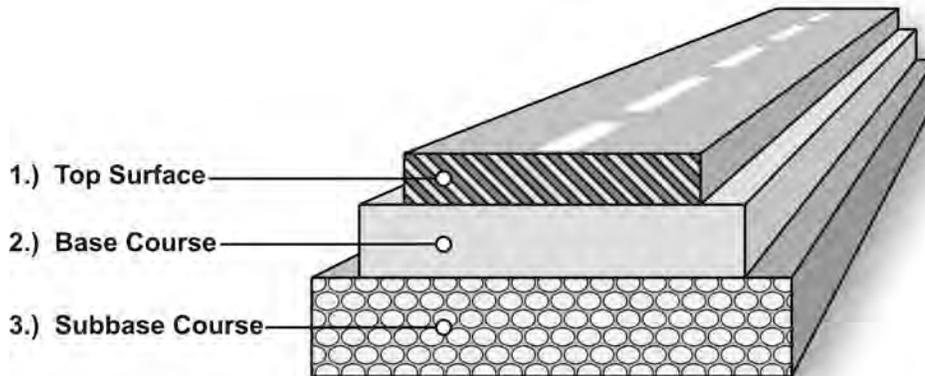
There are two primary reasons for the small number of road projects which received a LCCA. The first is IDOT’s definition of “pavement.” The second is that IDOT is not using LCCA on construction projects with special designs or other exemptions established by IDOT policy.

Pavement Definition

A central issue identified in our review of IDOT’s compliance with Public Act 96-715 pertained to the definition of “pavement.” Public Act 96-715 states that IDOT shall develop and implement a LCCA for each State road project under its jurisdiction “for which the total pavement costs exceed \$500,000.” The Public Act does not provide a more detailed definition of “pavement” or “pavement costs.”

We asked IDOT for its definition of “pavement.” The Department responded that Section 54-1.02 of the IDOT BDE Manual defines Pavement Structure as, “the combination of subbase, base course, and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.” Exhibit 2-3 graphically depicts the three typical pavement layers. However, this is the definition of pavement **structure**, not necessarily for pavement. According to IDOT officials, the key to the definition, and their understanding of pavements, is that pavements are structural systems and the entire cross-section should be considered in a structural manner. If a road project does not involve a change to the pavement structure, then it would not be required to undergo a LCCA. Consequently, IDOT officials stated that only “new construction” and “reconstruction” are deemed to be “pavement” for the purposes of LCCA because these are the only designs of the entire pavement system in which meaningful equivalent designs can actually be developed.

Exhibit 2-3
TYPICAL PAVEMENT LAYERS



Source: OAG Summary of Consultant data.

The law does not exclude or exempt the third type of road construction projects – rehabilitation projects – which includes resurfacing, from receiving a LCCA. However, IDOT does not conduct LCCAs on resurfacing projects. According to IDOT officials: “Simple resurfacing, which constitutes the vast majority of our so-called “paving” projects, does not lend itself to the production of equivalent sections.” To conduct a life-cycle cost analysis, at least two equivalent designs of pavement alternatives (with equal analysis periods) are required. The IDOT officials go on to state “These projects are not structural, but only aim to provide a smooth(er) wearing surface and prolong the life of the facility. By the diverse nature of the existing pavement systems in place under any proposed maintenance-type resurfacings, the design of equivalent alternative systems is impractical if not impossible.”

There are three general classes of overlays or resurfacing:

- 1) a thin overlay which is applied as a preventative treatment to correct minor distress and reduce the rate of deterioration;
- 2) functional overlay which restores the riding surface quality and also yields the benefits of the thin overlay; and
- 3) a structural overlay that increases pavement strength and also yields the benefits of functional overlays.

IDOT’s BDE Manual, Chapter 53 (Pavement Rehabilitation), indicates that overlays that play a structural role are not less than 5 inches of equivalent HMA (asphalt) pavement for interstate highways and 3.75 inches of equivalent HMA (asphalt) pavement for non-interstate highways. Our Consultant concluded that while non-structural resurfacings may not lend themselves to material type alternatives (and therefore developing a life-cycle cost analysis between two viable alternatives may not be possible), resurfacing of a **structural** nature **should** undergo a LCCA since there is an alternate choice of materials that could be used. Our

Consultant concluded that overlays of 4 inches or more are generally considered to be structural and, therefore, IDOT's parameters are reasonable.

Even though IDOT's practice has been not to conduct life-cycle cost analysis on resurfacing and other pavement rehabilitation projects, Chapter 53: Pavement Rehabilitation in IDOT's BDE Manual contains a section titled "Life-Cycle Cost Analysis (LCCA) for Rehabilitation Projects." The LCCA section for rehabilitation projects has been in the BDE Manual since 2000.

The Introduction for this two page section states that "This section provides guidance on conducting Life-Cycle Cost Analyses (LCCA) for pavement rehabilitation projects to assess the long-term cost effectiveness of alternative rehabilitation strategies." The Section then goes on to delineate the Purpose of LCCA, LCCA Procedures, and LCCA Guidelines for pavement rehabilitation.

We followed up with IDOT as to why Districts were not complying with Chapter 53 guidance. An IDOT official responded that the information in Chapter 53 is to give Districts an additional decision tool if they need it. He stated that the text of Chapter 53 only recommends LCCAs to be performed when reconstruction or structural overlays are being considered as options; however, even then a LCCA is not required. The official noted that IDOT's flowcharts in Chapter 53 over simplify the decision process and make it appear that LCCAs are required (see Appendix F for Chapter 53 flowcharts).

In contrast, our Consultant concluded that there are viable pavement alternatives for structural resurfacing projects. Since alternatives exist, such projects should undergo LCCAs as required by the Public Act. The use of asphalt to overlay existing asphalt or concrete pavement is common practice. Also, the use of concrete to overlay existing concrete or asphalt pavements, with a few exceptions, has been shown to be feasible and recommended.

In April 2011, which was after the calendar year 2010 awarded contracts covered in this audit, IDOT added maintenance and rehabilitation activity schedules associated with rehabilitation of pavements to its BDE Manual. This addition could be interpreted as recognition that LCCA could be conducted on some rehabilitation projects, not just construction/reconstruction projects. IDOT added maintenance and rehabilitation activity schedules for unbonded jointed plain concrete overlay, unbonded continuously reinforced concrete overlay, and asphalt overlay of rubblized concrete pavement to the life-cycle activities section of Chapter 54 (Pavement Design) of IDOT's BDE Manual. Previous versions of the Manual contained maintenance and rehabilitation activity schedules associated with pavement reconstruction only.

As will be discussed in greater detail in Chapter Four, states such as Minnesota and Wisconsin require LCCAs for resurfacing when certain criteria are met. For example, Wisconsin requires a LCCA for resurfacing if the project length is 5 miles or greater. Other states exempt resurfacing from LCCA requirements.

The April 2011 BDE Manual update added the \$500,000 pavement cost threshold as a criteria for a life-cycle cost analysis. During calendar year 2010, IDOT was not explicitly using the \$500,000 pavement cost threshold contained in Public Act 96-715 as a determining factor as to whether a project should receive a LCCA. According to IDOT officials, IDOT's BDE Manual Design policy required pavement design submittals for projects with more than 4,750 square yards of pavement. IDOT officials stated that the 4,750 square yard threshold should guarantee that any project even remotely close to the \$500,000 threshold would undergo the required life-cycle cost analysis, if it is appropriate. Our Consultant concurred that using approximate costs per square yard of pavement, the 4,750 minimum square yard policy would capture projects with at least \$500,000 in pavement costs.

Special Designs

The other primary reason why certain projects do not undergo a LCCA is because IDOT has determined that a "special design" is required or another policy exemption exists. Public Act 96-715 exempts "interstate highways with high traffic volumes or experimental projects" from the LCCA requirement. As discussed below, IDOT was using some experimental designs in 2010 which exempted them from the LCCA requirement.

However, IDOT's use of "special design" and other policy decisions results in additional pavement projects being exempt from life-cycle cost analysis that do not meet the criteria delineated in the Public Act. Examples of special designs and other IDOT policy exemptions from LCCA in 2010 included high stress intersections and a need to match surface type of small projects with those of abutting road sections. Also, for widening projects, IDOT's BDE Manual states that pavement design alternatives are evaluated on a first-cost basis (summation of initial costs of construction with no consideration of future maintenance and rehabilitation costs), rather than a life-cycle cost basis. The alternative with the lowest first-cost is selected for construction. These exemptions are established by IDOT policy; they are not specifically enumerated in State law.

Although IDOT exempts certain projects, we found that IDOT was not always consistent in its application of exempting projects from LCCA. We found two contracts which received life-cycle cost analyses even though they were project categories which IDOT exempts from LCCA. One of these contracts had a LCCA conducted on the widening portion of the project; however, according to IDOT, a LCCA was not required for the widening portion. The other contract had life-cycle cost analysis conducted despite meeting the BDE Manual's high stress intersection policy exception.

Our Consultant reviewed the "special design" criteria and other policy exemptions established by IDOT and concluded that there may be legitimate reasons why some project types, in addition to those delineated in the Public Act, may not lend themselves to life-cycle cost analysis. For example, for a paving project that involves a high stress intersection, IDOT's policy is to use concrete because the braking and turning of heavy trucks at the intersection can cause the asphalt to experience a kneading effect, resulting in a rippled pavement surface. From an engineering perspective, this appears to be a reasonable policy decision by IDOT.

Review of Road Projects Not Receiving a LCCA

To determine whether IDOT was conducting life-cycle cost analyses as required by State law and in accordance with its own policies, we reviewed a sample of nine road project contracts awarded in 2010 for which documentation provided by IDOT showed that no LCCA had been conducted. The projects we selected for review had high pavement costs and contained several inches of pavement.

In compiling information related to our requests for these nine projects, IDOT determined that, in fact, two of the nine did have LCCAs conducted on them and provided us with the documentation. For the remaining seven projects, we determined the following:

- Three projects involved structural overlays and should have received a LCCA. For one project, the rehabilitation of Interstate 39 in Lee County, 5 inches of pavement were laid. (contract #64E97) Regarding the second project, a rehabilitation of Interstate 80 in LaSalle and Grundy counties, when it was originally designed, the project called for a non-structural overlay of 3.75 inches of pavement. However, the pavement thickness was subsequently revised to a 6 inch overlay, which would be considered a structural rehabilitation. No LCCA was conducted on the revised design. (contract #66A08) On the third project, the resurfacing of US 51 in Macon County, the pavement overlay was 3.75 inches. Since this is a non-interstate highway, a 3.75 inch overlay is a structural overlay. (contract #74150)
- Two projects, with design approvals prior to September 2010, involved a process called rubblization (breaking existing concrete into small pieces and compacting it to create a uniform base which can then be repaved over). Up until September 2010, IDOT considered rubblization projects to be an “experimental” design and not subject to LCCA requirements. Public Act 96-715 specifically exempts experimental projects from undergoing a LCCA. Chapter 53 of the BDE Manual, in effect from 2002 to September 2010, stated that “Approval for use of the rubblizing method must be obtained from the BDE, and an **experimental** features work plan must be filed with the BMPR.” (emphasis added) However, with the 2010 update to IDOT’s BDE Manual, rubblization projects are no longer considered experimental and will be required to undergo a LCCA. (contract #76C93 and #78175)
- The remaining two projects involved resurfacing which was not structural in nature. The first project, the rehabilitation of I-290 and I-355, called for 4 inches of overlay, which was less than the 5 inch pavement thickness threshold IDOT considers structural on interstates. (contract #60G51) The second project involved the repaving of Interstate 55 using 3.25 inches of pavement. (contract #70845)

Exhibit 2-4 summarizes our findings in our review of the seven contracts sampled that did not receive a LCCA.

| Exhibit 2-4 OAG REVIEW OF NON-LCCA PROJECTS | | |
|---|--|---|
| Project Information | IDOT Reason for Not Conducting LCCA | OAG Comments: |
| <p>Proj. type: Rehabilitation of I-39 Pavement costs: \$18 million Pavement used: Primarily asphalt Contract #: 64E97</p> | <p>It was a pavement rehab project to extend the life of the existing pavement; therefore, no LCCA was necessary.</p> | <p>Since the overlay was 5 inches, which according to IDOT is a structural overlay of an interstate, a LCCA should have been conducted.</p> |
| <p>Proj. type: Rehabilitation of I-80 Pavement costs: \$9 million Pavement used: Primarily asphalt Contract #: 66A08</p> | <p>It was a pavement rehab project to extend the life of the existing pavement; therefore, no LCCA was necessary.</p> | <p>The overlay was originally planned to be 3.75 inches, but was revised to 6 inches, which according to IDOT is a structural overlay of an interstate. A LCCA should have been conducted.</p> |
| <p>Proj. type: Rehabilitation of US 51 Pavement costs: \$6 million Pavement used: Primarily asphalt Contract #: 74150</p> | <p>It was a pavement rehab project to extend the life of the existing pavement; therefore, no LCCA was necessary.</p> | <p>Since the overlay was 3.75 inches, which according to IDOT is a structural overlay of a non-interstate, a LCCA should have been conducted.</p> |
| <p>Proj. type: Rubblizing, Widening, and HMA Resurfacing of I-55 Pavement costs: \$27 million Pavement used: Primarily asphalt Contract #: 76C93</p> | <p>It was a pavement reconstruction project utilizing rubblization, which was a special design, and therefore no LCCA was necessary.</p> | <p>Rubblization was an experimental design prior to Sept. 2010, which is an exemption established by Public Act 96-715.</p> |
| <p>Proj. type: Milling, Rubblizing, and HMA Resurfacing of I-57 Pavement costs: \$22 million Pavement used: Primarily asphalt Contract #: 78175</p> | <p>It was a pavement reconstruction project utilizing rubblization, which was a special design, and therefore no LCCA was necessary.</p> | <p>Rubblization was an experimental design prior to Sept. 2010, which is an exemption established by Public Act 96-715.</p> |
| <p>Proj. type: Rehabilitation of I-290 & I-355 Pavement costs: \$18 million Pavement used: Primarily asphalt Contract #: 60G51</p> | <p>It was a pavement rehab project to extend the life of the existing pavement; therefore, no LCCA was necessary.</p> | <p>The overlay was 4 inches and therefore did not meet IDOT's policy of 5 inches of pavement for a structural overlay of an interstate.</p> |
| <p>Proj. type: Rehabilitation of I-55 Pavement costs: \$7 million Pavement used: Primarily asphalt Contract #: 70845</p> | <p>It was a pavement rehab project to extend the life of the existing pavement; therefore, no LCCA was necessary.</p> | <p>Since the overlay was 3.25 inches and the project was an interstate, according to IDOT policy it was not a structural overlay.</p> |
| <p>Source: OAG summary of Consultant report.</p> | | |

We provided an additional 20 projects with pavement costs in excess of \$500,000 to IDOT for review and comment as to why a LCCA was not required. According to IDOT, of the 20 contracts:

- 17 projects were pavement rehabilitation projects which extended the life of the existing pavement via milling, patching, and resurfacing. According to IDOT policy, LCCAs are not conducted for resurfacing projects. Of the 17:
 - One project placed a 3.75 inch HMA overlay which, according to IDOT’s BDE Manual, is a structural overlay of a non-interstate (US 24).
 - Five projects placed a combination of structural overlays and non-structural overlays for various portions of each project. For example, pavement rehabilitation work on I-72 in Macon and Piatt counties involved 5 inch overlays in two sections and 4 inch and 3.75 inch overlays in two other locations. According to IDOT policy, a 5 inch overlay on an interstate is structural; however, overlays of less than 5 inches are not structural.
 - One project involved resurfacing which was a structural overlay (3.75 inches on a non-interstate), but utilized an experimental process (Cold In-Place Recycling) and thus was exempted from LCCA requirements. The remaining portion of the project involved resurfacing which was not structural in nature.
 - Ten projects involved resurfacing which was not structural in nature.
- 1 contract was pavement reconstruction, but did not require a LCCA because it utilized rubblizing with an asphalt overlay. According to IDOT, prior to September 2010, rubblizing was considered an experimental design and thus was exempted from LCCA requirements by IDOT during 2010.
- 2 required a LCCA and had received a LCCA. IDOT had not previously identified these 2 as projects as having received a LCCA; however, according to IDOT, the LCCAs were in the files at the Districts and were subsequently provided to the auditors.

Conclusion

Our audit identified a significant number of IDOT contracts in 2010 where pavement costs exceeded \$500,000 for which a life-cycle cost analysis was not conducted. A strict interpretation of the law is that when pavement costs exceed \$500,000, unless it meets one of the exemptions established in the Public Act (experimental design or interstate with high traffic volume), a life-cycle cost analysis must be performed. During 2010, IDOT was not conducting life-cycle cost analyses for most rehabilitation projects. Also, IDOT had established other LCCA exemptions related to special designs and other policy decisions.

While we concur that in certain circumstances, such as thin overlay resurfacing or certain special designs, the development of alternative pavement designs needed to do a LCCA may not be possible, we also conclude that there are pavement projects awarded in 2010, most notably structural overlays, where LCCAs could have been conducted, but were not. We also note that IDOT's policy guidance in Chapter 53 of the BDE Manual needs to be revised to clearly delineate when policy requires a LCCA to be conducted. Given the disconnect between State law and IDOT policy, action needs to be taken to clearly delineate what projects require a LCCA and resolve the conflicts between the two.

| COMPLIANCE WITH STATUTORY REQUIREMENTS | |
|---|---|
| <p>RECOMMENDATION NUMBER</p> <p>1</p> | <p><i>The Department of Transportation should conduct life-cycle cost analysis on all projects that meet the requirements of Public Act 96-715. Should IDOT conclude that statutory changes are needed to include additional criteria as to when a LCCA is not feasible, then it should work with the General Assembly to revise the statutory requirements. Furthermore, the Department should more clearly define in the LCCA section of Chapter 53 in its BDE Manual regarding the circumstances when LCCA is required for rehabilitation projects.</i></p> |
| <p>DEPARTMENT OF TRANSPORTATION'S RESPONSE</p> | <p>The Department disagrees with the recommendation. The current policy in Chapter 54 of our BDE Manual requiring a life-cycle cost analysis (LCCA) on projects that newly construct or reconstruct pavement, and not requiring an LCCA on projects that rehabilitate or resurface pavement, does meet the requirements of the statute (20 ILCS 2705/2705-590 (PA 96-715)). The statute states, "As used in this Section, "life-cycle cost" means the total of the cost of the <u>initial project</u> plus all anticipated <u>future costs over the life of the pavement</u>" (<i>underlined emphasis added</i>). The Department understands this language to mean the initial project is the one that begins the pavement's life (i.e. new construction/reconstruction). Rehabilitation/resurfacing projects are a part of sustaining the pavement's life and thus considered a future cost which has already been accounted for in the original analysis. The audit report agrees with this understanding on page 1 (1st paragraph) when it states, "Life-cycle cost analysis (LCCA) is a process for evaluating the financial impact of a project by analyzing initial costs and discounted future costs, such as maintenance, user, reconstruction, rehabilitation, restoring, and resurfacing costs, over the life of the project."</p> <p>The Department's current policy in Chapter 54 also has been approved by the Federal Highway Administration (FHWA) as a control document in accordance with our Stewardship/Oversight Agreement. The FHWA requires an LCCA to consider three key points: 1) an equal analysis period when evaluating alternatives, 2) alternatives which require periodic maintenance and</p> |

rehabilitation, and 3) an analysis period which includes at least one major rehabilitation activity. To analyze options for rehabilitation projects which rarely have equal lives and by definition would not have any rehabilitation activities within their life as is suggested, would not meet these requirements.

In an effort to resolve this disagreement, the Department will initiate a legal review of the statute to validate its intent and to determine if clarifying language is necessary.

Chapter 53 of the BDE Manual deals with pavement rehabilitation and based upon the reasoning above, LCCAs are not required. The chapter presents information on the typical problems found in Illinois pavements and the various methods available for addressing them. In other words, the guidance is meant to facilitate selecting the proper scope of a rehabilitation project not in selecting the lowest cost material option for a given project scope which is what an LCCA does. To this end, the Department feels it would be better to change the terminology within Chapter 53 from LCCA to "asset management" of "project scope selection" to clarify the intent and separate it from the LCCAs mandated by statute.

Auditor Comment #1:

The auditors differ with the Department’s interpretation of the LCCA statute. The statute requires that a life-cycle cost analysis be conducted on each “State road project” for which the total pavement costs exceed \$500,000. The law does not limit this requirement to “new construction” or “reconstruction” projects as interpreted by the Department. The definitions of life-cycle cost analysis used in both the Act and in our audit report also do not limit the use of LCCAs only to “new construction” or “reconstruction” projects. Rather, the generic term “projects” is used which may include rehabilitation projects.

Contrary to the Department’s assertion that rehabilitation projects do not meet FHWA requirements, FHWA guidance on pavement design considerations states that as part of the project analysis for major rehabilitation projects, an economic analysis, “based on life cycle costs,” should be performed.

Regarding the Department’s position to conduct life-cycle cost analyses only for new construction or reconstruction projects, the auditors note the following:

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| | <p>Auditor Comment (cont.)</p> <ul style="list-style-type: none"> • Several other Midwestern states surveyed by auditors reported using LCCA on rehabilitation, resurfacing, and/or structural overlay projects (see Chapter 4). Furthermore, a 2011 report issued by the Transportation Research Board noted that 13 state departments of transportation perform LCCA for rehabilitation projects. • Chapter 53 (Pavement Rehabilitation) of IDOT's BDE Manual unequivocally states "This section provides guidance on conducting Life-Cycle Cost Analyses (LCCA) for <u>pavement rehabilitation projects</u> to assess the long-term cost effectiveness of alternative rehabilitation strategies." (emphasis added) It goes on to state that "LCCA should be conducted as early in the project development cycle as practicable. For rehabilitation projects, the appropriate time for conducting the LCCA is during the alternatives evaluation stage of Phase I." The Department's position taken in response to this audit is contrary to guidance delineated in its own policy manual since 2000. • Pavement costs and pavement technologies can dramatically change from the time the original LCCA was prepared to when a major rehabilitation occurs. To fulfill its fiduciary responsibilities, it would seem prudent for the Department to undertake a LCCA to ensure the rehabilitation strategy used is the most economical. |
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LCCA DATA INPUTS

Public Act 96-715 contains explicit requirements regarding the source of data to be used in conducting the life-cycle cost analyses. It **requires that, "Actual, relevant data, and not assumptions or estimates, shall be used to the extent such data has been collected."** It further requires that a "life-cycle cost analysis shall compare equivalent designs based upon this State's actual historic project schedules and costs as recorded by the pavement management system. . . ." (20 ILCS 2705/2705-590 (a) and (c)).

There are three basic types of project-specific data that go into a LCCA: the initial project costs, the maintenance and rehabilitation activity schedules, and the maintenance and rehabilitation costs. IDOT used actual cost data for its cost inputs. **However, IDOT's maintenance and rehabilitation activity schedules in use during calendar year 2010 were**

based primarily on engineering judgment and not actual historical project schedules, and therefore, were not in compliance with the Public Act.

The Public Act specifically mentions using “actual historic project schedules and costs as recorded by the **pavement management system**” in preparation of life-cycle cost analyses [emphasis added]. However, according to IDOT officials, data from the pavement management system (which is referred to as IRIS – Illinois Roadway Information System) is not used to obtain any historical construction costs (i.e., initial cost inputs or maintenance cost inputs) for the LCCA, nor is it used to develop maintenance and rehabilitation activity schedules.

According to IDOT officials, the Bureau of Materials and Physical Research (BMPR) uses IRIS to examine historical performance or forensics to know why something went wrong. BMPR could potentially use this data to develop rehabilitation activity schedules, but the system does not capture the level of detail they would need to use the data (e.g., construction and maintenance history on every pavement section). Additionally, if a District does not put all of the data into IRIS (such as treatments done to a road), then IRIS cannot show an accurate picture of pavement performance and would therefore skew maintenance and rehabilitation activity schedules based on this data. According to BMPR, IRIS’s primary function is to help IDOT’s Office of Planning and Programming, which is responsible for IRIS, plan and prioritize projects and funding. As a result, the pavement management system has had little to no impact on the LCCA process.

Initial Project Cost Inputs

According to an IDOT official, since 2006, each District uses a program called ProEstimate HEAVY to determine complicated initial unit cost inputs for the LCCAs. The official said that IDOT previously gathered all the data in Excel prior to using ProEstimate HEAVY. ProEstimate HEAVY is a program specifically designed for heavy/highway contractors and subcontractors to assist in the preparation of a bid. The program allows users to load pay items and quantities directly from State-supplied bid data. According to IDOT, ProEstimate HEAVY uses a combination of the following to determine unit cost inputs for each respective LCCA:

- Materials – Based on the type of material, historical prices are determined using IDOT’s in-house historical bid data.
- Labor rate database – Prevailing wage rates from the Illinois Department of Labor website for each county and the respective job title (e.g., cement mason).
- Crew database – Crew databases are built and saved by each user (i.e., District personnel). This allows crew composition to be reflective of what is seen in each county in view of the fact that crew composition varies among contractors.
- Equipment rate database – Equipment Watch Rental Rate Blue Book provides equipment rates. These rates are updated regularly.

Maintenance Cost Inputs

Maintenance unit costs are used in the maintenance and rehabilitation activity schedules of a LCCA to estimate the cost of each maintenance and rehabilitation activity. IDOT officials report using maintenance and contract prices from previous maintenance contracts.

Maintenance and Rehabilitation Activity Schedules

Prior to April 2011, IDOT's maintenance and rehabilitation (M&R) activity schedules were not in compliance with Public Act 96-715. Maintenance and rehabilitation activity schedules are used to calculate the present value of anticipated maintenance and rehabilitation activities for each respective pavement alternative. According to IDOT officials, prior to the April 2011 updates to Chapter 54 (Pavement Design) of the BDE Manual, the activity schedules were based primarily on engineering judgment from experienced engineers and personnel and not actual historical project schedules. As a result, the LCCAs conducted during our audit period (contracts awarded in calendar year 2010), were not based on actual historical project schedules as required by the Public Act.

Review of Cost Inputs

Despite the autonomy given to IDOT's nine Districts as to how policies are implemented, LCCA procedures and data sources were fairly comparable. Auditors met with IDOT officials at three Districts. District officials reported using software and spreadsheets provided by IDOT to conduct the LCCA. As noted previously, the software and spreadsheets appear to be producing and using actual, relevant data.

Our Consultant's review of initial construction and maintenance construction costs used in the LCCA projects they reviewed indicated that, after correcting for inflation, the values used by IDOT were reasonable and generally consistent with the practice in other states. Our Consultant also reviewed IDOT's maintenance and rehabilitation treatment types and timings in effect as of September 2010 (before April 2011 updates). They concluded that the treatment types (i.e., milling, overlay, patching, routing and sealing) for each respective pavement were appropriate. They found that the treatment timings were appropriate and reasonable from an engineering standpoint, even though these timings were found not to be based on historical data from IDOT's pavement management system.

April 2011 Changes

In April 2011, IDOT updated its maintenance and rehabilitation activity schedules and, unlike the activity schedules used for the 2010 projects, the updated schedules are based on historical schedules. IDOT officials noted that the changes were based on actual pavement performance. According to IDOT officials, the maintenance and rehabilitation activity schedule updates were based on pavement survey data and long-term efforts between IDOT and the paving/construction industry between 2003 and 2009. IDOT officials said these changes were confirmed by data collected by IDOT in 2010 (interim report released in March 2011), as well as a review of other states' data as contained in Colorado DOT's 2009 study of LCCA. IDOT's

March 2011 Performance Monitoring of Mechanistically-Designed Pavements interim report states that a total of 105 contracts were monitored, the majority of which (over 800 lane-miles of pavement) were surveyed in the field in 2010. The report notes that an additional 350 lane-miles of high traffic volume roadways were reviewed on video.

The maintenance and rehabilitation treatments are now slightly less frequent than they were prior to the April 2011 revisions, meaning the pavements will require less frequent maintenance. **Our Consultant concluded that the updated maintenance and rehabilitation activity schedules are reasonable and also are consistent with data presented in IDOT's report on monitoring of performance of mechanistically-designed pavements.**

IDOT also updated its mechanistic designs for jointed plain concrete pavement and full-depth hot mix asphalt. IDOT's mechanistic design procedures determine the pavement thickness for each pavement alternative based on various factors (e.g., design HMA strain, subgrade support ratio, PCC stresses, etc.). The mechanistic design for jointed plain concrete pavement was updated to reflect an improved design based on research conducted by the University of Illinois, Urbana-Champaign (UIUC) over the past 15-year period. The mechanistic design for full-depth hot mix asphalt pavement was updated to reflect an improved design based on research findings from lab testing by UIUC. According to IDOT, IDOT developed its design process in the late 1980s, and, since its development, has made modifications to its design process based upon pavement performance. **In the Consultant's view, IDOT's updates to its designs are reasonable and justified.**

Analysis Period

IDOT's LCCA analysis period, or the time period over which it evaluates the future costs to maintain and rehabilitate the roadway for each pavement alternative, was 40 years during calendar year 2010. The Federal Highway Administration's LCCA Policy Statement recommends an analysis period of at least 35 years for all pavement projects.

One of the changes IDOT made in the April 2011 policy revisions was to increase the LCCA analysis period from 40 years to 45 years. An IDOT official said this was changed because IDOT realized its pavements were lasting longer, possibly due to selecting and using better materials.

A lengthening of the analysis period would have a potentially beneficial impact on pavement constructed with materials that have lower initial costs (such as asphalt), but higher later-year costs associated with maintenance and repair. This is the result of the discounting of future years' costs.

Discount Rate

IDOT uses a 3 percent discount rate when calculating a LCCA. This falls within the range of discount rates used by other states we surveyed (2.7 to 5 percent). According to the Federal Highway Administration (FHWA), the discount rates employed in LCCA should reflect historical trends over long periods of time and noted that 3 to 5 percent is an acceptable range.

As with the analysis period discussed above, the discount rate used also impacts LCCA calculations for different pavement types. With a lower discount rate, the present values of costs incurred in later years are relatively high. Conversely, with a higher discount rate, the present values of costs incurred in later years are relatively low. As such, IDOT's policy of using the lowest possible discount rate within the FHWA-recommended range would potentially have a more beneficial impact to material alternatives with relatively higher initial costs and relatively lower costs of life-cycle maintenance (such as concrete), compared to those materials with relatively lower initial costs and relatively higher costs of life-cycle maintenance (such as asphalt).

USER COSTS

Although including costs incurred by the traveling public is noted as a best-practice by the FHWA, IDOT's LCCA calculation does not include user costs in its life-cycle cost analysis. According to IDOT officials, they have looked at including user costs several times. However, the quality of the analysis is difficult to ensure and it is hard to get an accurate number. IDOT officials said the user costs can be two to five times the amount of the total project and, if used, the user costs could be the overwhelming majority of costs for some projects. If user costs would have that large of impact, for this reason alone, it would seem user costs should be an important consideration in at least some capacity (e.g., weighted), especially in urban projects. Public Act 96-715 states that IDOT "**may** include estimates of user costs throughout the entire pavement life." [emphasis added]

The FHWA LCCA Primer, which provides guidance on the use of LCCA, notes that incorporating user costs into LCCA enhances the validity of the results, but also admits that it can be a challenging task. The Primer states, "Although best-practice LCCA considers both agency and user costs, in actual practice many analysts are reluctant to assign the same level of validity to user costs that they assign to agency costs. Thus, alternatives are often compared chiefly on agency costs." The FHWA designed LCCA software (*RealCost*) is free and, among its features, has an optional user cost calculation capability.

IDOT's non-use of user cost in its LCCA is consistent with standard practice among states. Only three (Indiana, Michigan, and Pennsylvania) of ten survey respondents (nine other states and the Illinois State Toll Highway Authority) reported including user costs in the analysis of life-cycle costs.

| INCORPORATING USER COSTS INTO LCCA | |
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| RECOMMENDATION NUMBER 2 | <i>The Department of Transportation should consider including some measure or acknowledgment of user costs in its life-cycle cost analysis.</i> |
| DEPARTMENT OF TRANSPORTATION'S RESPONSE | The Department agrees with the recommendation to consider whether life-cycle cost analysis should include user costs. As part of that process, we will see if new techniques and/or data are available to make the inclusion of such user costs in an LCCA more credible. |

Chapter Three

REVIEW OF LCCAs

CHAPTER CONCLUSIONS

IDOT reported conducting LCCAs for 19 contracts awarded in calendar year 2010. IDOT initially provided LCCAs for 15 contracts; however, IDOT identified 4 additional contracts with LCCAs at the end of fieldwork after auditors inquired about several projects that did not receive a LCCA. Because we did not receive the 4 LCCAs until after our testing was completed, the detailed LCCA testing presented in this chapter deals primarily with the initial 15 contracts with LCCAs we received.

We found that IDOT’s pavement design spreadsheet is generally sufficient to address the core issues of pavement design in Illinois and therefore produces equivalent designs. To assess the adequacy of IDOT’s design outputs from its pavement design spreadsheet, our Consultant carried out an independent pavement design using the Mechanistic-Empirical Pavement Design Guide (MEPDG) software. MEPDG is a national-level software package for pavement design. The Consultant’s results using the MEPDG software indicated a general consistency with the designs obtained by IDOT.

When reviewing the 15 contracts with LCCAs, we found many did not contain unit cost documentation for all of the major pavement pay items as required by IDOT policy. Unit cost documentation provides support for the unit costs used to calculate the initial construction costs of a project. **Twelve of 15 contracts (80%) were missing unit cost support for one or more of the major pay items for concrete or asphalt.** Our Consultant reviewed the initial construction material costs for eight contracts and concluded that the values used by IDOT were reasonable and generally consistent with the practice in other states; however, without all of the unit cost documentation, we can not have complete assurance that the unit costs used were appropriate and reflective of District costs. Likewise, it would be difficult for IDOT’s Bureau of Design and Environment (BDE) Central Office to perform its review and ensure appropriate unit costs were used for each respective District.

In our review of 15 contracts with LCCAs, we found that 8 of 15 contracts utilized LCCAs that were 3 or more years old (at the time of project letting), ranging from 3 years to over 12 years old. The average age for the 15 LCCAs was 3.7 years old. We found projects let and awarded in calendar year 2010 that had LCCAs prepared as early as 1998 and 2003. **Costs could have changed dramatically** over the time period between when the LCCAs were prepared and when the project was put out for bid. Public Act 96-715 requires the data used to be actual and relevant which would require up-to-date traffic data, material prices, and pavement designs to be used in the LCCA.

In 8 of 15 contracts reviewed, we found 21 instances where the costs were miscalculated in the LCCA. Fourteen of the 21 (67%) were errors of \$10,000 or more, and **two of the errors**

resulted in a pavement being selected that actually had higher life-cycle costs than the alternative.

Furthermore, according to IDOT officials, IDOT's Central Office does not check to ensure that all eligible projects receive a LCCA. Given the passage of Public Act 96-715 which now statutorily requires the completion of LCCAs, the recent revisions to the BDE Manual which will require a greater number of projects to undergo a LCCA, and the calculation errors identified by auditors in our review of LCCAs, IDOT's Central Office needs to strengthen its control and oversight to ensure that Districts are complying with State law and IDOT policy.

We found the Pavement Selection Committee was not functioning as required by IDOT policy. According to the BDE Manual, for projects awarded during calendar year 2010, if the difference in life-cycle costs between two equivalent designs was 10 percent or less, the pavement type and design selection was to be determined by the Pavement Selection Committee (comprised of one representative each from the Bureau of Design and Environment, the Bureau of Materials and Physical Research, and the Bureau of Construction and two from the respective IDOT District office). In response to a request from auditors for all Pavement Selection Committee decisions in 2010, IDOT officials responded that all LCCA projects went to the lowest cost alternative; therefore, the Pavement Selection Committee did not meet or make any pavement decisions in 2010. The IDOT officials also added that very few designs ever go to the Committee because Districts choose to accept most of the lowest life-cycle cost designs. The BDE Manual, however, gives the Pavement Selection Committee, not District staff, authority to formally make the pavement selection decision when the cost difference between the two alternatives is 10 percent or less (Section 54-7.05 of the BDE Manual).

LCCAS CONDUCTED

IDOT reported conducting LCCAs for 19 contracts awarded in calendar year 2010. IDOT initially provided 15 contracts with LCCAs; however, IDOT identified 4 additional contracts with LCCAs at the end of fieldwork after we inquired about a sample of projects that did not receive a LCCA. Because we did not receive the 4 LCCAs until after our testing was completed, the detailed LCCA testing presented in this chapter deals primarily with only the initial 15 contracts with LCCAs received.

We reviewed the LCCAs for the 15 contracts which included a total of 27 life-cycle cost analyses. Of the 15 contracts, 6 contracts had LCCAs conducted on multiple sections. For example, the contract to construct a four-lane divided rural expressway on US 67 actually contained 5 LCCAs for various components of the road construction project (e.g., Mainline, Mainline North, IL 16, IL 16 Ramps, and Flyover Ramps A & B). Our Consultant also conducted an in-depth examination of 8 of the 15 LCCAs to determine whether IDOT complied with their policies and procedures; the analyses were accurate; and the data was valid, reliable, and compliant with Section 2705-590 of the Department of Transportation Law (20 ILCS 2705/2705-590).

EQUIVALENT DESIGNS

We found that IDOT’s pavement design spreadsheet is generally sufficient to address the core issues of pavement design in Illinois and therefore produces equivalent designs. We also found IDOT’s procedures for pavement design to be reasonable and generally consistent with a number of other states. Equivalent design, according to federal regulations (23 CFR 626 Non-Regulatory Supplement), implies that each alternative will be designed to perform equally, and provide the same level of service, over the same performance period.

To assess the adequacy of IDOT’s design outputs from its pavement design spreadsheet, our Consultant carried out an independent pavement design using the Mechanistic-Empirical Pavement Design Guide (MEPDG) software. MEPDG is a national-level software package for pavement design and the underlying models it uses for pavement performance and other pavement behavior processes are based on national averages. In using the MEPDG software, our Consultant used input data relevant to Illinois wherever available, and their results indicated a general consistency with the designs originally obtained by IDOT. Our Consultant concluded that the differences, while minor, arose from the use of MEPDG pavement performance parameters that were national and did not entirely reflect Illinois characteristics.

UNIT COST DOCUMENTATION

When reviewing the 15 contracts with LCCAs, we found many that did not contain unit cost documentation for all of the major pavement pay items. Unit cost documentation provides support for the unit costs used to calculate the initial construction costs of a project. According to the BDE Manual (54-8.02), all calculations and assumptions related to an economic analysis should be included in a pavement design submittal. The BDE Manual also notes that unit cost sheets for each major pay item involved in each of the alternative designs are required to be submitted to the Central Office for BDE approval. Having the appropriate documentation when reviewing a project helps ensure the most accurate cost figures were used in the LCCA.

Twelve of 15 contracts (80%) were missing unit cost support for one or more of the major pay items for concrete or asphalt. For the concrete LCCAs prepared, seven contracts had no support for any pay items and an additional three were missing support for at least one pay item. For the asphalt LCCAs prepared, eight contracts had no support for any pay items and an additional four were missing support for at least one pay item.

Our Consultant reviewed the initial construction material costs for eight contracts. Our Consultant concluded that the values used by IDOT are reasonable and generally consistent with the practice in other states; however, without all of the unit cost documentation, we can not have complete assurance that the unit costs used were appropriate and reflective of District costs. Likewise, it would be difficult for IDOT’s BDE Central Office to perform its review and ensure appropriate unit costs were used for each respective District. Inclusion of the unit cost documentation also provides transparency.

| UNIT COST DOCUMENTATION | |
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| RECOMMENDATION NUMBER 3 | <i>The Department of Transportation should ensure unit cost documentation accompanies the life-cycle cost analysis submittals as required by Department policy.</i> |
| DEPARTMENT OF TRANSPORTATION'S RESPONSE | The Department agrees with the recommendation and will ensure unit cost documentation accompanies the LCCA submittals as required by Department policy. The Department also appreciates the OAG's affirmation of our costs on page 30 of the report, "Our Consultant's review of initial construction and maintenance construction costs used in the LCCA projects they reviewed indicated that, after correcting for inflation, the values used by IDOT were reasonable and generally consistent with the practice of other states". |

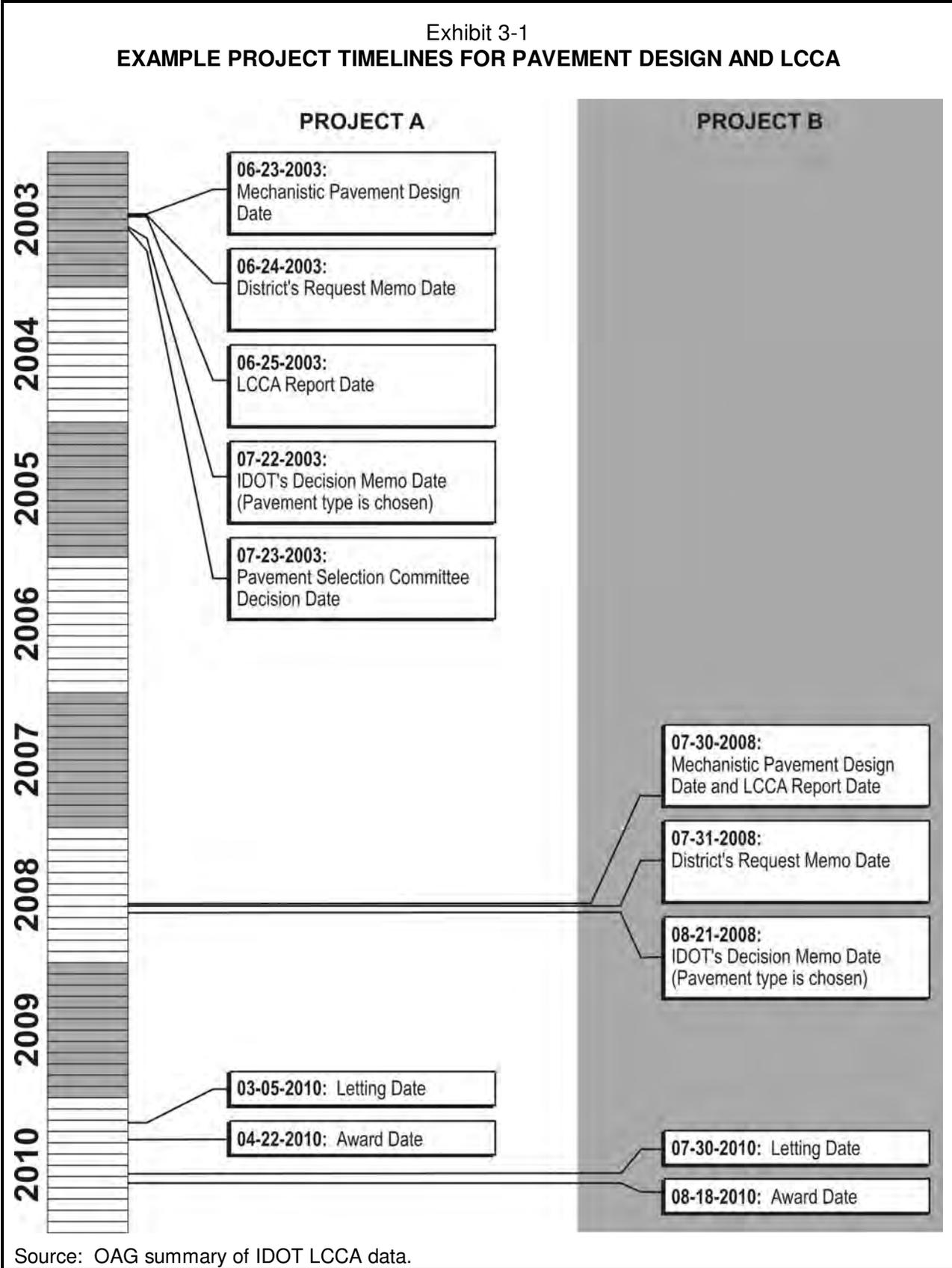
OUTDATED LCCAS

Public Act 96-715 requires the data used in LCCAs to be actual and relevant which would require up-to-date traffic data, material prices, and pavement designs. LAC Resolution Number 140 requires the audit to examine LCCAs conducted for road construction **contracts awarded in calendar year 2010**. Given the amount of time needed to conduct a LCCA, and plan and fund the construction projects, for 14 of the 15 CY10 awarded contracts reviewed which had a LCCA, the LCCA was prepared prior to the Public Act taking effect (August 25, 2009). Additionally, IDOT had approved the LCCAs for 13 of the 15 contracts before the effective date of the Public Act.

In our review of 15 contracts with LCCAs, we found that 8 of 15 contracts utilized LCCAs that were 3 or more years old (at the time of project letting), ranging from 3 years to over 12 years old. The average age for the 15 LCCAs was 3.7 years old. We found projects let and awarded in calendar year 2010 that had LCCAs prepared as early as 1998 and 2003. Costs could have changed dramatically over the time period between when the LCCAs were prepared and when the project was put out for bid.

Exhibit 3-1 provides timelines for two projects showing two different examples of the time it can take a project to progress from design to award. Project A was designed in June 2003, the pavement type was chosen in July 2003, and the project was not let until March 2010. Project B was designed in July 2008 and the contract was let two years later.

According to an IDOT official, part of the dilemma is receiving pavement designs early in the letting and construction process. Pavement designs may be submitted as one large project; however, due to funding constraints or other priorities, IDOT may be forced to split a project into smaller projects and postpone some.



According to an IDOT official, IDOT does not have a policy explicitly stipulating a period for which a particular LCCA is valid and beyond which it must be revisited. The IDOT official noted that a “rule of thumb” is that a LCCA should be prepared within 12 to 18 months of the letting date. However, our testing indicated that this “rule of thumb” is not being met.

We discussed the issue of redoing a LCCA with officials at three Districts. The main concern of redoing a LCCA was the time involved if the pavement choice changed. District officials noted that they update plans to be in compliance with any changes to the BDE Manual, but it is a significant amount of additional work to create a new set of plans if the type of pavement changed. District officials noted that it does not just affect the pavement; it could also affect the earthwork and other prep work.

Several other states noted that they did not have a standard “shelf-life” defined in policy, or time after which a LCCA is no longer considered valid; however, a maximum of 3 to 4 years prior to letting was a general consensus. Other states’ practices regarding use of a LCCA shelf-life are discussed in more detail in Chapter Four.

| OUTDATED LCCAS | |
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| RECOMMENDATION NUMBER 4 | <i>The Department of Transportation should develop an appropriate time period for which a life-cycle cost analysis is valid to ensure the analyses are based on up-to-date data, such as traffic numbers, pavement designs, and material prices and require updating of LCCAs whose age exceeds that time period.</i> |
| DEPARTMENT OF TRANSPORTATION'S RESPONSE | <p>The Department disagrees with the recommendation. The audit report concluded on page 33, "The average age for the 15 LCCA's was 3.7 years old". Considering an LCCA is done at the beginning of a project, such age is consistent with the time it takes to plan, design, and construct/reconstruct a roadway. Such reasonableness of the average age would seem to indicate the process is working just fine without the need for a pre-determined LCCA "shelf-life". Further, according to page 47 of the report, IDOT's practice is in-line with other states; "Most other states surveyed, like Illinois, did not have a standard shelf-life defined in policy, or time after which a LCCA is no longer considered valid."</p> <p>In an attempt to resolve this disagreement, the Department will conduct a review of FHWA guidance and other state's policies to assure we are following accepted practices.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p>Auditor Comment #2:</p> <p>While the <u>average</u> age for the 15 LCCAs reviewed was 3.7 years old, <u>four of the LCCAs were at least 6 years old (with the oldest being 12 years old) at the time the project was eventually let.</u> Auditors stand by their conclusion that using</p> </div> |

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| | <p>Auditor Comment (cont.)</p> <p>such outdated LCCAs: 1) does not comply with the intent of the LCCA statute which requires the use of relevant data; and 2) does not comply with IDOT’s “rule of thumb” to prepare LCCAs within 12 to 18 months of the letting date.</p> |
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LCCA CALCULATION ERRORS

Auditors noted various calculation errors in the LCCAs. For 8 of 15 contracts reviewed, we found 21 instances where the LCCA costs were miscalculated (9 of these errors were on the same contract). In 14 of the 21 (67%) instances, the errors were greater than \$10,000. The miscalculations are summarized in Exhibit 3-2.

Two of the errors resulted in a pavement being selected that actually had higher life-cycle costs than the alternative. The first (U.S. Route 20, contract #64D92) was caused by a transposition error resulting in a \$51,200 understatement of initial costs, which, when added in, made the pavement option selected (concrete) more expensive than the alternative not selected (asphalt). The pavement selection for this 2010 project should have been made by the Pavement Selection Committee because the life-cycle costs were within 10 percent; however, the pavement for this project appears to have been chosen based on the lower costs in the erroneous life-cycle cost computation.

The other miscalculation resulting in pavement with a higher life-cycle cost being selected was caused by a data input error, which created a negative value of \$76,893 instead of a positive value of \$549,254 for the asphalt alternative (US 67/IL 267, contract #76311). Because this was within the maintenance and rehabilitation activity schedule, the negative value decreased the maintenance costs and therefore the total life-cycle costs for the asphalt alternative. As a result, the asphalt pavement that, from the submitted IDOT LCCA outputs, had lower life-cycle costs by 1.3 percent, actually was found to have higher life-cycle costs by 7 percent. Relying on cost data from the erroneous LCCA, the Pavement Selection Committee chose the asphalt pavement over the concrete.

Exhibit 3-2
LCCA CALCULATION ERRORS GREATER THAN \$10,000
 On 15 Projects Reviewed

| Location & Contract Number | Dis-trict | \$ Amount of Calculation Error | LCCA item affected | Impact Determination of Lowest LCCA? |
|---|------------------|---------------------------------------|--|---|
| US 67/IL 267 (contract #76311 - Mainline) | 8 | \$626,147 | Understated asphalt year 20 maintenance cost | Yes – Asphalt was chosen but Concrete actually had lowest LCCA costs |
| US 45 from IL 120 to Washington St. (contract #60956) | 1 | \$625,780 | Overstated concrete pavement costs | No |
| IL 255 (contract #76323 - Mainline) | 8 | \$465,517 | Understated asphalt pavement costs | No |
| US 45 from IL 120 to Washington St. (contract #60956) | 1 | \$310,725 | Understated concrete pavement costs | No |
| I-270 & IL Route 3 (contract #76D87) | 8 | \$259,335 | Understated asphalt year 20 maintenance cost | No |
| US 45 from IL 120 to Washington St. (contract #60956) | 1 | \$69,740 | Understated asphalt pavement costs | No |
| 22 nd St. from IL 83 to IL 56 (contract #60D12) | 1 | \$59,720 | Understated concrete pavement costs | No |
| US 45 from IL 120 to Washington St. (contract #60956) | 1 | \$59,000 | Overstated concrete pavement costs | No |
| U.S. Route 20 (contract #64D92) | 2 | \$51,200 | Understated concrete pavement costs | Yes – Concrete was chosen but Asphalt actually had lowest LCCA costs |
| US 45 from IL 120 to Washington St. (contract #60956) | 1 | \$46,968 | Understated concrete pavement costs | No |
| US 45 from IL 120 to Washington St. (contract #60956) | 1 | \$31,201 | Overstated asphalt pavement costs | No |
| US 45 from IL 120 to Washington St. (contract #60956) | 1 | \$26,640 | Overstated concrete pavement costs | No |
| US 45 from IL 120 to Washington St. (contract #60956) | 1 | \$24,983 | Overstated asphalt pavement costs | No |
| US 45 from IL 120 to Washington St. (contract #60956) | 1 | \$13,530 | Overstated asphalt pavement costs | No |

Source: OAG summary of LCCA documentation.

IDOT officials indicated that IDOT’s Central Office reviews all LCCAs prepared by the Districts. The review includes checking traffic factors, pavement thickness calculations, and prices used in the LCCA calculations. However, given the extent and impact of errors auditors identified in their review of LCCAs, a more detailed review needs to be undertaken by Central Office of the LCCAs completed by the Districts.

Furthermore, according to IDOT officials, IDOT’s Central Office does not check to ensure that all eligible projects receive a LCCA. Projects are designed at the District level and only projects submitted to IDOT’s Central Office for design approval (greater than 4,750 square yards or if the design involves any special designs or waiver requests) undergo a review by Central Office. Projects that do not require a pavement design submittal receive only a cursory review by Central Office to provide assurance the contract contains all constituent parts, approvals, and clearances so that it can be legally let and bid. This type of review would not indicate whether a project should have received a LCCA.

IDOT’s Central Office did not maintain effective controls which would enable them to readily identify which projects had undergone a LCCA and which had not. As noted previously in this chapter, IDOT had originally identified 15 projects as receiving a LCCA; subsequent to auditors’ inquiries, 4 more were identified. There are no other reviews or sampling of projects that would identify projects that did not, but should have received a LCCA. Given the passage of Public Act 96-715 which now statutorily requires the completion of LCCAs, the recent revisions to the BDE Manual which will require a greater number of projects to undergo a LCCA, and the LCCA miscalculations identified by the auditors, IDOT’s Central Office needs to strengthen its control and oversight to ensure that Districts are complying with State law and IDOT policy.

| REVIEW OF LCCAS | |
|--|--|
| RECOMMENDATION NUMBER 5 | <i>The Department of Transportation should establish a process to ensure a complete and thorough review of life-cycle cost analyses to prevent errors and to ensure the integrity of the life-cycle cost analysis results. In addition, IDOT should improve its tracking and controls to ensure that LCCAs are being done on all projects required by State law and IDOT policy.</i> |
| DEPARTMENT OF TRANSPORTATION’S RESPONSE | <p>The Department agrees with the first part of the recommendation. The number of errors should indeed be limited to ensure the integrity of the LCCA process. IDOT will develop an improved excel spreadsheet to replace the one reviewed in this audit which seemed to be the predominant source of the errors.</p> <p>The Department disagrees with the second part of the recommendation. Per the 29 contracts tested in this audit, IDOT performed an LCCA on each and every pavement construction/reconstruction project per policy. The projects that the audit determined the Department missed were pavement resurfacing/rehabilitation projects for which LCCAs are not required. Therefore, this recommendation comes not from a lack</p> |

| | |
|--|--|
| | <p>of control over the process but from a difference in interpretation of 20 ILCS 2705/2705-590 (PA 96-715) which is a part of Recommendation Number 1.</p> <div style="border: 1px solid black; padding: 5px;"> <p>Auditor Comment #3:</p> <p>The auditors' recommendation does not come from a difference in interpretation of the LCCA statute, as purported by the Department. Rather, it is based on IDOT's own actions. When auditors requested a listing of all LCCAs performed by the districts for contracts awarded in 2010, the list provided by IDOT was inaccurate and incomplete. When auditors followed up with IDOT officials inquiring "Does central office do any type of review to ensure all projects with pavement costs greater than \$500,000 receive a LCCA?", an IDOT official responded, "With respect to central office checking that all eligible projects received LCCA's, <u>we do not.</u>" (emphasis added) The official went on to say they periodically review a sampling of projects to ascertain the extent to which they are policy-compliant.</p> </div> |
|--|--|

PAVEMENT SELECTION COMMITTEE

According to the BDE Manual, for projects awarded during calendar year 2010, if the difference in life-cycle costs between two equivalent designs is 10 percent or less, the pavement type and design selection was to be determined by the Pavement Selection Committee (comprised of one representative each from the Bureau of Design and Environment, the Bureau of Materials and Physical Research, and the Bureau of Construction and two from the respective IDOT District office). Although this process is not specifically delineated in statute, the State law does allow the Department to make a decision on other criteria "when alternative material options are substantially equivalent on a life-cycle cost basis" (20 ILCS 2705/2705-590 (b)).

Auditors requested the decisions of the Pavement Selection Committee for 2010. IDOT's initial response was that the Committee did not meet formally in 2010; however, an IDOT official offered to provide decisions made via e-mail chains. IDOT officials responded that, after looking at the e-mail record, all LCCA projects for 2010 went to the lowest cost alternative; therefore, **the Pavement Selection Committee did not meet or make any pavement decisions in calendar year 2010.** The IDOT official also added that very few designs ever go to the Committee because Districts choose to accept most of the lowest life-cycle cost designs. **The BDE Manual, however, gives the Pavement Selection Committee, not District staff, authority to formally make the pavement selection decision when the cost difference between the two alternatives is 10 percent or less.**

Auditors requested Committee decisions from 2009 or 2008. IDOT officials provided six Pavement Selection Committee examples (two from 2009 and four from 2008); however, only three actually went to the Pavement Selection Committee.

Of the three projects that went to the Pavement Selection Committee, the Committee recommended one project based on the lowest life-cycle costs. The other two projects received approval from the Pavement Selection Committee to select the pavement option with higher life-cycle costs for reasons such as traffic control concerns and costs and ease of construction and staging.

The remaining three were submitted to BDE for approval, but not specifically to the Pavement Selection Committee. These three had life-cycle cost differences which were greater than 10 percent, which exceeds the authority of the Pavement Selection Committee; therefore, these projects received approval from the Director of the Division of Highways.

Pavement Selection Committee Results from LCCA Testing

During our review of IDOT's 15 contracts with LCCAs, we found 9 contracts (60%) with LCCAs which had a difference in life-cycle costs of 10 percent or less. According to IDOT policy, these would require the pavement be selected by the Pavement Selection Committee. We requested documentation to support that the projects went before the Pavement Selection Committee. IDOT provided support for 3 of the 9 projects (33%). One of these 3 was decided upon in 1998 and the Pavement Selection Committee chose to go with the pavement with the more expensive LCCA (concrete) due to the high truck volumes and lower initial cost. The remaining 2 were decided upon in 2003 and the Pavement Selection Committee chose the pavement with the lowest life-cycle cost (both asphalt).

For the six projects that IDOT did not provide support, an IDOT official responded that due to workload and scheduling conflicts, very few formal meetings have been held. IDOT provided the following explanations for the remaining six projects:

- Two projects were discussed by phone with the Bureau of Materials and Physical Research (BMPR), but not documented. An IDOT official noted that they have tried to streamline the process. Due to the makeup of the Committee, if BMPR and BDE agree on the design along with the District, they have a simple majority and they go straight to the approval memo instead of involving the Bureau of Construction for a tie-breaking vote.
- One project was designed by BMPR and would not have gone before the Committee.
- One project was bid as an alternate bid therefore the pavement type was ultimately determined by the lowest bid.
- For one project, IDOT officials were not able to locate any documentation dealing with the Pavement Selection Committee.

- One project did not go to the Pavement Selection Committee because it went to the lowest cost alternative.

The updates to IDOT's pavement design/selection procedures will generally result in fewer projects being referred to the Pavement Selection Committee. As of April 2011, if the difference in life-cycle costs is 10 percent or less, the selection will be based upon the newly added alternate pavement bidding process, instead of being referred to the Pavement Selection Committee. Alternate bidding is a process by which contractors are given the opportunity to submit a bid to construct a designed pavement as either asphalt pavement or portland cement concrete pavement. According to Chapter 54 (Pavement Design) of IDOT's BDE Manual, only projects that do not fit the criteria for alternate pavement bidding, or if one pavement type is preferable, will be referred to the Pavement Selection Committee.

| PAVEMENT SELECTION COMMITTEE | |
|--|--|
| RECOMMENDATION NUMBER 6 | <i>The Department of Transportation should ensure the Pavement Selection Committee meets and documents its pavement selection recommendation as required by IDOT's BDE Manual.</i> |
| DEPARTMENT OF TRANSPORTATION'S RESPONSE | The Department agrees with the recommendation. Future meetings will be held per policy and decisions made will be memorialized via a memorandum to the district office instead of via email. |

ADHERENCE TO LOWEST LCCA

Public Act 96-715 allows IDOT to make a decision based on criteria other than the lowest life-cycle cost "when alternative material options are substantially equivalent on a life-cycle cost basis." LAC Resolution Number 140 asks us to determine the frequency in which IDOT has made these types of decisions.

During our review of 15 LCCAs performed on projects awarded in 2010, auditors found that in most instances, IDOT chose the alternative material which had the lowest life-cycle costs. However, for two projects, IDOT chose the alternative with the higher life-cycle costs. Exhibit 3-3 shows the 15 contracts and whether the pavement with the lowest LCCA was chosen.

For the two projects for which the lowest life-cycle cost paving alternative was not chosen, only one of them was substantially equivalent on a life-cycle cost basis (i.e., the cost difference between the two alternatives was less than 10%). The pavement type selection for this project was made by the Pavement Selection Committee in 1998.

For the other project, the difference between the pavement alternatives was greater than 10 percent. For this project, the choice to use the pavement alternative with the higher LCCA

was approved by the Director of the Division of Highways. According to the BDE Manual, when the difference in life-cycle costs is greater than 10 percent a waiver can be obtained from BDE based on issues related to policy, local agency requests, or constructability. Exhibit 3-3 shows, for the 15 projects we reviewed, those projects with life-cycle cost differences less than, and those greater than, 10 percent, as well as whether the alternative with the lowest life-cycle cost was selected.

As was discussed earlier in this chapter, there were two additional projects where the lowest life-cycle cost alternative was not selected because of calculation errors identified by the auditors. These two projects are footnoted in Exhibit 3-3.

| Exhibit 3-3 Was Lowest Life-Cycle Cost Analysis Chosen? 15 LCCAs examined by OAG ¹ | | | | |
|---|---|--|---|-------------------|
| Location & Contract Number | Calendar Year LCCA Conducted | Was Lowest LCCA Chosen? | If no – reason | Pavement Selected |
| Life-Cycle Cost Difference 10% or Less | | | | |
| US 45 from IL 120 to Washington St. – Dist. 1 (contract #60956) | 2008 | Yes | | Concrete |
| U.S. Route 20 – Dist. 2 (contract #64D92) | 2009 | Yes ² | | Concrete |
| IL 8 – Dist. 4 (contract #88859) | 1998 | No | Pavement type selection made by Pavement Selection Committee on 2/24/98 based on construction staging and high truck volumes. | Concrete |
| US 67/IL 267 – Dist. 8 (contract #76311 – Mainline and Ramps A&B) | 2003 | Yes ³ | | Asphalt |
| IL 255 – Dist. 8 (contract #76323 – Mainline) | 2003 | Yes | | Asphalt |
| I-270 & IL 3 – Dist. 8 (contract #76D87) | 2010 | Yes | | Asphalt |
| I-57 & IL 13 – Dist. 9 (contract #78194 – both sections) | 2007 | Selected through Alternate Bid process | | Asphalt |
| IL 146/IL 3 – Dist. 9 (contract #78060) | 2007 | Yes | | Asphalt |
| IL 13 – Dist. 9 (contract #98857) | 2004 | Yes | | Concrete |
| Life-Cycle Cost Difference Greater than 10% | | | | |
| 22 nd St. & IL 56 – Dist. 1 (contract #60D12 – both sections) | 2008 (22 nd St.) 2009 (IL 56) | Yes | | Concrete |
| IL Route 47 – Dist. 1 (contract # 62882) | 2007 | Yes | | Concrete |
| IL 2 – Dist. 2 (contract #64E17) | 2008 | Yes | | Concrete |
| I-80 & IL 178 – Dist. 3 (contract #66542) | 2005 | No | Director of the Division of Highways approved based on exception in IDOT policy for high stress intersection. | Concrete |
| US 24 – Dist. 6 (contract #72432) | 2007 | Yes | | Asphalt |
| US 67/IL 267 – Dist. 8 (contract #76311 – Access Roads 1,2, & 3) | 2003 | Yes | | Asphalt |
| US 67 – Dist. 8 (contract #76318 – all sections) | 2009 | Yes | | Asphalt |
| IL 255 – Dist. 8 (contract #76323 – Ramps) | 2003 | Yes | | Asphalt |
| Notes: ¹ There were 15 contracts examined, several of which had multiple LCCAs for various parts of the project. In this exhibit, two of the contracts (#76311 and #76323) had multiple LCCAs some of which were less than 10% and others which were greater than 10% and thus they appear twice in this exhibit. | | | | |
| ² Based on IDOT's LCCA, IDOT selected lowest life-cycle cost paving alternative, concrete. However, auditors identified an error in IDOT's LCCA calculation which, when corrected, actually gives asphalt the lowest LCCA value. | | | | |
| ³ Based on IDOT's LCCA for the Mainline pavement, the Pavement Selection Committee selected the lowest life-cycle cost paving alternative, asphalt. However, auditors identified an error in IDOT's LCCA calculation which, when corrected, actually gives concrete the lowest LCCA value. | | | | |
| Source: OAG analysis of IDOT data. | | | | |

OTHER STATE LCCA PRACTICES

CHAPTER CONCLUSIONS

IDOT's LCCA program compares similarly to other states' programs. We surveyed the Illinois State Toll Highway Authority (ISTHA) and ten other states to determine their road construction life-cycle cost analysis practices for pavement type selection. Of those survey respondents regularly using LCCA as part of their pavement type selection, as few as 5 LCCAs (Pennsylvania) and as many as 100 LCCAs (Kentucky) were conducted in calendar year 2010.

Over half of the states' requirements to perform a LCCA are based on the type of project or work being done (i.e., new construction, reconstruction, pavement widening, etc.). Only two states (Michigan and Minnesota) are required by statute, like Illinois, to conduct LCCAs on road pavement projects. Also, only two states (Michigan and Pennsylvania) in addition to Illinois have a pavement cost threshold for projects to receive a LCCA. One state (Iowa) uses a square yard threshold that must be met before a LCCA will be conducted.

The types of projects required to have a LCCA as part of the pavement type selection process varied by survey respondent. Like Illinois, all survey respondents are required to conduct a LCCA for new construction and reconstruction projects; however, most require a LCCA for at least one other type of project in addition to new construction and reconstruction.

IDOT's LCCA program assumptions compare similarly to other states and the ISTHA. In calendar year 2010, IDOT used a 40-year analysis period when conducting the life-cycle cost analysis. The analysis period for other states and the ISTHA ranged between 35 and 50 years. IDOT uses a 3 percent discount rate. The discount rate used by other states and the ISTHA ranged between 2.7 and 5 percent. **IDOT does not include user costs in its analysis. Only three (Indiana, Michigan, and Pennsylvania) of the ten respondents reported including user costs in the analysis of life-cycle costs.** Like Illinois, eight of the survey respondents (ISTHA, Indiana, Iowa, Michigan, Minnesota, Ohio, Pennsylvania, and Wisconsin) reported using actual historical cost data in their LCCAs.

The process for pavement selection when competing alternatives have similar life-cycle costs varied by state. These different processes included pavement review committees, alternate bidding, alternate bidding with a bid adjustment factor, and letting other factors determine the pavement type (e.g., adjacent pavement type).

Most other states surveyed, like Illinois, did not have a standard "shelf-life" defined in policy, or time after which a LCCA is no longer considered valid. However, responses indicated a maximum of 3 to 4 years prior to letting was a general practice.

OTHER STATES SURVEY

IDOT's LCCA program compares similarly to other states' programs. We surveyed the Illinois State Toll Highway Authority (ISTHA) and ten other states to determine their road construction life-cycle cost analysis practices for pavement type selection. The ISTHA responded that it has not used LCCA in 6 years. Other survey respondents conducted as few as 5 LCCAs (Pennsylvania) and as many as 100 LCCAs (Kentucky) in calendar year 2010. New York responded that it has used LCCA less than 3 times in more than 15 years because most of its pavement work is single course overlay. Exhibit 4-1 provides a breakdown of the number of LCCAs performed by each state, as well as the total projects awarded in calendar year 2010.

Illinois law requires IDOT to develop and implement a LCCA for each State road project under its jurisdiction, with limited exceptions, for which the total pavement costs exceed \$500,000 funded in whole, or in part, with State or State-appropriated funds. Only two states (Michigan and Minnesota) are statutorily required, like Illinois, to conduct LCCAs on road pavement projects. Also, only two states (Michigan and Pennsylvania) have a pavement cost threshold for projects to receive a LCCA. Michigan statute requires a LCCA for each project for which total pavement costs exceed \$1 million. Pennsylvania's DOT policy requires a LCCA if pavement costs exceed \$3 million for interstate projects and \$15 million for non-interstate projects. All other entities surveyed do not have a pavement cost threshold for projects to receive a LCCA. Iowa did however respond that typically the project needs to be 5,000 square yards in size before it will conduct a LCCA. The remaining respondents' requirements to perform a LCCA are based on the type of project or work being done (i.e., new construction, reconstruction, pavement widening, etc.).

| Exhibit 4-1 SURVEY OF OTHER STATES' PROJECTS AWARDED AND LCCAS PERFORMED Calendar Year 2010 | | |
|---|---------------------|--------------------|
| State | Projects Awarded | LCCAs Performed |
| Illinois | 1,481 | 15 |
| ISTHA | 2 | 0 |
| Indiana | 550 | 11 |
| Iowa | 52 | 20 |
| Kentucky | 690 | 100 |
| Michigan | 1,015 | 9 |
| Minnesota | 280 | 70 ¹ |
| Missouri | 351 | 23 |
| Ohio | 723 | 6 |
| Pennsylvania | 907 | 5 |
| Wisconsin | 500 | 36 |
| Note: ¹ Annual estimate of projects that received LCCA as required by law. Source: OAG survey of other states. | | |

Types of Projects Requiring a LCCA

The types of projects required to have a LCCA as part of the pavement type selection process varied by survey respondent. According to IDOT's Pavement Design policy (Chapter 54) in its BDE Manual, Illinois conducts a LCCA for new construction and reconstruction projects. Like Illinois, all survey respondents are required to conduct a LCCA for new construction and reconstruction projects; however, most require a LCCA for at least one other type of project in addition to new construction and reconstruction. Iowa and Ohio require LCCAs to be conducted only on new construction and reconstruction projects. Following are examples of some of the varying requirements reported by states regarding when a LCCA must be conducted.

- Iowa requires LCCA on new construction or reconstruction projects that contain greater than 5,000 square yards or tons of full-depth paving. Iowa also routinely performs LCCAs on rehabilitation alternatives as a good engineering practice.
- Ohio requires LCCAs to be conducted only on new construction and reconstruction projects and has a minimum project size of 4 lane-miles.
- Per statute, Michigan requires LCCA if the project's pavement costs exceed \$1 million (as long as the alternates have comparable/equivalent designs). If the cost criterion is met, the Michigan DOT conducts LCCA on all new/reconstruction projects and certain major rehabilitation projects (by comparing rubblization with hot mix asphalt overlays to unbonded concrete overlays).
- Minnesota requires a LCCA if the project places two inches of paving material and is two miles or longer (if a two-lane roadway) and 30,000 square yards or longer (if a multi-lane roadway).
- Pennsylvania requires a LCCA on new construction, reconstruction, and structural overlays if the total cost of pavement items is in excess of \$3 million for interstate and \$15 million non-interstate projects.
- Wisconsin requires LCCAs on all projects unless specifically exempt (e.g., ramps, bridge approaches, local projects that meet specific criteria). Additionally, a resurfacing project less than 5 miles long does not require a LCCA.

Exhibit 4-2 shows the types of projects that are required to have a LCCA as part of the pavement type selection process.

Exhibit 4-2
TYPE OF PAVEMENT PROJECTS REQUIRED TO HAVE A LCCA¹
 Reported by States for Calendar Year 2010

| State | New Construct. | Reconstruct. | Rehab. | Widening | Struct. Overlay | Resurfacing |
|--------------|----------------|--------------|----------------|----------|-----------------|-------------|
| Illinois | ✓ | ✓ | | | | |
| ISTHA | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Indiana | ✓ | ✓ | ✓ | | | |
| Iowa | ✓ | ✓ | | | | |
| Kentucky | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Michigan | ✓ | ✓ | ✓ ² | | ✓ ² | |
| Minnesota | ✓ | ✓ | ✓ | | ✓ | ✓ |
| Missouri | ✓ | ✓ | | | ✓ | |
| Ohio | ✓ | ✓ | | | | |
| Pennsylvania | ✓ | ✓ | | | ✓ | |
| Wisconsin | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

Notes:

¹ States may have varying requirements such as square yardage of pavement or project cost thresholds which dictate when a LCCA must be conducted.

² Only required on major rehabilitation and structural overlays when unbonded concrete overlays are compared with rubblization with HMA resurfacing.

Source: OAG survey of other states.

LCCA Assumptions

IDOT's LCCA program assumptions compare similarly to other states and the ISTHA. In calendar year 2010, IDOT used a 40-year analysis period when conducting the life-cycle cost analysis; however, as of April 2011, IDOT began using a 45-year analysis period. The analysis period for other states and the ISTHA ranges between 35 and 50 years. The Federal Highway Administration (FHWA) recommends using at least 35 years for the period of analysis. IDOT uses a 3 percent discount rate. The discount rate used by other states and the ISTHA ranged between 2.7 and 5 percent. According to the FHWA, the discount rates employed in LCCA should reflect historical trends over long periods of time and 3 to 5 percent is an acceptable range. Four respondents cited using discount rates that were below 3 percent; however, these discount rates were based on the 30-year real treasury interest rates published annually by the U.S. Office of Management and Budget (OMB). Exhibit 4-3 shows the assumptions used by the states surveyed when performing a LCCA. IDOT does not include user costs in its analysis. Only three (Indiana, Michigan, and Pennsylvania) of the ten respondents reported including user costs in the analysis of life-cycle costs. Indiana reported including a maximum of 10 percent of the user costs.

| Exhibit 4-3 COMPARISON OF ANALYSIS PERIODS, DISCOUNT RATES, AND INCLUSION OF USER COSTS IN LIFE-CYCLE COST ANALYSIS Calendar Year 2010 | | | |
|--|--|---------------------------|-------------------|
| State | Analysis Period | Discount Rate | User Costs |
| Illinois | 40 years | 3 percent | No |
| ISTHA | 50 years | 3 - 5 percent | No |
| Indiana | 50 years | 4 percent | Yes |
| Iowa | 40 years | 3 percent | No |
| Kentucky | 40 years | 4 percent | No |
| Michigan | varies | 2.7 percent ¹ | Yes |
| Minnesota | 50 years for reconstruct; 35 years for pavement rehab | 2.84 percent ² | No |
| Missouri | 45 years | 2.7 percent ¹ | No |
| Ohio | 35 years | 2.7 percent ¹ | No |
| Pennsylvania | 50 years | 4 percent | Yes |
| Wisconsin | 50 years | 5 percent | No |
| Notes: ¹ Based on OMB's 30-year real discount rate (CY2010) from Circular A-94. ² Based on 5-year average of OMB's 30-year real discount rate from Circular A-94. Source: OAG survey of other states. | | | |

Level at which LCCAs are Conducted

Unlike Illinois, the majority of the survey respondents conduct LCCAs at a central/statewide office level. According to IDOT officials, the same people designing the projects are the same staff preparing the LCCA – usually 2 to 3 district staff, including an estimator and designer. There is no LCCA unit or section at the districts. Like Illinois, Pennsylvania and Wisconsin conduct LCCAs at the district/regional office level. Indiana, Kentucky, and Minnesota conduct LCCAs at both the central/statewide office level and the district/regional office level. Exhibit 4-4 provides a breakdown of the level at which LCCAs are conducted by state.

Source of Cost Data

Like Illinois, eight of the survey respondents (ISTHA, Indiana, Iowa, Michigan, Minnesota, Ohio, Pennsylvania, and Wisconsin) report using actual historical cost data in their LCCAs. Kentucky's cost data is provided by its Engineering Estimating Branch and is based on

quantities and project location or type. Missouri noted its cost data used in LCCAs is based on the current-month unit price quotes.

Process when Life-Cycle Costs are Similar among Alternatives

The process for pavement selection when competing alternatives have similar life-cycle costs varies by state. During calendar year 2010 in Illinois, if the difference in life-cycle costs for a project was less than 10 percent, the selection was to be determined by the Pavement Selection Committee. As of April 2011, this same project's pavement selection would be based on a new alternate pavement bidding process (proposers can submit a bid to complete the project using concrete or asphalt pavement). If the project did not meet the alternate bid process criteria or one pavement was preferred over another (for reasons such as existing adjacent sections or maintenance requirements), then the pavement selection would be determined by the Pavement Selection Committee. Similar to Illinois' new policy, Ohio responded that it would use optional or alternate bidding if the cost difference between alternatives was 10 percent or less.

| Exhibit 4-4 LEVEL WHERE LCCAS ARE CONDUCTED | | |
|---|---------------------------------|---------------------------------|
| State | Central/ Statewide Office | District/ Regional Office |
| Illinois | | ✓ |
| ISTHA | ✓ | |
| Indiana | ✓ | ✓ |
| Iowa | ✓ | |
| Kentucky | ✓ | ✓ |
| Michigan | ✓ | ¹ |
| Minnesota | ✓ | ✓ |
| Missouri | ✓ | |
| Ohio | ✓ | |
| Pennsylvania | | ✓ |
| Wisconsin | | ✓ |
| Note: ¹ Regions and Transportation Service Centers provide information and participate in reviews. Source: OAG survey of other states. | | |

Four states (Kentucky, Minnesota, Missouri, and Pennsylvania) use LCCA, but it is in conjunction with alternate bidding. In other words, the project is bid using the alternate bidding process. Life-cycle costs are calculated and used to create a bid adjustment factor. The bid adjustment methods varied by state. After including the LCCA bid adjustment, the pavement type selection is determined by the lowest bid. Illinois and Ohio do not use the LCCA to adjust bids.

Wisconsin lets the region (with supporting documentation) select the pavement type only if the difference in life-cycle costs is less than 5 percent; however, if the difference for the preferred alternative is 5 percent or greater, the final selection is made by a review committee. Two states (Indiana and Iowa) and the ISTHA report using other factors such as adjacent pavement type, etc. when the alternatives have similar life-cycle costs. Per statute, Michigan makes its selection based on the alternative with the lowest life-cycle cost.

Specialized LCCA Software

Generally, like Illinois, other states reported using Excel or another type of spreadsheet to calculate life-cycle costs. Indiana reported using the FHWA's RealCost software. Wisconsin

noted that it uses its own software (WisPave). Michigan uses user cost analysis software based on the user cost analysis method recommended by the FHWA and developed by the University of Michigan with financial support from the Michigan Department of Transportation. Michigan reported using spreadsheets for all other calculations.

LCCA “Shelf-Life”

Most other states surveyed, like Illinois, did not have a standard “shelf-life” defined in policy, or time after which a LCCA is no longer considered valid. However, responses indicated a maximum of 3 to 4 years prior to letting was a general practice. Pennsylvania’s Pavement Policy Manual specifically states that the maximum shelf life of a LCCA is 3 years from the time it is performed, the reason being the materials and construction costs from 3 years ago may not be reflective of current costs. Michigan noted that it implemented a new process (effective February 9, 2012) which specifies that the LCCA should be done within 24 months of letting. If the results are needed before then to do the design, the new process would allow an informational LCCA to be done early with the understanding that when the letting date gets closer, a new LCCA would be prepared and the results could change. Exhibit 4-5 is a summary of LCCA shelf-life responses.

Exhibit 4-5
SURVEY OF OTHER STATES' LCCA SHELF-LIFE
 Calendar Year 2010

| State | LCCA Shelf-Life |
|--------------|--|
| Illinois | No set shelf-life; however, 12 to 18 months has developed as a "rule of thumb." |
| ISTHA | Little, if any shelf-life. LCCAs are performed shortly before the projects are slated to be designed and constructed. |
| Indiana | No set shelf-life; time to letting is very short (approximately a month). |
| Iowa | No set shelf-life. Would depend if costs changed significantly, but likely update the costs used in the LCCA if it was about 2-3 years old. |
| Kentucky | No set shelf-life. With the variability in asphalt prices, a year is about the longest we would go. For the purposes of establishing the actual bid adjustments for alternate bid projects, those are done within a month or so of the actual bidding. |
| Michigan | A new process was adopted effective Feb. 9, 2012: LCCAs submitted more than 24 months before lettings will not receive final approval; instead a final approved LCCA will be done inside the 24 month period using the latest costs and following the latest processes in place. Prior to this, there was no set shelf-life. |
| Minnesota | No set shelf-life. Typically projects are let within 3 or so years from the time the original LCCA is done. |
| Missouri | LCCAs are created every month; use current unit bid prices so as to not use "old" LCCA adjustment factors with future alternate bid projects. |
| Ohio | Initial LCCA 3 to 4 years prior to award; reanalyze LCCA at approximately 1 year before award. |
| Pennsylvania | 3 years |
| Wisconsin | 4 years, but based on structure reevaluation (to ensure changes/updates in traffic stream, etc. are accounted for); at this point, the designer would possibly use up-to-date pricing. |

Source: OAG summary of other states' responses.

Appendix A
LAC Resolution Number 140

Legislative Audit Commission

RESOLUTION NO. 140

Presented by Representative Mautino

WHEREAS, the Department of Transportation is responsible for the planning, design, construction, operation and maintenance of the 16,500 mile State highway system; and

WHEREAS, to maximize limited State resources, the most cost effective method of road construction should be utilized; and

WHEREAS, costs associated with road construction and paving not only include the cost of the initial construction project, but also the cost of maintaining and rehabilitating the road in future years; and

WHEREAS, the calculation of the total cost of such highway construction is referred to as "life-cycle cost", which means the total cost of the initial project plus all anticipated future costs over the life of the pavement; and

WHEREAS, Public Act 96-0715, effective August 25, 2009, requires the Illinois Department of Transportation to develop and implement a life-cycle cost analysis for each State road project under its jurisdiction for which the total pavement costs exceed \$500,000 funded in whole, or in part, with State or State appropriated funds; therefore;

BE IT RESOLVED, BY THE LEGISLATIVE AUDIT COMMISSION that the Auditor General is directed to conduct a management audit of the Illinois Department of Transportation's implementation of the life-cycle cost analysis required by Section 2705-590 of the Department of Transportation Law (20 ILCS 2705/2705-590) for road construction contracts awarded in calendar year 2010;

RESOLVED, that the audit include, but need not be limited to, the following determinations:

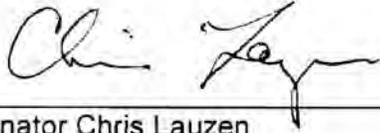
1. Whether the Department has developed and implemented a life-cycle cost analysis which complies with the requirements of Section 2705-590 of the Department of Transportation Law, for each State road project under its jurisdiction for which the total pavement costs exceed \$500,000 funded, in whole, or in part, with State or State-appropriated funds;
2. Whether the Department has designed and awarded these projects utilizing material having the lowest life cycle cost; and

3. The frequency in which the Department has made a decision based on other criteria when alternative material options are substantially equivalent on a life-cycle cost basis; and

BE IT FURTHER RESOLVED, that the Illinois Department of Transportation and any other entity having information relevant to this audit cooperate fully and promptly with the Auditor General's Office in the conduct of this audit; and

RESOLVED, that the Auditor General commence this audit as soon as possible and report findings and recommendations upon completion in accordance with the provisions of Section 3-14 of the Illinois State Auditing Act.

Adopted this 16th day of November 2010.



Senator Chris Lauzen
Co-Chair



Representative Frank J. Mautino
Co-Chair

Appendix B

Public Act 96-715

**IDOT Life-Cycle Cost Analysis Requirement
Effective August 25, 2009**

Public Act 096-0715

AN ACT concerning transportation.

**Be it enacted by the People of the State of Illinois,
represented in the General Assembly:**

Section 5. The Department of Transportation Law of the Civil Administrative Code of Illinois is amended by adding Section 2705-590 as follows:

(20 ILCS 2705/2705-590 new)

Sec. 2705-590. Roadbuilding criteria; life-cycle cost analysis.

(a) As used in this Section, "life-cycle cost" means the total of the cost of the initial project plus all anticipated future costs over the life of the pavement. Actual, relevant data, and not assumptions or estimates, shall be used to the extent such data has been collected.

(b) The Department shall develop and implement a life-cycle cost analysis for each State road project under its jurisdiction for which the total pavement costs exceed \$500,000 funded in whole, or in part, with State or State-appropriated funds. The Department shall design and award these paving projects utilizing material having the lowest life-cycle cost. All pavement design life shall ensure that State and State-appropriated funds are utilized as efficiently as possible. When alternative material options are substantially equivalent on a life-cycle cost basis, the Department may make a decision based on other criteria. At the discretion of the Department, interstate highways with high traffic volumes or experimental projects may be exempt from this requirement.

(c) Except as otherwise provided in this Section, a life-cycle cost analysis shall compare equivalent designs based upon this State's actual historic project schedules and costs as recorded by the pavement management system, and may include estimates of user costs throughout the entire pavement life.

(d) For pavement projects for which this State has no actual historic project schedules and costs as recorded by the pavement management system, the Department may use actual historical and comparable data for equivalent designs from states with similar climates, soil structures, or vehicle traffic.

Section 99. Effective date. This Act takes effect upon becoming law.

Effective Date: 8/25/2009

Appendix C
Audit Methodology

Appendix C

AUDIT METHODOLOGY

We conducted this management audit in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on the audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. This audit was also conducted in accordance with audit standards promulgated by the Office of the Auditor General at 74 Ill. Adm. Code 420.310.

The audit objectives for this audit were those as delineated in Legislative Audit Commission Resolution Number 140 (see Appendix A), which directed the Auditor General to conduct a management audit of the Illinois Department of Transportation's implementation of the life-cycle cost analysis required by Section 2705-590 of the Department of Transportation Law (20 ILCS 2705/2705-590) (see Appendix B) for road construction contracts awarded in calendar year 2010.

In conducting the audit, we reviewed applicable State statutes and rules. We reviewed compliance with those laws to the extent necessary to meet the audit's objectives. Any instances of non-compliance we identified are noted in this report.

We assessed risk by reviewing recommendations from previous IDOT audits, IDOT internal documents, policies and procedures, management controls, and IDOT's Bureau of Design and Environment Manual. We reviewed management controls relating to the audit objectives that are identified in Section 2705-590 of the Department of Transportation Law (20 ILCS 2705/2705-590). This audit identified some weaknesses in those controls, which are included as recommendations in this report.

We interviewed representatives and obtained information and documentation from the Illinois Department of Transportation and the Federal Highway Administration. We examined the current IDOT organizational structure, policies and procedures, IDOT's LCCA process, including the Pavement Selection Committee process, federal requirements related to LCCA, documentation requirements, and changes to Chapter 54 (Pavement Design) of IDOT's BDE Manual.

Given the technical nature of the life-cycle cost analysis process, we contracted with Consultants to provide assistance in reviewing IDOT's LCCA process. Our Consultants were Kumares Sinha, Ph.D., P.E. and Samuel Labi, Ph.D., from Purdue University's School of Civil Engineering. Both individuals have years of experience in transportation and pavement engineering and have been a part of an extensive number of research projects, transportation committees, and projects relevant to pavement evaluation and life-cycle cost analysis; however, the Consultants have not done any work for or with the Illinois Department of Transportation. The Consultants provided expertise in both pavement design, as well as life-cycle cost analysis practices.

IDOT conducted LCCAs for 19 contracts awarded in calendar year 2010. We requested a list of all projects from IDOT and received a list containing 1,481 awards. We found 313 State

jurisdiction contracts awarded in calendar year 2010 that contained over \$500,000 in pavements costs. IDOT initially identified 24 contracts that received a LCCA, with a total award amount of \$375.8 million for calendar year 2010. After requesting and reviewing these 24 projects, we determined and confirmed with IDOT that only 15 of 24 actually received a LCCA. IDOT provided 4 additional LCCAs at the end of fieldwork after we inquired about samples of projects that did not receive a LCCA. Because we did not receive the 4 LCCAs until after our testing was completed, the detailed LCCA testing presented deals primarily with only the initial 15 contracts with LCCAs received.

We tested the LCCAs for these 15 contracts for the following: LCCA calculations; documentation for unit costs utilized in the LCCA; whether the appropriate process was followed for LCCA differences less than or greater than 10 percent; and the age of the LCCA at the contract's letting.

Our Consultant reviewed 8 of the 15 LCCAs judgmentally selected by the OAG. This included a review of IDOT processes pertaining to pavement design and pavement LCCA. The Consultant examined the specific procedures, input data, assumptions of IDOT's pavement design and pavement life-cycle cost analysis. The Consultant also carried out an independent pavement design and LCCA for each design to ensure the results were consistent with IDOT's. Results from the sample are presented in Chapter Three.

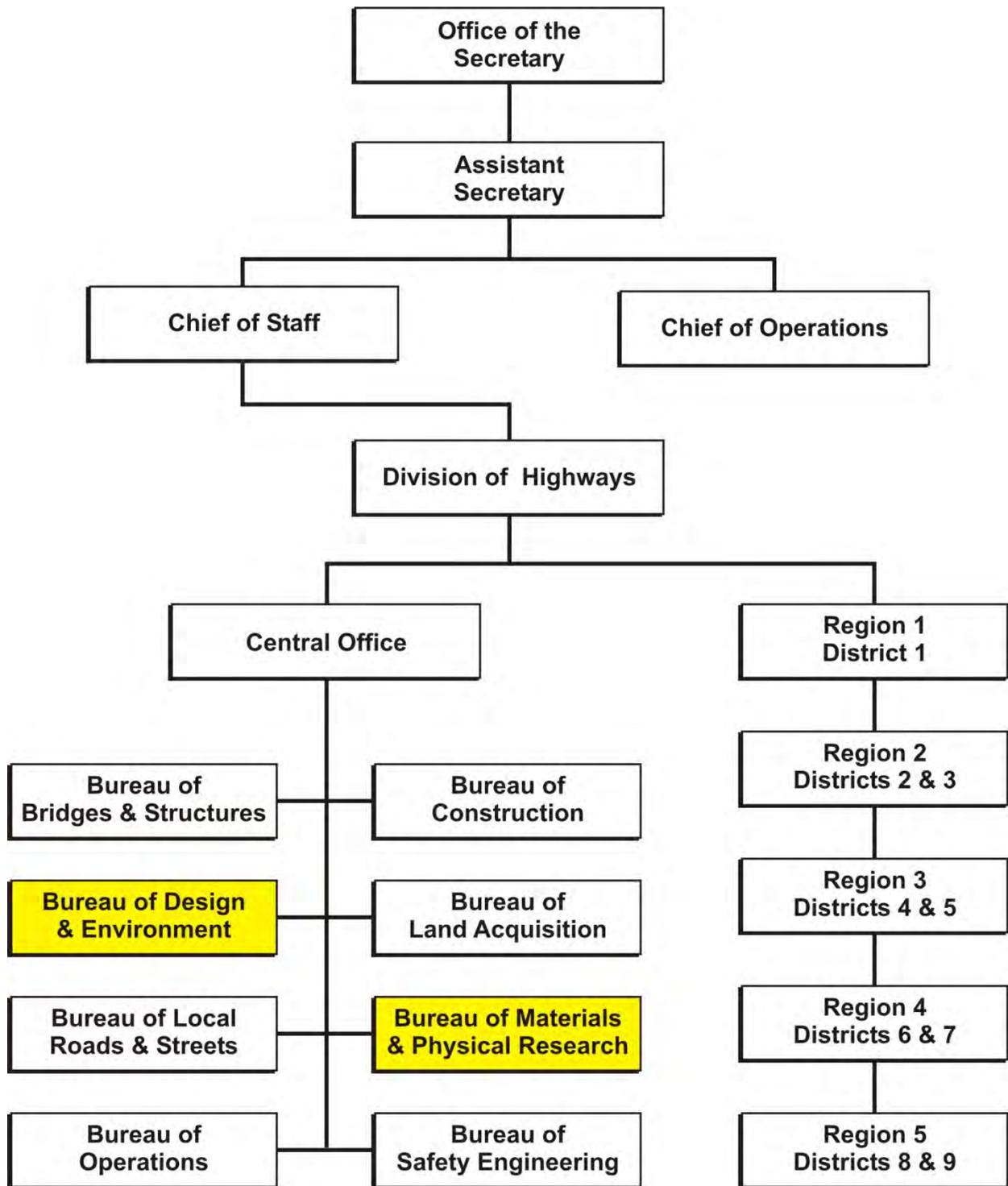
We judgmentally selected 29 contracts from the list of 313 State jurisdiction contracts with \$500,000 or more in paving costs that did not receive a LCCA. We ensured this sample contained projects from all Districts. Our Consultant also reviewed 9 of these. Results from the sample are presented in Chapter Two.

Auditors requested the decisions of the Pavement Selection Committee for 2010. IDOT's initial response was that the Committee did not meet formally in 2010; however, an IDOT official offered to provide decisions made via e-mail chains. IDOT officials responded that, after looking at the e-mail record, all LCCA projects for 2010 went to the lowest cost alternative; therefore, the Pavement Selection Committee did not meet or make any decisions. We reviewed the Pavement Selection Committee decisions from 2009 and 2008. We also reviewed any Pavement Selection Committee documentation provided for 15 of the contracts with LCCAs.

We surveyed the Illinois State Toll Highway Authority (ISTHA) and several other states to determine their road construction life-cycle cost analysis practices for pavement type selection. Surveyed states were: Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, and Wisconsin. Results of this survey are discussed in Chapter Four.

Appendix D
IDOT's Organization Chart

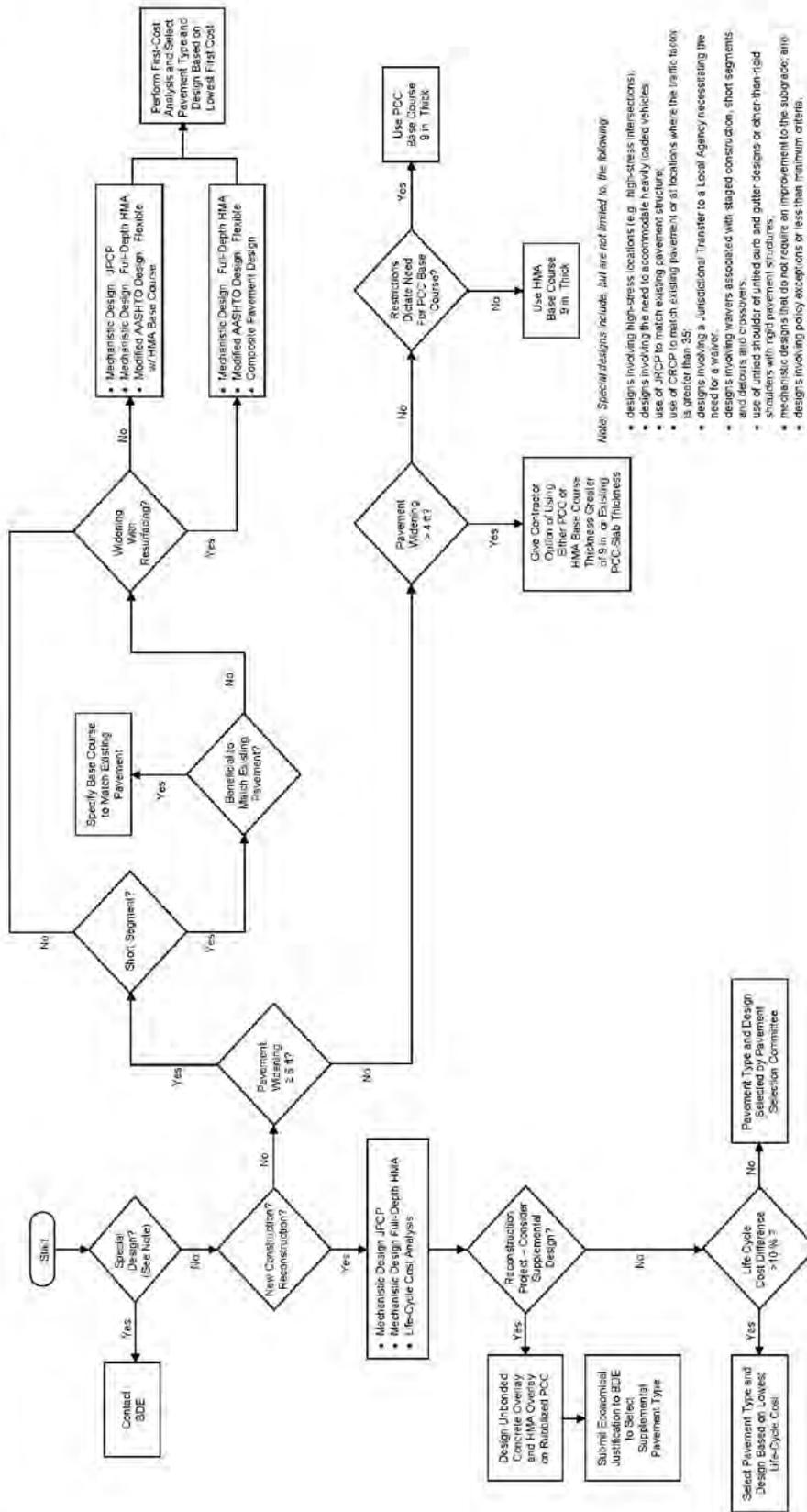
**Illinois Department of Transportation
Organizational Chart
As of December 31, 2010**



Source: IDOT.

Appendix E
IDOT's Flowchart of Pavement Selection
Process

(Prior to April 2011 BDE Manual updates)



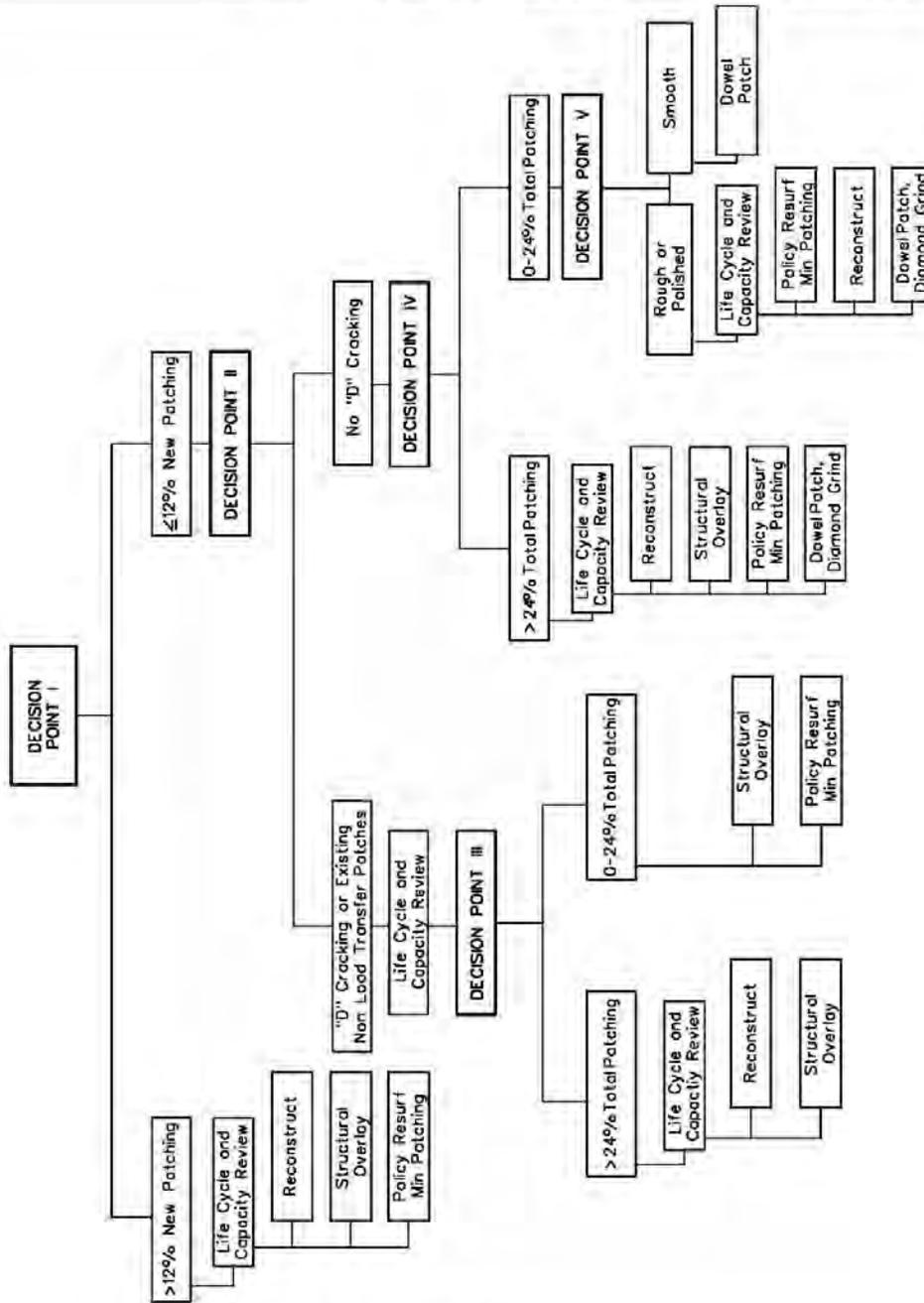
- Note: Special designs include, but are not limited to, the following:
- designs involving high-stress locations (e.g. high-stress intersections);
 - designs involving the need to accommodate heavily loaded vehicles;
 - use of JPCP to match existing pavement structure;
 - use of CRCP to match existing pavement or at locations where the traffic load is greater than 35;
 - designs involving a Jurisdictional Transfer to a Local Agency necessitating the need for a waiver;
 - designs involving waivers associated with staged construction, short segments or other pavement structures;
 - use of utility or other overhead structures and gutter designs or other than rigid shoulders with rigid pavement structures;
 - mechanistic designs that do not require an improvement to the subgrade; any;
 - designs involving policy exceptions or less than minimum criteria.

FLOWCHART FOR SELECTION OF DESIGN METHODOLOGY, PAVEMENT TYPE, AND DESIGN CRITERIA
Figure 54-1 A

HARD COPIES UNCONTROLLED

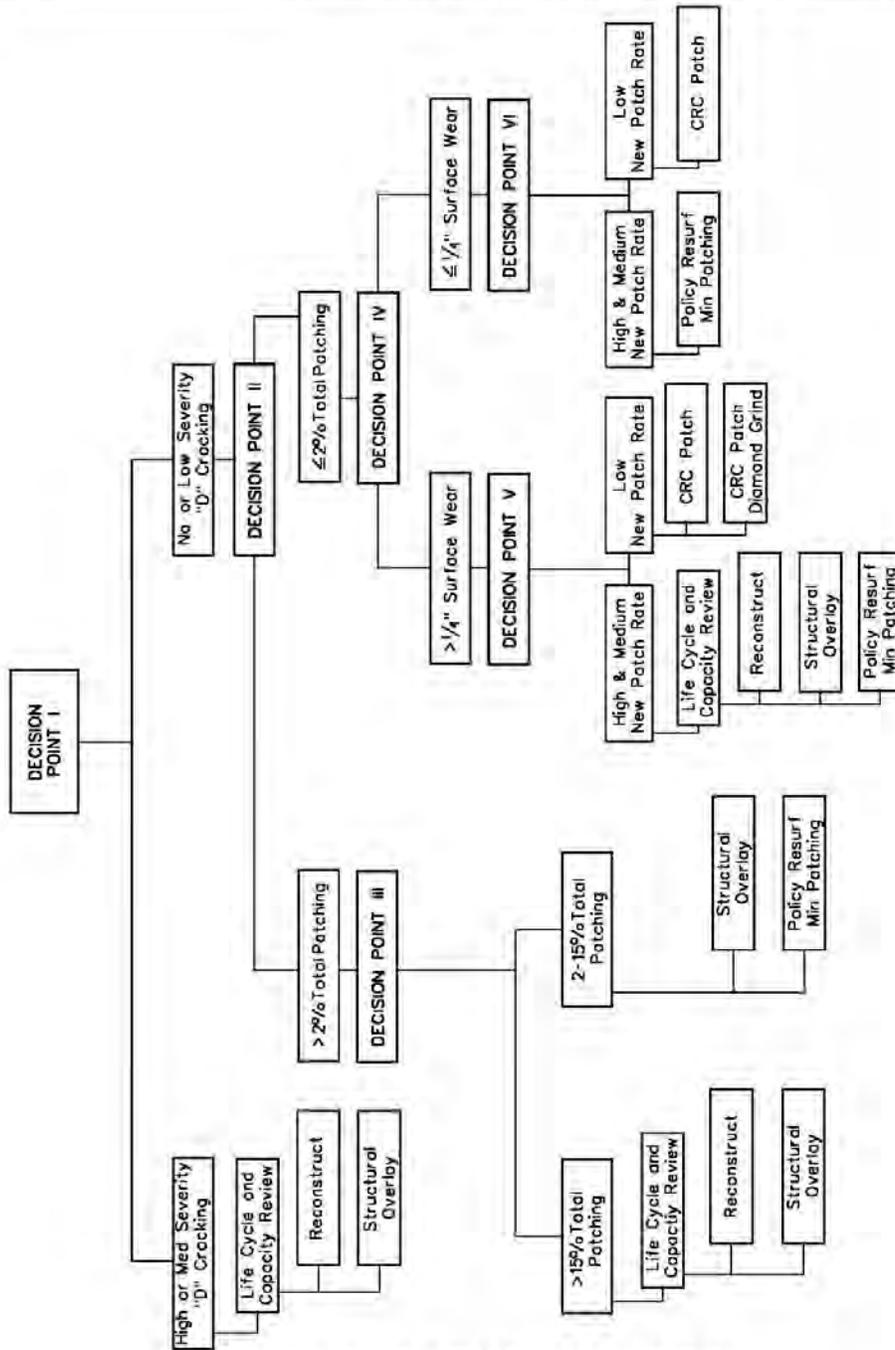
Source: Chapter 54 (Pavement Design) of IDOT's Bureau of Design and Environment Manual.

Appendix F
IDOT's Flowchart of Rehabilitation Strategy Selection



REHABILITATION STRATEGY SELECTION
 (Bare Jointed Plain/Reinforced Concrete Pavements (JPCP/JRCP))

Figure 53-4.E



REHABILITATION STRATEGY SELECTION
(Bare Continuously Reinforced Concrete Pavements)

Figure 53-4.F

Appendix G
Agency Responses



Illinois Department of Transportation

Office of the Secretary
2300 South Dirksen Parkway / Springfield, Illinois / 62764
Telephone 217/782-5597

April 17, 2012

MEMORANDUM TO WILLIAM G. HOLLAND, AUDITOR GENERAL STATE OF ILLINOIS

SUBJECT: Management Audit of the Illinois Department of
Transportation's Implementation of the
Life Cycle Cost Analysis

Thank you for your letter dated March 27, 2012 regarding the draft report for the management audit of the Department's implementation of the life-cycle cost analysis.

The Illinois Department of Transportation would like to thank the Office of the Auditor General for the hard work and recommendations that went into this report. The opportunities for improvement and validation that stem from an independent viewpoint are always beneficial. We also appreciate the level of effort that went into reviewing such a detailed and technical process as Pavement Life-Cycle Cost Analysis. The Department has been using this process for over 25 years and understands the difficulty and complexity associated with it. The Department provides the following responses:

Recommendation 1: The Department disagrees with the recommendation. The current policy in Chapter 54 of our BDE Manual requiring a life-cycle cost analysis (LCCA) on projects that newly construct or reconstruct pavement, and not requiring an LCCA on projects that rehabilitate or resurface pavement, does meet the requirements of the statute (20 ILCS 2705/2705-590 (PA 96-715)). The statute states, "As used in this Section, "life-cycle cost" means the total of the cost of the initial project plus all anticipated future costs over the life of the pavement" (*underlined emphasis added*). The Department understands this language to mean the initial project is the one that begins the pavement's life (i.e. new construction/reconstruction). Rehabilitation/resurfacing projects are a part of sustaining the pavement's life and thus considered a future cost which has already been accounted for in the original analysis. The audit report agrees with this understanding on page 1 (1st paragraph) when it states, "Life-cycle cost analysis (LCCA) is a process for evaluating the financial impact of a project by analyzing initial costs and discounted future costs, such as maintenance, user, reconstruction, rehabilitation, restoring, and resurfacing costs, over the life of the project."

The Department's current policy in Chapter 54 also has been approved by the Federal Highway Administration (FHWA) as a control document in accordance with our Stewardship/Oversight Agreement. The FHWA requires an LCCA to consider three key points: 1) an equal analysis period when evaluating alternatives, 2) alternatives which require periodic maintenance and rehabilitation, and 3) an analysis period which includes at least one major rehabilitation activity. To analyze options for rehabilitation projects which rarely have equal lives and by definition would not have any rehabilitation activities within their life as is suggested, would not meet these requirements.

In an effort to resolve this disagreement, the Department will initiate a legal review of the statute to validate its intent and to determine if clarifying language is necessary.

Chapter 53 of the BDE Manual deals with pavement rehabilitation and based upon the reasoning above, LCCAs are not required. The chapter presents information on the typical problems found in Illinois pavements and the various methods available for addressing them. In other words, the guidance is meant to facilitate selecting the proper scope of a rehabilitation project not in selecting the lowest cost material option for a given project scope which is what an LCCA does. To this end, the Department feels it would be better to change the terminology within Chapter 53 from LCCA to "asset management" or "project scope selection" to clarify the intent and separate it from the LCCAs mandated by statute.

Auditor Comment #1:

The auditors differ with the Department's interpretation of the LCCA statute. The statute requires that a life-cycle cost analysis be conducted on each "State road project" for which the total pavement costs exceed \$500,000. The law does not limit this requirement to "new construction" or "reconstruction" projects as interpreted by the Department. The definitions of life-cycle cost analysis used in both the Act and in our audit report also do not limit the use of LCCAs only to "new construction" or "reconstruction" projects. Rather, the generic term "projects" is used which may include rehabilitation projects.

Contrary to the Department's assertion that rehabilitation projects do not meet FHWA requirements, FHWA guidance on pavement design considerations states that as part of the project analysis for major rehabilitation projects, an economic analysis, "based on life cycle costs," should be performed.

Regarding the Department's position to conduct life-cycle cost analyses only for new construction or reconstruction projects, the auditors note the following:

Auditor Comment (cont.)

- Several other Midwestern states surveyed by auditors reported using LCCA on rehabilitation, resurfacing, and/or structural overlay projects (see Chapter 4). Furthermore, a 2011 report issued by the Transportation Research Board noted that 13 state departments of transportation perform LCCA for rehabilitation projects.
- Chapter 53 (Pavement Rehabilitation) of IDOT's BDE Manual unequivocally states "This section provides guidance on conducting Life-Cycle Cost Analyses (LCCA) for pavement rehabilitation projects to assess the long-term cost effectiveness of alternative rehabilitation strategies." (emphasis added) It goes on to state that "LCCA should be conducted as early in the project development cycle as practicable. For rehabilitation projects, the appropriate time for conducting the LCCA is during the alternatives evaluation stage of Phase I." The Department's position taken in response to this audit is contrary to guidance delineated in its own policy manual since 2000.
- Pavement costs and pavement technologies can dramatically change from the time the original LCCA was prepared to when a major rehabilitation occurs. To fulfill its fiduciary responsibilities, it would seem prudent for the Department to undertake a LCCA to ensure the rehabilitation strategy used is the most economical.

Recommendation 2: The Department agrees with the recommendation to consider whether life-cycle cost analysis should include user costs. As part of that process, we will see if new techniques and/or data are available to make the inclusion of such user costs in an LCCA more credible.

Recommendation 3: The Department agrees with the recommendation and will ensure unit cost documentation accompanies the LCCA submittals as required by Department policy. The Department also appreciates the OAG's affirmation of our costs on page 30 of the report, "Our Consultant's review of initial construction and maintenance construction costs used in the LCCA projects they reviewed indicated that, after correcting for inflation, the values used by IDOT were reasonable and generally consistent with the practice of other states".

Recommendation 4: The Department disagrees with the recommendation. The audit report concluded on page 33, “The average age for the 15 LCCA’s was 3.7 years old”. Considering an LCCA is done at the beginning of a project, such age is consistent with the time it takes to plan, design, and construct/reconstruct a roadway. Such reasonableness of the average age would seem to indicate the process is working just fine without the need for a pre-determined LCCA “shelf-life”. Further, according to page 47 of the report, IDOT’s practice is in-line with other states; “Most other states surveyed, like Illinois, did not have a standard shelf-life defined in policy, or time after which a LCCA is no longer considered valid.”

In an attempt to resolve this disagreement, the Department will conduct a review of FHWA guidance and other state’s policies to assure we are following accepted practices.

Auditor Comment #2:

While the average age for the 15 LCCAs reviewed was 3.7 years old, four of the LCCAs were at least 6 years old (with the oldest being 12 years old) at the time the project was eventually let. Auditors stand by their conclusion that using such outdated LCCAs: 1) does not comply with the intent of the LCCA statute which requires the use of relevant data; and 2) does not comply with IDOT’s “rule of thumb” to prepare LCCAs within 12 to 18 months of the letting date.

Recommendation 5: The Department agrees with the first part of the recommendation. The number of errors should indeed be limited to ensure the integrity of the LCCA process. IDOT will develop an improved excel spreadsheet to replace the one reviewed in this audit which seemed to be the predominant source of the errors.

The Department disagrees with the second part of the recommendation. Per the 29 contracts tested in this audit, IDOT performed an LCCA on each and every pavement construction/reconstruction project per policy. The projects that the audit determined the Department missed were pavement resurfacing/rehabilitation projects for which LCCAs are not required. Therefore, this recommendation comes not from a lack of control over the process but from a difference in interpretation of 20 ILCS 2705/2705-590 (PA 96-715) which is a part of Recommendation Number 1.

Auditor Comment #3:

The auditors’ recommendation does not come from a difference in interpretation of the LCCA statute, as purported by the Department. Rather, it is based on IDOT’s own actions. When auditors requested a listing of all LCCAs performed by the districts for contracts awarded in 2010, the list provided by

Auditor Comment (cont.)

IDOT was inaccurate and incomplete. When auditors followed up with IDOT officials inquiring “Does central office do any type of review to ensure all projects with pavement costs greater than \$500,000 receive a LCCA?”, an IDOT official responded, “With respect to central office checking that all eligible projects received LCCA’s, we do not.” (emphasis added) The official went on to say they periodically review a sampling of projects to ascertain the extent to which they are policy-compliant.

Recommendation 6: The Department agrees with the recommendation. Future meetings will be held per policy and decisions made will be memorialized via a memorandum to the district office instead of via email.

Thank you for the opportunity to comment on this issue. If you have any questions or need further information, please contact Ms. Lori Beeler in IDOT’s Division of Finance and Administration, located at 2300 South Dirksen Parkway, Springfield, Illinois 62564. Ms. Beeler may also be contacted by e-mail at lori.beeler@illinois.gov, or by telephone at (217) 558-5075.

Sincerely,

A handwritten signature in black ink, appearing to read "Matthew R. Hughes", with a long horizontal flourish extending to the right.

Matthew R, Hughes
Director
Office of Finance & Administration

