CHAPTER 601

Pavement Design

Design Memorandum	Revision Date	Sections Affected
20-01	Jan. 2020	Previously 304-1.0 through 5.0

The design memorandum applicable revision date is noted in brackets next to each section heading below.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 601

PAVEMENT DESIGN

601-1.0 INTRODUCTION

This chapter provides guidance for the investigation, evaluation, and analysis of pavements for the public roadway system under the jurisdiction of the Indiana Department of Transportation. It can also be used by local governments in Indiana at their discretion. The pavement analysis should be based on, but not limited to, sound pavement engineering principles, concepts, and economics, as well as geotechnical conditions, environmental conditions, pavement material properties, and traffic loadings. It is the ultimate goal and primary purpose of the pavement designer to determine a pavement treatment that provides an appropriate level of service while yielding the least cost of ownership to the Department unless otherwise directed by INDOT pavement staff. In the instance that the most cost-effective pavement treatment lacks viability from either a project budget or constructability standpoint, the pavement designer should work with INDOT pavement staff to determine if a different pavement treatment should be recommended or if the programmatic intent should be altered through change management.

601-2.0 HISTORY

The history of pavements in Indiana has transcended a number of types and configurations from surfaces using bricks, aggregates, and Kentucky rock asphalt, to the most modern Superpave Asphalt Binders. Kentucky rock asphalt is naturally occurring asphalt that has not been used in recent years but can be found within an existing pavement structure when coring the roadway. Sand surfaces were used extensively on asphalt pavements in the 1970's and 1980's. Both sand surfaces and Kentucky rock asphalts appear as a relatively thin black dense layer in the core, typically less than an inch thick.

Most of the initial interstate pavement constructed in the 1960's and early 1970's was either continuously reinforce concrete (CRC) or jointed reinforced concrete pavement (JRCP) with 40-ft joint spacing. In the early 1980's these concrete pavements were undersealed and overlaid with at least two lifts of HMA as a first rehabilitation measure. In the 1990's the HMA was milled or removed and new HMA applied as a rehabilitation measure. Also, in the 1990's the HMA was removed and the concrete pavements on the interstates were either cracked and seated, or rubblized as a new method of slab reduction emerged, these concrete pavements were then resurfaced with at least two lifts of HMA. INDOT did not get good performance from the cracked and seated pavements as the technology in equipment used to crack the concrete had not advanced enough. However, it is not sound engineering to fully rely on a pavement's history without obtaining pavement cores, non-destructive tests, etc.

The National Highway System (NHS) routes were also constructed with different typical cross-sections; such as variable thickness 9-7-9 in. from edge to center to edge with portland cement concrete. These NHS routes were also typically 18 - 20 ft wide. Tilt sections were also common in the early interstate and NHS pavements. As the tilt section pavements reached the point of rehabilitation INDOT typically converted them to crown sections by milling and applying variable thickness of HMA overlays.

Pavements on most state routes were initially 9-ft lanes, with little to no shoulders. Some of these routes were initially county roads that were given to the State. Asphalt pavements used sand surfaces, hot asphalt emulsions (HAE), bituminous coated aggregate (BCA) or "Greasy 5's" on these routes in the early days. The majority of all pavements today have been widened to at least 10-ft, 11-ft, or 12-ft lanes, with or without shoulders. Beginning in about 1992, SuperPave Performance Grade (PG) binders were being used and replaced the Marshall Method of HMA binder design. Beginning in 2011 most HMA pavement applied to these state routes with aggregate or earth shoulders had the safety edge incorporated.

Underdrains have been utilized since the 1950's. Transverse underdrains were some of the first underdrains installed. Beginning in the 1960's, longitudinal pipes were constructed along the edges of the pavement and outlet to the side ditches. Geocomposite edge drains were used as retrofit underdrains from the mid 1980's to the mid 1990's. From the mid 1990's to present retrofit underdrains consist of open graded material and 4-in. or 6-in. pipe along the pavement's edge. Little or no maintenance has been performed on the underdrain systems and studies show that poor performance of the underdrain systems is a primary cause of failures of pavement structures. INDOT has also improved on the design of underdrain systems since the mid 1990's to facilitate better maintenance. This includes 45º elbows to facilitate video logging, paved outlet protector pads, and rodent screens. INDOT district maintenance now has underdrain maintenance as an activity on the Work Management System (WMS).

601-3.0 ABBREVIATIONS

AADT	Average Annual Daily Traffic
AADTT	Average Annual Daily Truck Traffic
AASHTO	American Association of State Highway and Transportation Officials
AC	Asphaltic Concrete
ACPA	American Concrete Pavement Association
ADA	Americans with Disabilities Act
ARRA	Asphalt Recycling and Reclaiming Association
APAI	Asphalt Pavement Association of Indiana
ASR	Alkali-Silica Reactivity
ASTM	American Society for Testing and Materials
BARM	Basic Asphalt Recycling Manual
BCA	Bituminous Coated Aggregate
CAB	Compacted Aggregate Base
CAP	Compacted Aggregate Pavement
CBR	California Bearing Ratio
CCPR	Cold Central Plant Recycling
CIR	Cold In-Place Recycling
CPP	Concrete Pavement Preservation
CPR	Concrete Pavement Restoration
CR	Cold Recycling
CRCP	Continuously Reinforced Concrete Pavement
CTE	Coefficient of Thermal Expansion
DMF	Design Mix Formula (for HMA)
HAE	Hot Asphalt Emulsion
ERC	Employee of Responsible Charge
ERMS	Electronic Records Management System
ESAL	Equivalent Single Axle Load (18-kip)
EUAC	Equivalent Uniform Annual Cost
FDR	Full Depth Reclamation
FHWA	Federal Highway Administration
FN	Friction Number
FWD	Falling Weight Deflectometer
GPR	Ground Penetrating Radar
HIR	Hot In-Place Recycling
HMA	Hot Mix Asphalt
ICM	Integrated Climatic Module
IHCP	Interstate Highway Congestion Policy
ID	Identification
IRI	International Roughness Index

JMF	Job Mix Formula (for HMA)
JPCP	Jointed Plain Concrete Pavement
JTRP	Joint Transportation Research Program
PLCC	Pavement Life-Cycle Cost
LCPCA	Life-Cycle Pavement Cost Analysis
LL	Liquid Limit
LOI	Loss on Ignition
LPA	Local Public Agency
LTE	Load Transfer Efficiency
LTPP	Long-Term Pavement Performance
MEPDG	Mechanistic Empirical Pavement Design Guide
MOT	Maintenance of Traffic
NCHRP	National Cooperative Highway Research Program
NDT	Non-Destructive Testing
NHS	National Highway System
NMAS	Nominal Maximum Aggregate Size
OG	Open-Graded
PCC	Portland Cement Concrete
PCCP	Portland Cement Concrete Pavement
PG Binder	Performance-Graded Binder
PI	Plasticity Index
PM	Preventive Maintenance
PMS	Pavement Management System
PPG	Pavement Peer Group
PPI	Pavement Preservation Initiative
PV	Present Value
PW	Present Worth
QC/QA-HMA	Quality Control / Quality Assurance Hot Mix Asphalt
QC/QA-PCCP	Quality Control / Quality Assurance Portland Cement Concrete Pavement
RCBA	Reinforced-Concrete Bridge Approach
RFC	Ready for Contract
RH	Relative Humidity
SMA	Stone Matrix Asphalt
SUPERPAVE	Superior Performing Asphalt Pavements
SV	Salvage Value
TWRG	Truck Weight Road Group
TCO	Thin Concrete Overlay
UBWC	Ultrathin Bonded Wearing Course
USCS	Unified Soil Classification System
WMS	Work Management System (INDOT Maintenance)

601-4.0 INDOT PAVEMENT PHILOSOPHY

INDOT pavement analysis and design philosophy are based on producing the most effective pavement section that provides acceptable service life at the least cost of ownership, represented by cost/lane mile/year of life. INDOT pavements should be investigated, evaluated, analyzed, and designed to cost the least amount of money over the design life of the treatment, and constructed using Quality Control/Quality Assurance (QC/QA) materials to be durable and be structurally and functionally sound through that entire period. This pavement design process includes, but is not limited to:

1. Investigation
   a. Determination of pavement history, age, treatment history, etc.
   b. Falling Weight Deflectometer (FWD)
   c. Generation and assessment of pavement cores
   d. Geotechnical investigation
   e. Pavement condition data
   f. Traffic data forecast
   g. Other special testing

2. Evaluation
   a. Identify types of distresses; severity and extent
   b. Identify causes of distresses
   c. Identify functional versus structural distress

3. Analysis
   a. Multiple pavement treatment alternatives
      i. See Figure 601-4A, Pavement Design Life for details regarding the minimum design life expected for various pavement treatments.
   b. Mechanistic-Empirical Pavement Design Guide (MEPDG), AASHTOWare Pavement ME Design Software
      i. See Figure 601-4B, Performance Criteria for New or Rehabilitation HMA Pavement for MEPDG performance inputs for asphalt pavement
      ii. See Figure 601-4C, Performance Criteria for New or Rehabilitation Concrete Pavement for MEPDG performance inputs for concrete pavement
      iii. See Figure 601-4D, MEPDG General Input Values for Asphalt Pavement for MEPDG general asphalt pavement input values
      iv. See Figure 601-4E, ESAL Category for QC/QA-HMA Mixtures for determining specific asphalt categories to be used in MEPDG analysis for 401 mixtures

v. See Figure 601-4F, Mixture Type HMA Mixtures for determining specific asphalt types to be used in MEPDG analysis for 402 mixtures

c. Cost of ownership analysis for each pavement treatment

d. Life-Cycle Pavement Cost Analysis (LCPCA) for alternate bid projects. An LCPCA example is available on the Pavement Engineering section of Standards and Specifications webpage, http://www.in.gov/dot/div/contracts/standards/.

e. Maintenance considerations

601-5.0 PAVEMENT ANALYSIS AND DESIGN DEVELOPMENT

The pavement analysis and design process should be a continuous development flow as data is collected, assessed and analyzed, converted to decision-support information and alternatives are considered. The overall pavement design development process varies depending on whether the project is an INDOT project or an LPA project. However, regardless of the project type and the development requirements associated with the project type, there are general milestones to be considered during the pavement design development process. The milestones include Preliminary Pavement Design (no later than 30% (Stage 1) of overall project development), Final Pavement Design (by 60% (Stage 2) of overall project development), and Pavement Design Validation at 90% (Stage 3) of overall project development).

The pavement designer will recommend the pavement type and thickness of the pavement layers of the pavement structure based on subgrade conditions, materials, traffic, climate, economics, and other considerations.

A Pavement Design Engineer is a qualified licensed engineer who has been trained in pavement design analysis. Throughout this chapter the Pavement Design Engineer will be referred to as the pavement designer. A pavement designer will be an INDOT Approved Consultant, a District Pavement Engineer, or Central Office Pavement Engineer. For consultant pavement designers, prequalification is required. See the *INDOT Consultant Prequalification Manual* for Pavement Analysis – Design Services prequalification requirements. The manual is available on the INDOT Consultants Prequalification webpage at https://www.in.gov/indot/2732.htm.

A pavement designer is responsible for the following:

1. Identification of the extent and severity of distresses,

2. Review and understand INDOT’s programming intent for the project

The pavement designer should determine feasible, acceptable, and suitable potential pavement treatment solutions to address the project’s programming intent.

3. Collection of pavement history

4. Determination of estimated cost of proposed pavement treatment alternatives,

5. Requests that other pertinent data, including but not limited to, the following be obtained:
    a. Falling Weight Deflectometer (FWD)
    b. Department's pavement condition
    c. Maintenance records
    d. Cores
    e. Geotechnical
    f. Traffic data from appropriate source, with % truck
    g. Ground Penetrating Radar (GPR)

6. Analysis
    a. The pavement designer should provide multiple pavement design alternatives in accordance with the Mechanistic-Empirical Pavement Design Guide (MEPDG) methodology utilizing AASHTOWare Pavement ME Design software. The pavement design analysis provided with the pavement report should support the chosen alternative by depicting service lives and cost of ownership of the alternative treatments.
        i. Functional treatments must show a 30-year projection or until functional failure is observed, whichever is further.
        ii. Structural treatments must show a 50-year projection.
        iii. When in doubt, show a 50-year projection.
    b. Life-Cycle Pavement Cost Analysis (LCPCA)
    c. Alternate Pavement Types/Treatments Determination (this will require coordination with INDOT pavement staff)
    d. Specifying pavement material properties and/or pay items

7. Future Maintenance Considerations

8. Pavement Design Validation at 90% of overall project development

9. Pavement Design Life: Functional and Structural

601-5.01 INDOT Pavement Design Process

Every INDOT proposed pavement project is generally evaluated for proper treatment prior to being added to a construction and funding program as a project in the Call for Projects. The project intent and its impacts on the existing or new pavement structure should be understood by the pavement designer prior to developing the pavement treatment recommendation.

Utility projects and other small projects that address isolated pavement issues that result in small cuts of no more than 100 ft wide or long, will require that the pavement designer check the structural adequacy of the existing pavement to carry the current and future projected traffic loads. This minimal pavement design, unless otherwise directed, will include pavement history or cores, pavement condition assessment, and appropriate drainage and subsurface drainage provisions.

601-5.01(01) INDOT Preliminary Pavement Scope

The project intent is not always driven by the pavement design, e.g., improved safety, addition of travel lanes, interchange construction, improved sight distance, ADA compliance, correction of deficient drainage, bridge projects, correction of geometric deficiencies, etc. The scoping engineer must collaborate with the Central Office and District Pavement Engineer to determine the project scope.

Pavement distresses are the first characteristics that should be determined and described in consideration of the appropriate treatment for the project. See the *Distress Identification Manual for the Long-Term Pavement Performance Program*, Publication Number: FHWA-RD-03-031, latest edition for additional information.

The preliminary pavement treatment defined in the scope should identify potential pavement alternatives to correct pavement structural or functional problems at the start of a project. The preliminary pavement scope for INDOT projects will come from the data produced from the Department’s Pavement Management System, such as International Roughness Index (IRI), rut depth, Friction Number (FN), cracking, pavement history, maintenance history, as well as any additional data that is available or recommendations from INDOT pavement personnel. It may not include FWD data, cores and geotechnical investigation.

The preliminary pavement scope will fall into one of the following four project categories:

1. New Alignment,
2. Pavement Reconstruction,
3. Pavement Rehabilitation
4. Preventive Maintenance

Each category has numerous alternative treatments to be considered to accomplish the intent of the project. Added travel lanes projects may be included in Pavement Reconstruction, Pavement Rehabilitation or Preventive Maintenance (Mill and Fill) Projects.

601-5.01(02) INDOT Pavement Design Analysis Assignment

INDOT Central Office Pavement Engineering will assign a preliminary pavement design project or a final pavement design project to an INDOT Pavement Engineer or an INDOT Approved Consultant Pavement Engineer and notify the District Project Manager of the assignment. INDOT Approved Consultant Pavement Engineers who receive a pavement design assignment should follow steps 1-4 below, while INDOT Pavement Engineer should proceed to step 4 below.

1. Receive project specific information from INDOT Central Office Pavement Engineering
2. Review the available project specific information, determine the Project Manager, and determine the Design Engineer for the project.
3. Review the project type and scope, prepare a scope and fee to complete the pavement design process, and submit the proposed scope and fee to INDOT Central Office Pavement Engineering and the District Project Manager.
4. Prepare a pavement design for the project assignment
    a. If a preliminary pavement design project has been assigned proceed with the preliminary pavement design process, see Section 601-5.01(03).
    b. If a final pavement design project has been assigned, complete a final pavement per the final pavement design process, see Section 601-5.01(04).

See Figure 601-5A, INDOT Pavement Design Process-INDOT Projects Flowchart for details regarding the pavement design process.

601-5.01(03) INDOT Preliminary Pavement Design

The pavement designer, in collaboration with the Pavement Area Engineer, should submit a preliminary pavement proposal for review no more than 30 days after the acceptance of the proposed pavement design scope and fee. The preliminary pavement design should consist of the following:

1. clear identification of pavement type, extent, and severity of distresses;
2. core report, if available, with core photographs to determine pavement structure;
3. site visit findings and recommendations with photographs;
4. other pavement history and data, such as original construction and all rehabilitations;
5. recommended pavement treatment alternatives based on distresses;
6. structural capacity of the pavement treatment alternatives based on initial AASHTOWare Pavement ME software iterations, using assumed input data based on engineering judgement where technical data is unavailable;
7. determination of estimated cost of recommended pavement treatment alternatives; and
8. traffic data, with % truck.

The preliminary pavement design should state what subsequent additional activities or testing must be obtained, i.e., a geotechnical investigation, FWD data, cores, projected construction year traffic data, and/or other testing data. The subsequent activities should be as appropriate to further identify the causes of distress and obtain necessary data to help select the appropriate alternative and to finalize the design to achieve the most effective solution at least cost of ownership.

601-5.01(04) INDOT Final Pavement Design

The pavement designer will determine if all pertinent data to complete a final pavement design is available. If all pertinent data to complete a pavement design is not available, the pavement designer will work with the Pavement Area Engineer, the District Pavement Engineer, and when necessary the District Project Manager to obtain the necessary information required to complete a final pavement design. Once all pertinent project data has been provided to the pavement designer, a draft of final pavement design should be completed and submitted to INDOT Central Office Pavement Engineering for review.

The final pavement design memorandum should include the intent of the project, existing pavement type, history of the pavement from initial construction through the last treatment, thickness of all layers, site visit findings and recommendations, test data findings and recommendations, key professional engineering assumptions and facts, table of design data, pavement design recommendations, patching summary table, and other pertinent information, i.e., critical utilities issues, recommend future maintenance schedule, and key constructability issues. Constructability issues may include temporary widening, temporary runarounds, temporary ramps, assumed pavement thicknesses or variations, profile grade assumptions, and other challenges. A patching summary table should be approved by the District Pavement Engineer and the design engineer and included in the contract documents before the letting.

A pavement designer contracted by INDOT should submit the final pavement design by memorandum on their letterhead including a report with the information listed below. The submittal should provide evidence that all pavement designs are checked and signed by a qualified peer. The executive summary should be clear and concise and only include the necessary pavement information to implement the design.

1. Executive Summary;
2. Project Description;
3. Pavement History;
4. Methodology for selecting preferred pavement strategy;
5. Assessment of Current Pavement Condition (Functional and Structural) with photographs;
6. Pavement Design and Recommendations, including at least one feasible Alternate Pavement treatment;
7. Life-Cycle Pavement Cost Analysis (LCPCA) for projects equal to or greater than 10,000 yd^2;
8. Functional and Structural life of the pavement alternatives analyzed;
9. Construction and Maintenance Issues and Concerns; and
10. Appendices as follows:
    a. Traffic Data;
    b. Geotechnical Investigation Report;
    c. Pavement Cores with Photographs and Pavement Distress Photographs;
    d. Non-Destructive Testing Results, such as FWD;
    e. HMA Binder Selection using LTPPBind;
    f. Typical Sections;
    g. AASHTOWare Pavement ME Design Input Summary;
    h. AASHTOWare Pavement ME Design output, at least the optimal design and then one failure iteration; and
    i. LCPCA Results.

After the draft of the final pavement design has been reviewed and approved by the INDOT Central Office Pavement Engineering Assigned Reviewer, the final pavement design should be signed, stamped, and sealed with an active Indiana Professional Engineer (PE) stamp by the responsible Engineer for the project. The final pavement design should then be routed by the Central Office pavement designer through the District Pavement Engineer for their review and approval. After district approval, a copy of the design will be sent to the Pavement Area Engineer and Pavement Director. Finally, the pavement design will be reviewed and approved by the Manager of the

Pavement Division. The approved final pavement design is then returned to the designer and project manager. This process assures that all pavement designs are checked by a qualified peer.

601-5.02 Local Public Agency (LPA) Pavement Design Process

The qualifications of the pavement designer noted in Section 601-5.0 apply to LPA Projects that involve federal funding. The project intent and its impacts on the pavement structure should be understood prior to developing the pavement treatment recommendation. LPA pavement designs may be reviewed by INDOT as noted in the following sections.

601-5.02(01) LPA Final Pavement Design for Locally-Owned, Non-NHS Routes

Projects that include work on a locally-owned, non-NHS route do not require review and approval by INDOT.

The LPA may follow the INDOT pavement design process (Section 601-5.01), or choose to use their own pavement design criteria. If the INDOT pavement design process is chosen, it is the LPA's responsibility to request FWD testing and analysis through ITAP.

Where an LPA chooses to use their own pavement design criteria, the following will apply:

- The LPA is responsible for the design and performance of the pavement section.
- A Life-Cycle Pavement Cost Analysis in accordance with Section 606-1.0 is not required.
- It is the LPA's responsibility to ensure that the pavement pay items are compatible with the INDOT Standard Specifications.
- If the LPA uses a standard typical pavement section, it must be included in the final pavement design.
- The final pavement design must be initialed by the Employee in Responsible Charge (ERC) sealed, signed, and dated by a licensed Indiana Professional Engineer and uploaded to ERMS as the Final Pavement Design.

See Figure 601-5B, INDOT Pavement Design Process-LPA Projects Flowchart for details regarding LPA pavement design process requirements.

601-5.02(02) LPA Final Pavement Design for State and NHS Routes

Projects that include work on a State route or NHS route must be reviewed and approved by a Central Office Pavement Design Engineer and follow the INDOT pavement design process. See Section 601-5.01.

601-5.02(03) Standard Pavement Designs for Low Volume Roads and Trails

Standard pavement sections may be used in lieu of project-specific pavement designs for low volume roads and trails as follows:

1. Aggregate Pavement on Low Volume Roads, AADTT ≤ 50 trucks. The pavement section will consist of:

    4 in. Compacted Aggregate No. 73, on
    6 in. Compacted Aggregate No. 53, on
    Subgrade Treatment, Type III, or as specified in the geotechnical report

2. Trails and other Non-Vehicular Use Facilities. The pavement sections will consist of the section as shown on the INDOT Standard Drawings series 502-NVUF for concrete pavement and 604-NVUF for HMA pavement.

601-5.02(04) Notification of Pavement Design Approval [Rev. Feb. 2018]

For projects reviewed and approved by INDOT, the Central Office pavement engineer will send a Letter of Pavement Analysis/Design Acceptance (acceptance letter) to the ERC, INDOT project manager, and the LPA pavement designer.

The acceptance letter should be initialed by the ERC, combined with the final pavement design, and uploaded into ERMS as the Final Pavement Design. Preferably, the file should be uploaded within two weeks of receiving the acceptance letter. The pavement designer should notify the district coordinator, INDOT project manager, INDOT Central Office Pavement Design Coordinator, and the ERC when the file has been uploaded.

601-6.0 PAVEMENT DESIGN REQUEST AND INSTRUCTIONS

A Pavement Design Request should be submitted to the Pavement Design Coordinator. An editable version of the Pavement Design Request and instructions are available for download from the Department's website at www.in.gov/dot/div/contracts/design/dmforms/. An incomplete Pavement Design Request will be returned without review.

Pavement-Work Type	Minimum Acceptable Design Life, Years[2]
CRCP (Continuously Reinforced Concrete Pavement)	50
PCCP	30
PCCP over Existing Pavement	25
HMA Pavement with SMA	20
HMA with Surface Overlay on Rubblized PCCP	20
HMA Pavement	20
HMA Overlay on CRCP	20
HMA Overlay on Rubblized PCCP	20
Thin Concrete Overlay (TCO)	20
HMA Overlay on Cracked and Seated PCCP	12
HMA Overlay over Asphalt Rehabilitation (≥ 3 layers) Rehabilitation (2 layers) Preventative Maintenance (1 layer) [1]	 18 15 9
HMA Overlay over PCCP Rehabilitation (≥ 3 layers) Rehabilitation (2 layers)	 15 12
Full Depth Reclamation FDR with Surface Treatment FDR with HMA Overlay	 6 15
Cold In-Place Recycling (CIR)	10
Cold Central Plant Recycling	10
Hot In-Place Recycling (HIR)	6
PCCP Joint Sealing	8

PAVEMENT DESIGN LIFE

Figure 601-4A
(Page 1 of 2)

Pavement-Work Type	Minimum Acceptable Design Life, Years[2]
Ultrathin Bonded Wearing Course (UBWC)	9
Microsurface Overlay	8
Thin HMA Overlay with Profile Milling	9
Concrete Pavement Rehabilitation (CPR) Techniques	6
Chip Seal	4
Asphalt Crack Sealing, Rout and Seal	3
Asphalt Crack Filling	1

[1] The performance period should be decreased to 8 yr for existing composite HMA.

[2] It is the ultimate goal and primary purpose of the pavement designer to determine a pavement treatment that yields the least cost of ownership to the Department unless otherwise directed by INDOT pavement staff. In the instance that the most cost-effective pavement treatment lacks viability from either a project budget or constructability standpoint, the pavement designer should work with INDOT pavement staff to determine if a different pavement treatment should be recommended or if the programmatic intent should be altered through change management.

PAVEMENT DESIGN LIFE

Figure 601-4A
(Page 2 of 2)

Performance Criteria	Performance Limit at End of Design Life	Reliability New Pavement Design	Reliability Overlay Design
Terminal IRI (in./mi.)	Freeway: 160	90%	90%
	Arterial, Urban: 190	90%	90%
	Arterial, Rural: 200	85%	85%
	Collector, Urban: 190	80%	80%
	Collector, Rural: 200	75%	75%
	Local: 200	70%	70%
AC Top-Down Fatigue Cracking (ft./mi.)	Freeway: 2000	90%	90%
	Arterial, Urban: 2000	90%	90%
	Arterial, Rural: 2000	85%	85%
	Collector, Urban: 2000	80%	80%
	Collector, Rural: 2000	75%	75%
	Local: 2000	70%	70%
AC Bottom-Up Fatigue Cracking (% lane area)	Freeway: 10	90%	*50%
	Arterial, Urban: 20	90%	*50%
	Arterial, Rural: 25	85%	*50%
	Collector, Urban: 30	80%	*50%
	Collector, Rural: 35	75%	*50%
	Local: 35	70%	*50%
AC Thermal Cracking (ft/mi/lane)	Freeway: 500	90%	*50%
	Arterial, Urban: 500	90%	*50%
	Arterial, Rural: 500	85%	*50%
	Collector, Urban: 500	80%	*50%
	Collector, Rural: 500	75%	*50%
	Local: 500	70%	*50%

PERFORMANCE CRITERIA FOR NEW OR REHABILITATION HMA PAVEMENT

Figure 601-4B (Page 1 of 2)

Performance Criteria	Performance Limit at End of Design Life	Reliability New Pavement Design	Reliability Overlay Design
Permanent Deformation - Total Pavement (in.)	Freeway: 0.75	90%	90%
	Arterial, Urban: 0.75	90%	90%
	Arterial, Rural: 0.75	85%	85%
	Collector, Urban: 0.75	80%	80%
	Collector, Rural: 0.75	75%	75%
	Local: 0.75	70%	70%
Permanent Deformation - AC Only Pavement (in.)	Freeway: 0.40	90%	90%
	Arterial, Urban: 0.40	90%	90%
	Arterial, Rural: 0.40	85%	85%
	Collector, Urban: 0.40	80%	80%
	Collector, Rural: 0.40	75%	75%
	Local: 0.40	70%	70%
AC Total Fatigue Cracking: Bottom-Up + Reflective (% Lane Area)	Freeway: 10	-	90%
	Arterial, Urban: 20	-	90%
	Arterial, Rural: 25	-	85%
	Collector, Urban: 30	-	80%
	Collector, Rural: 35	-	75%
	Local: 35	-	70%
AC Total Transverse Cracking: Thermal + Reflective (ft./mi.)	Freeway: 2500	-	90%
	Arterial, Urban: 2500	-	90%
	Arterial, Rural: 2500	-	85%
	Collector, Urban: 2500	-	80%
	Collector, Rural: 2500	-	75%
	Local: 2500	-	70%

* AC Bottom-Up Cracking and AC Thermal Cracking reliability for overlays are for analysis purposes only and should not be used as a criteria, because they cannot be visually distinguished from reflective cracking.

PERFORMANCE CRITERIA FOR NEW OR REHABILITATION HMA PAVEMENT

Figure 601-4B (Page 2 of 2)

Performance Criteria	Performance Limit at End of Design Life	Reliability
Terminal IRI (in./mi)	Freeway: 160	90%
	Arterial, Urban: 190	90%
	Arterial, Rural: 200	85%
	Collector, Urban: 190	80%
	Collector, Rural: 200	75%
	Local: 200	70%
Transverse Slab Cracking (%)	Freeway: 10	90%
	Arterial, Urban: 10	90%
	Arterial, Rural: 10	85%
	Collector, Urban: 10	80%
	Collector, Rural: 10	75%
	Local: 10	70%
Mean Joint Faulting (in.)	Freeway: 0.15	90%
	Arterial, Urban: 0.20	90%
	Arterial, Rural: 0.22	85%
	Collector, Urban: 0.25	80%
	Collector, Rural: 0.25	75%
	Local: 0.25	70%

PERFORMANCE CRITERIA FOR NEW OR REHABILITATION CONCRETE PAVEMENT

Figure 601-4C

Asphalt General Input	Value
Reference Temperature, °F	70
Thermal Conductivity, Asphalt, BTU/h-ft-°F	0.63
Heat Capacity, Asphalt, BTU/lb-°F	0.31
Poisson Ratio	0.35

Volumetric Properties as Built	NMAS, mm	Value
Effective Binder Content, %	25.0	8.7
	19.0	9.5
	12.5	10.7
	9.5	11.6
	SMA 9.5	13.4
Air Voids, %	25.0	8
	19.0	8
	12.5	8
	9.5	8
	SMA 9.5	7
Total Unit Weight, lb/ft^3	25.0	144.4
	19.0	143.8
	12.5	143.08
	9.5	142.6
	SMA 9.5	160

MEPDG GENERAL INPUT VALUES
FOR ASPHALT PAVEMENT

Figure 601-4D

Initial AADTT, trucks per day	Design ESALs, millions*	QC/QA-HMA Category**
AADT < 510	ESAL < 3	2
510 ≤ AADTT < 1700	3 ≤ ESAL < 10	3
AADTT ≥ 1700	≥ 10	4

2-LANE ROAD

Initial AADTT, trucks per day	Design ESALs, millions*	QC/QA-HMA Category**
AADTT < 570	< 3	2
570 ≤ AADTT < 1900	3 ≤ ESAL < 10	3
AADTT ≥ 1900	≥ 10	4

4-LANE ROAD

Initial AADTT, trucks per day	Design ESALs, millions*	QC/QA-HMA Category**
AADTT < 870	< 3	2
870 ≤ AADTT < 2900	3 ≤ ESAL < 10	3
AADTT ≥ 2900	≥ 10	4

6-LANE ROAD

Initial AADTT, trucks per day	Design ESALs, millions*	QC/QA-HMA Category**
AADTT < 1140	< 3	2
1140 ≤ AADTT < 3800	3 ≤ ESAL < 10	3
AADTT ≥ 3800	≥ 10	4

8-LANE ROAD

*ESAL values based on INDOT calculations of ESALs

**For open-graded mixtures OG 19.0 and 25.0, the QC/QA-HMA Category is 4

ESAL CATEGORY FOR QC/QA-HMA MIXTURES

Figure 601-4E

Initial AADTT, trucks per day	Design ESALs, millions*	HMA Category
AADT < 510	< 3	B
510 ≤ AADTT < 1700	3 ≤ ESAL < 10	C
AADTT ≥ 1700	≥ 10	D

2-LANE ROAD

Initial AADTT, trucks per day	Design ESALs, millions*	HMA Category
AADTT < 570	< 3	B
570 ≤ AADTT < 1900	3 ≤ ESAL < 10	C
AADTT ≥ 1900	≥ 10	D

4-LANE ROAD

Initial AADTT, trucks per day	Design ESALs, millions*	HMA Category
AADTT < 870	< 3	B
870 ≤ AADTT < 2900	3 ≤ ESAL < 10	C
AADTT ≥ 2900	≥ 10	D

6-LANE ROAD

Initial AADTT, trucks per day	Design ESALs, millions*	HMA Category
AADTT < 1140	< 3	B
1140 ≤ AADTT < 3800	3 ≤ ESAL < 10	C
AADTT ≥ 2900	≥ 10	D

8-LANE ROAD

*ESAL values based on INDOT calculations of ESALs

MIXTURE TYPE FOR HMA MIXTURES

Figure 601-4F

NOTES:

1. This flowchart diagram outlines the general steps to be taken when completing a pavement design for INDOT projects. Detailed information regarding the pavement design process and the necessary requirements can be found in Chapter 600 of the Indiana Design Manual.

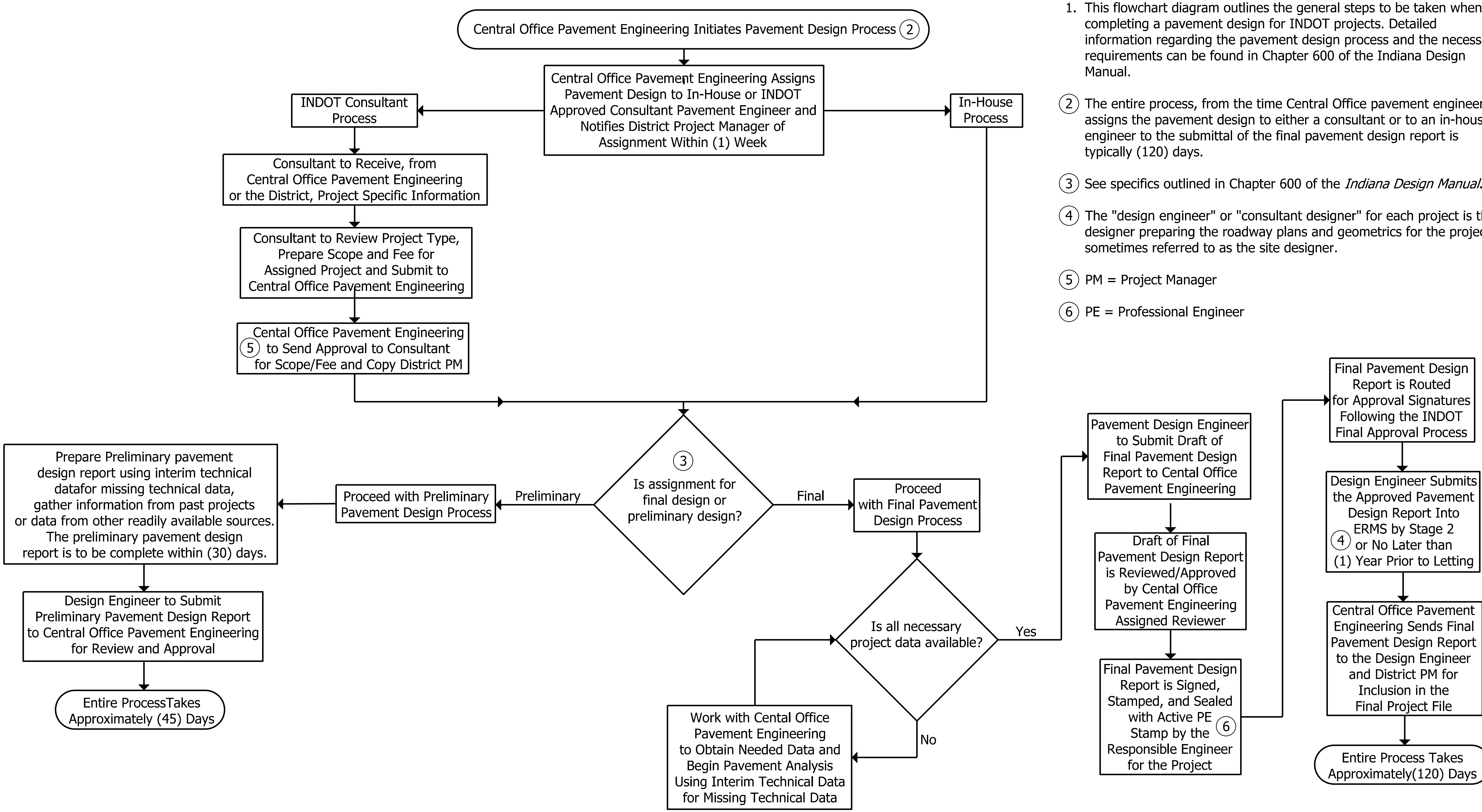
(2) The entire process, from the time Central Office pavement engineering assigns the pavement design to either a consultant or to an in-house engineer to the submittal of the final pavement design report is typically (120) days.

(3) See specifics outlined in Chapter 600 of the *Indiana Design Manual*.

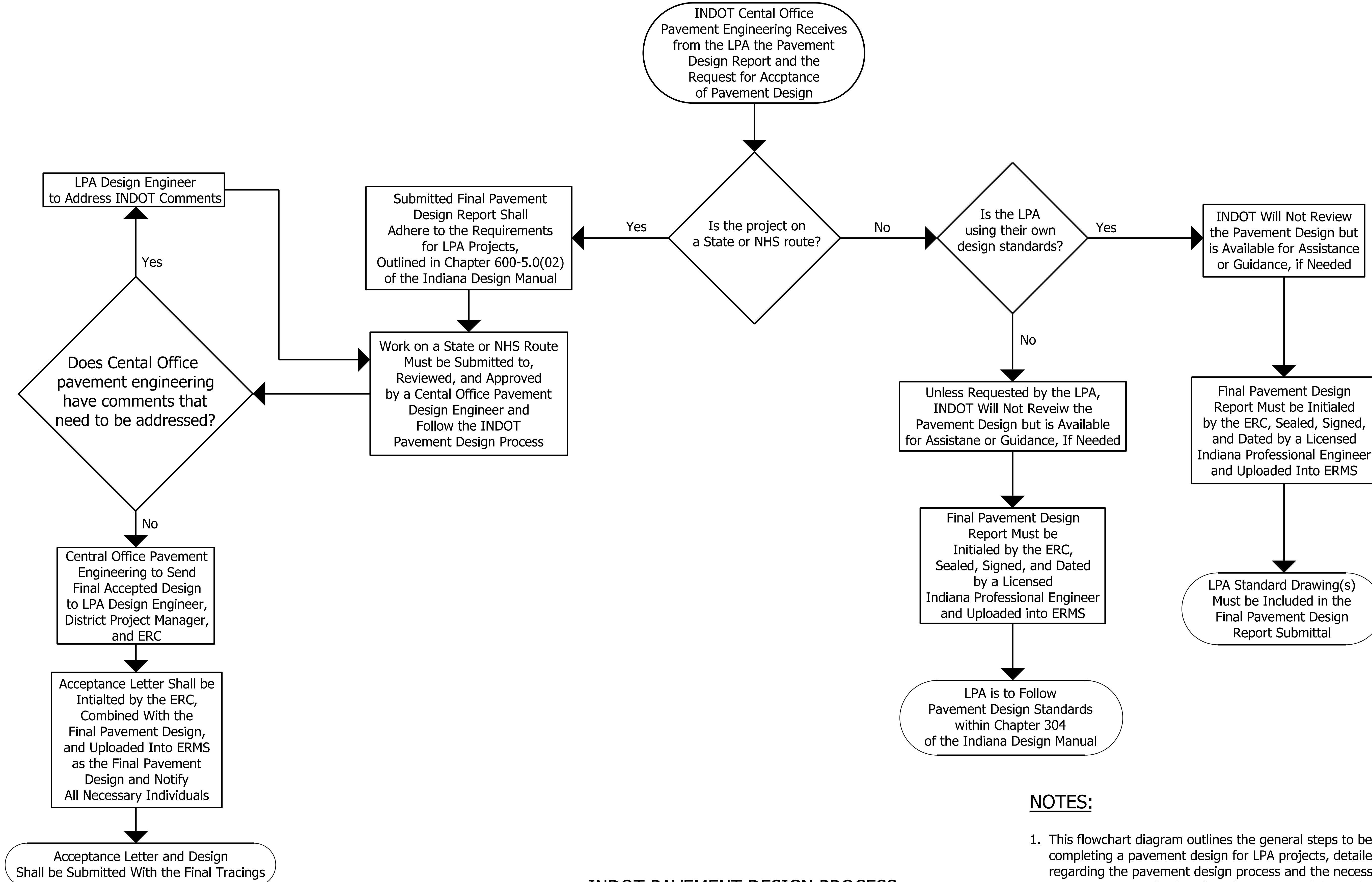
(4) The "design engineer" or "consultant designer" for each project is the designer preparing the roadway plans and geometrics for the project, sometimes referred to as the site designer.

(5) PM = Project Manager

(6) PE = Professional Engineer



INDOT PAVEMENT DESIGN PROCESS
INDOT PROJECTS
Figure 601-5A



INDOT PAVEMENT DESIGN PROCESS
LPA PROJECTS

Figure 601-5B

NOTES:

1. This flowchart diagram outlines the general steps to be taken when completing a pavement design for LPA projects, detailed information regarding the pavement design process and the necessary requirements can be found in Chapter 600 of the *Indiana Design Manual*.

2. The "design engineer" or "consultant engineer" for each project is the designer preparing the roadway plans and geometrics for the project, sometimes referred to as the site designer.