

## Chapter 1 – INTRODUCTION

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# CHAPTER 1

## INTRODUCTION

### 1.1 GENERAL

Approximately one-third of the total land area of the United States is owned or controlled by the Federal Government. One of the world's largest highway networks has been constructed to serve these Federal lands.

Several Federal agencies are responsible for managing public lands and consequently are also responsible for managing a part of this vast network of Federal roads. The role of the Federal Highway Administration's (FHWA) Office of Federal Lands Highway in designing and constructing highway facilities on Federal and tribal lands is well defined in existing legislation and supplemental national interagency agreements.

The [Office of Federal Lands Highway](#) is headquartered at FHWA in Washington D.C. and maintains three Federal Lands Highway (FLH) Division offices. See [Exhibit 1.1-A](#) for a geographical breakdown of FLH Division offices. For more than 100 years, FLH and its predecessor offices have offered their expertise to other Government agencies for the planning, location, design and construction of Federal lands transportation facilities in and adjacent to the Federal domain. Many foreign countries have also been assisted in the development and construction of road systems.

One primary goal of the FLH program is to provide safe, cost-effective and environmentally sound highways and roads to serve our nation's Federal Lands. FLH uses context sensitive solutions (CSS) and sound engineering practice to achieve this goal. This requires a collaborative, interdisciplinary approach to roadway planning, design and construction, involving all partners, stakeholders and the public to ensure that transportation projects are in harmony with communities and that they preserve environmental, scenic, aesthetic and historic resources. The effective application of CSS techniques when using the *PDDM* achieves these goals while providing safe and efficient access to our nation's Federal lands.

Refer to [[EFLHD](#) – [CFLHD](#) – [WFLHD](#)] Division Supplements for more information.

#### 1.1.1 PURPOSE

The *PDDM* has been developed to provide information and guidance to internal FLH employees, our partner and stakeholder agencies and our consultants involved with project development and design of highways. It is a key reference tool that is useful to both the veteran manager and the entry-level designer. Its use requires an interdisciplinary team approach. Users of this edition of the *PDDM* will find links between the manual's chapters that will allow them to be aware of related information in chapters other than those of their own discipline. Additionally, the *PDDM* serves as a portal for numerous external technical manuals and reports using links to other websites. The manual identifies those policies, standard practices, criteria, guidance and references



approved for use in carrying out the highway and bridge design responsibilities in the Federal Lands Highway Programs (FLHP). In this regard, the following definitions will be used:

1. **Policy.** Guiding principle; general course of action to be followed without exception. Where policy is cited the source of the policy is also referenced, when applicable and appropriate. Policy statements are presented in **bold** type.
2. **Standard.** A fixed reference to guide the outcome and content (product) of the work. FLH Standards are fixed references that the Office of Federal Lands Highway impose to guide the content of FLH products. Standards are established where there is a consistent level of risk, or there is a consistent technical or performance expectation, for a specific product to work well in most cases. FLH standards are based on successful past performance on FLH projects after meeting goals of risk management, quality, and efficiency. Variances to FLH Standards are not uncommon, but they need always be justified in writing. Attention to this and guidance on how to do it are included in this manual.
3. **Criteria.** Tests or indicators, in addition to standards, used to measure/judge achievement of applicable policy or standard objectives. Criteria may vary from project-to-project. The *PDDM* provides typical criteria, with guidance on how to select criteria for specific project types and/or conditions.
4. **Standard Practice.** FLH Standard Practices are established methodology that the Office of Federal Lands Highway imposes to guide the approach to the work, and which will generally produce a consistent outcome that meets FLH expectations. Standard Practices are established where a certain process or method is necessary, in addition to or as assurance, for achieving a sufficient end result product (see Standard). FLH Standard Practices have a history of demonstrated quality and successful use. Variances from FLH Standard Practices may sometimes be appropriate, but require written justification.
5. **Guidance.** Suggested actions to meet policies and standards, and expectations for applying discretion. Considerations for selecting appropriate standards and design criteria are included in the manual.
6. **Discretion.** Where the practitioner is expected to exercise engineering judgment to apply an optimum technique or solution that is within an acceptable range of values.

Policies, standards and criteria are condensed and written for the user. Where appropriate, relevant procedures, instructional aids and publications are referenced. References to specific computer programs, AASHTO guidelines, manuals and regulations are included in this manual. It is expected that the user will be knowledgeable in the use of the referenced items. The *PDDM* does not detail technical methods or procedures. Users are expected to consult the documents referenced for such purposes, and otherwise stay informed of current technologies.

Compliance with all policies and standards in the *PDDM* is essential to ensure consistency in project development throughout FLH. Although policy cannot be compromised, flexibility of standards is sometimes necessary to meet project specific objectives. Deviation from standards cited within this manual will require formal justification and approval. Division variances in standards, criteria and guidance are typically found in the Division Supplements at the end of the various chapters.

## 1.1.2 PHILOSOPHY AND TECHNICAL POLICIES

Policies presented in the *PDDM* are interpretations of agency directives and objectives, based on legislation and federal regulations pertaining to the FHWA and FLH programs. This section describes the FLH project development philosophy and technical policies that are to be followed at all times in the conduct of project development work for FLH projects. The sources of the philosophy and technical policies are found in [Section 1.2](#).

The technical activities for FLH project development can be very challenging, since projects are located from the Atlantic to the Pacific and from the tropics to the arctic. The natural settings and technical issues vary tremendously; however, an equal challenge comes from the variety of projects and stakeholders. Some projects are multi-lane divided highways and bridges, but much of the work deals with low volume roads on resource sensitive public lands. These areas have significant and diverse stakeholders, regulations, management goals, environmental resources, cultural resources, wildlife, scenic beauty and intrinsic value. Furthermore, FLH is a partner with federal land management agencies and other government property managers and owners, but does not own or manage federal land, or the improvements it designs and constructs. Upon successful completion, another agency accepts FLH projects and agrees to maintain them. Therefore, technical work should embrace the following key FLH project delivery objectives:

- Be respectful of the land, partner agency goals, tribal values, cultural significance of landforms and sites, wildlife, and habitat;
- Provide a safe passage for residents, travelers, visitors, tourists, recreationists, and wildlife;
- Minimize impacts to existing features and conditions in a “lightly on the land” manner; blend improvements into the setting with as little impact as possible; and
- Complete quality work within budget constraints, recognizing that funding is often comparatively less for low-volume, rural public access roads serving federal lands than for higher volume state and municipal projects.

The combination of protecting cultural and environmental resources; accommodating public lands stakeholders and their values/regulations; providing safety and quality; and working within limited funding means searching for technical solutions that are both context-sensitive and cost effective. Dealing with the variability of FLH projects, terrains, climates and partner agency constraints requires flexibility, resourcefulness, and collaboration. FLH roadway design philosophy and context sensitive solutions are further described in [Section 9.1.5](#).

This section provides guidance in identifying and planning appropriate levels of technical practice to fit the unique circumstances and challenges posed by FLH projects. The highest-level guidance is in the form of policy, which is followed without exception. The following FLH *technical policies* represent the FLH project development philosophy to be followed by the technical practitioner:

1. **Support the mission, vision and program management objectives of FLH and FHWA.** FLH policy is to support the mission, vision and program management objectives of FLH and the FHWA. The technical practitioner does so by performing work that is consistent with prevailing laws and regulations, executive orders, DOT orders, FHWA

regulations and administrative rules, and FLH mission and vision statements. This is the ultimate technical policy and the other technical policies help to fulfill it.

2. **Meet the technical scope requirements defined by this PDDM.** FLH policy is to meet the technical scope defined by the standards and guidance presented in this PDDM regarding project development activities, including investigation, analysis, reporting, PS&E development, construction support, technical support and other agency needs. This defines that project development and technical work is guided by the contents of this PDDM.
3. **Advance the state of practice by seeking and implementing new technology.** FLH policy is to evaluate, promote and implement new technology and to continually update technical capabilities. This conveys a guiding principle for utilizing advances in technology.
4. **Demonstrate environmental stewardship in planning and designs.** FLH policy is to perform technical investigations and develop design recommendations that minimize environmental impacts and demonstrate environmental, cultural and natural resource stewardship while meeting other project objectives. This conveys environmental stewardship responsibility. [Chapter 3](#) provides further environmental guidance.
5. **Conduct work safely and seek safety improvement solutions.** FLH policy is to conduct work in a manner that is safe for workers and the public, and to seek solutions that improve safety and minimize roadside hazards on federal and tribal lands. Appropriate safety applications are to be incorporated while respecting the associated natural resource impacts and historic, cultural and community values. This intends to protect the general public, FHWA personnel and contractors, and public and private property. It applies to work conducted as part of technical activities from planning through construction, as well as the safety of the completed project with respect to technical issues. Some partner agencies may have standards and requirements that could limit the implementation of safety features. The FLH Safety Memorandum 2004 describes the philosophy of enhancing safety through collaborative effort, integrating technical standards, environmental stewardship and partner agency requirements. The practitioner or technical discipline leadership will seek clarification within FHWA when confronted with situations that are not adequately defined. More detail of the FLH safety philosophy is presented in [Section 8.1.1](#).
6. **Achieve quality through established quality control, quality assurance and oversight procedures.** FLH policy is to strive for quality through established quality control and quality assurance (QA/QC) procedures and through oversight of technical work performed by others. This technical policy includes performing QA/QC and managing outsourced work. A quality control and assurance program must be maintained and applied to all project work. Every functional discipline performing work is responsible for the technical adequacy of their project development and design activities. Technical consultants shall also follow an established QA/QC process, either their own approved process or a FLH internal QA/QC process. Unless specific arrangements are made to the contrary, the FLH does not provide QC or QA for the work of its consultants, but still retains responsibility for independent quality assurance and oversight for the project delivery.

7. **Demonstrate financial stewardship, risk assessment, and workforce and resource management.** FLH policy is to coordinate and manage project development work by multi-disciplinary and multi-agency project teams and within jointly established scopes, schedules, budgets, quality, and project criteria and constraints. Usually more than one option exists to achieve the functional requirements for the project. Evaluations of design options include the assessment of risk and consequences as well as performance and cost. This includes assessing risk, planning and managing project development work, personnel, and resources, both workforce and technical resources.

### 1.1.3 RISK

Risk is inherent in the delivery and operation of FLH projects, and it has several forms. Risk is incurred with respect to cost when decisions are made regarding the scope of investigation and analysis. A greater investigation scope generally means fewer unknowns are carried into construction, thereby reducing the risk of bidding and construction cost escalation. Risk is incurred with respect to serviceability when designs are advanced that do not fully address all possible performance demands. Risk is incurred with respect to safety whenever recommendations are incorporated into geometric designs and structures such as culverts, bridges, walls, and rock slopes. The practitioner's responsibility lies in identifying risks incurred through analysis of all pertinent issues, informing project team members and partners of these risks, and assisting in evaluating whether the risks are tolerable.

Risks are more tolerable when they are low relative to the potential benefit of the action incurring the risk. Risk assessment is the process of assessing the probability and severity of adverse consequences associated with activities, recommendations or designs. For most FLH projects the risk assessment is not a complicated quantitative assessment, but rather a simplified practical assessment based on experience, engineering judgment and historical standard of practice on previous partner agency projects.

It is not feasible or intended for highway projects to be entirely risk-free, as there are potential rewards to the project when risk is taken. Knowledge of physical conditions, traffic and safety conditions for each project, as well as the basis and assumptions underlying the standards, is essential to understand the risks associated with decisions involving the selection and application of the standards and criteria. In many cases, the risks associated with decisions can be mitigated with inclusion or enhancement of other features, which may offset the risk. To the extent possible, risks should be quantified based on their potential probability and consequences.

On a project-by-project basis, a consistent level of safety, operational, and project delivery risk should be maintained from programming through construction. Where risk levels vary with different design or construction options, these risks must be fully explained, especially where there are disagreements over cost, impacts, safety, service life, aesthetics, etc. For each of the engineering disciplines involved in the project development, the operational and long-term performance risks (i.e., functionality, service life, maintenance, safety) of various engineering solutions, and the level of risk associated with performing varying levels of engineering analysis during the design, should be assessed continuously. Within the project development process the



costs, time and resources that are devoted to the process should be evaluated continuously with respect to the demands and risks for a successful project delivery and adherence to established schedule, budget, scope of work, and quality expectations.

The evaluation of potential risk and benefit is not solely a single discipline practitioner responsibility, as it is an interdisciplinary process requiring involvement of the Project Manager and other team members and stakeholders, as appropriate, based on all issues and participation in evaluation of the tolerability of the risk. Risk levels may vary between different disciplines or may impact other disciplines, or may cause risks to arise later in the project delivery process. Decisions resulting from risk-driven conflicts must be fully discussed and documented by the interdisciplinary project development team. The Project Manager will generally lead the decision-making process using a collaborative interdisciplinary approach to resolve disagreement over the acceptable level of risk. The FLH Branch Chiefs will normally oversee and endorse the level of risk taken to achieve a consistent office-wide level of risk acceptance over time. Where risks are elevated, the endorsement of the Project Manager, the Division Functional Managers, Division Branch Chiefs, Directors or Division Engineer may be necessary.

### 1.1.3.1 Federal Lands Management of Risk

Risk management planning is the process of determining how to approach and conduct risk activities for the project. Planning is critical to establish the importance of risk management, allocating proper resources and time to risk management and establish the basis for evaluating risk. During the risk management planning phase, the Project Manager selects the correct risk tool for their project and customizes the probability and impact charts for the specific project. [Exhibit 1.1-B](#) provides general guidance to assist the PM with selection of the appropriate risk tool based on project complexities and costs. Refer to Division supplements for specific guidance on risk management implementation. FHWA has led two [Risk Management SHRP2 initiatives](#) that help transportation professionals. The research results, summarized below, are an available resource that will improve the way transportation professionals plan, operate, maintain, and ensure safety on America's roadways.

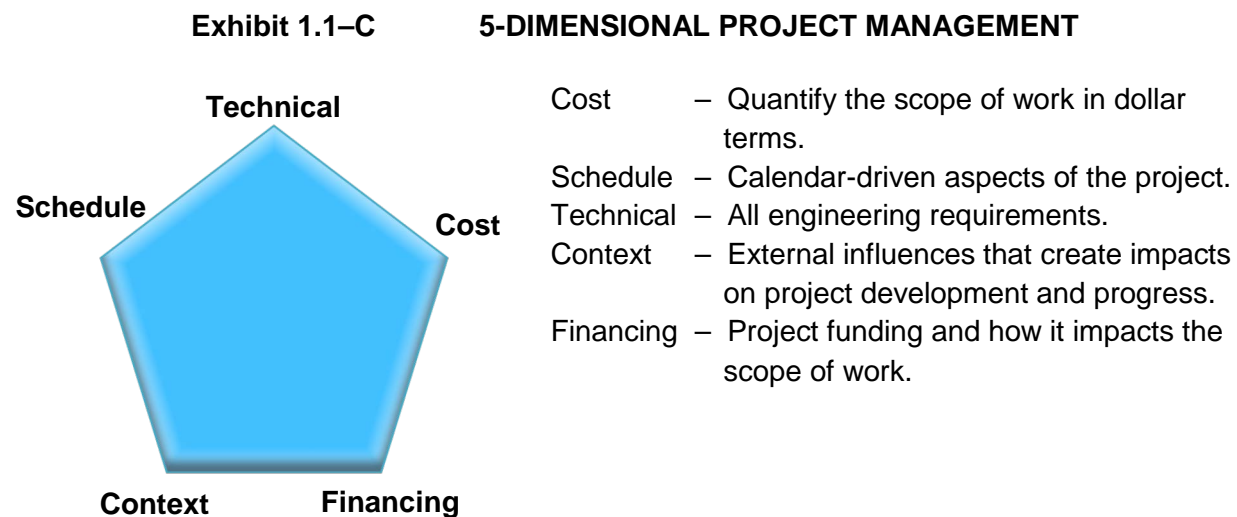
**Exhibit 1.1-B FLH GUIDANCE FOR RISK MANAGEMENT**

Project Parameters		Risk Tools	PER PM RECOMMENDATION WITH PMBC APPROVAL
PROJECT COSTS ↑	PROJECT COMPLEXITIES ↑	<b>Above \$100M</b>	
		Full Probabilistic Risk Model	
		<b>\$20M to \$100M</b>	
R09 SHRP2 Rapid Renewal Projects or P6 Integrated Risk Module &/or R10 SHRP2 Complex Projects			
<b>\$0 - \$10M</b>			
Simplified Methods per Division Guidance			

*Note- Risk Tool used is a Project by Project decision led by the PM*

### 1.1.3.2 Method for Risk Management on Complex Projects (R10)

The SHRP2 [Project Management Strategies for Complex Projects](#) provides one solution for addressing risk in projects of significant size, complexity and cost. While the traditional project management model encompasses cost, schedule, and technical aspect of a project; the SHRP report uses a 5-dimensional project management (5DPM) model. 5DPM restructures the project team's thought process by adding context and financing dimensions and elevating them to the same level as cost, schedule, and technical.



Complex projects are defined as:

- Projects where standard practices do not apply to:
  - ◊ Design
  - ◊ Funding
  - ◊ Contracting
- Projects with high levels of uncertainty regarding objectives and/or implementation strategy
- Projects with significant public interest or controversy
- Generally, projects above \$20M

The Project Management Branch Chief makes the decision to use 5DPM based on these criteria. The PM for the project should be named early in the project's development.

5DPM promotes early planning, estimating and risk analysis. Other benefits include:

- Communication early in the process (especially with project stakeholders)
- Early identification of complexity based on specific project needs
- Early preparation of the financials, schedule and resources
- Accelerated project delivery if implemented correctly
- Consideration of context and financing as project drivers
- Creates a realistic balance between the available financing and scope
- Can help minimize or reduce traffic disruption

The 5DPM principals stress being focused on the success of the project. Consider the project as being on the verge of chaos to help execute innovative strategies and fundamental change. Treat the project as an emergency and make decisions quickly. This can be accomplished by early consideration of complexity factors for each of the five dimensions. Generally, implementation starts when the PM has been assigned during the planning phase.

The 5DPM consists of 5 methods and 13 tools. The methods include:

1. Define Critical Project Success Factors
2. Assemble Project Team
3. Select Project Arrangements
4. Prepare Early Cost Model and Finance Plan
5. Develop Project Action Plans

The project manager and project planning team identifies success factors (Method 1) early in the project development process. Assembling the project team, selecting project arrangements, and developing a cost model and finance plan (Methods 2 through 4) occurs concurrently, soon after identification of the success factors. These may be revisited and changed during further project development. The team starts developing project action plans (Method 5) almost at project conception and continues doing so throughout project development as needed. Finally, the team selects from among the 13 tools, depending on the project needs:

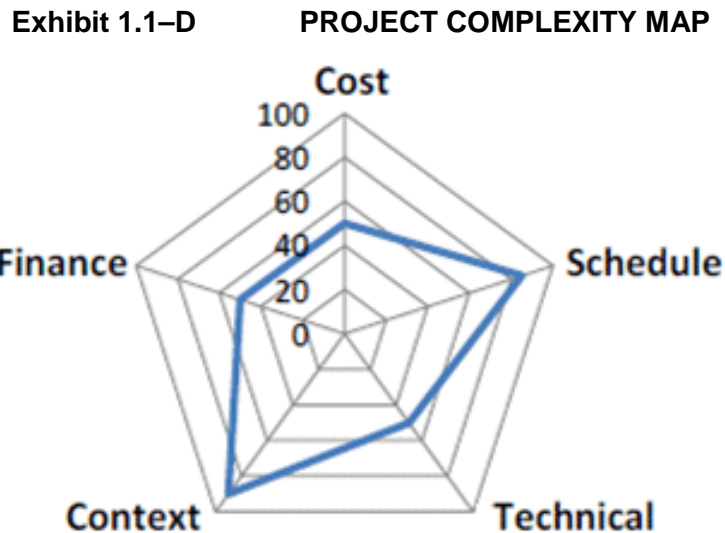
1. Incentivize Critical Project Outcomes
2. Develop Dispute Resolution Plans
3. Perform Comprehensive Risk Analysis
4. Identify Critical Permit Issues
5. Evaluate Applications of Off-Site Fabrication
6. Determine Involvement in ROW and Utilities
7. Determine Work Packages and Sequencing
8. Design to Budget
9. Co-locate Team
10. Establish Flexible Design Criteria
11. Evaluate Flexible Financing
12. Develop Finance Expenditure Model
13. Establish Public Involvement Plans

The tools help the project team address and manage the complexities of each project. Not every tool will be used on every project. For each project, select the tools that will help throughout the development of the complex-project management plan.

The project complexity map is a visual tool to identify and understand the dimension(s) with the most complexity. The map assists the team make resource allocation and tool selection decisions. Project complexity maps help organizational leaders to assign internal team members, develop effective procurement plans, advocate for project needs, and allocate financial resources. [Exhibit 1.1-D](#) provides an example of an initial project complexity map where the team identified Schedule and Context as the greatest areas of concern. Other uses of complexity mapping include:

- Discussing critical project issues at early stage of project planning and project definition

- Shared understanding of complexity dimensions that drive the project
- Rational resource allocation to maximize potential for project success
- Tracking project performance over time



Update the complexity map at each project development phase.

See the [Guide to Project Management Strategies for Complex Projects](#) and the [FHWA Project Management Strategies for Complex Projects](#) resources for more information.

### 1.1.3.3 Managing and Reducing Risk in Accelerated Highway Construction Projects (R09)

Highway projects come in many sizes and use various financing mechanisms and delivery methods. Work on such projects often involves the potential for schedule delays, budget overruns, and other unexpected problems or “risks” that affect project performance. The risks of underestimating schedule, cost, or disruption can increase delays, negatively affect budgets, require expensive changes, and undermine public confidence. Managing a project by anticipating and planning for these risks can significantly improve its outcome for the transportation agency and the traveling public.

Current traditional risk assessment and mitigation activities used by transportation agencies often lack rigor and formality in project planning, design, and delivery continuum. Failure to adhere to a formal risk analysis process can result in unanticipated problems, delays, and costs. In addition, finding solutions during later phases of a project can be more difficult and costly. The [Guide for the Process of Managing Risk on Rapid Renewal Projects](#) provides practical tools and techniques to optimize innovation, minimize schedule and budget risks, and build better projects.

[Managing Risk in Rapid Renewal Projects \(R09\)](#) helps managers quantify risks and provides guidance on the level of risk management needed. It presents a formal risk management process that optimizes performance for accelerated reconstruction on projects. R09 offers practical methods to identify, assess, mitigate, allocate, and monitor risk. Also, it fills the gaps that current

risk management practices do not address by adding project performance measures, and different project delivery and construction methods.

The process described in the R09 Guidebook allows users to factor in project scope, strategy and conditions, structuring, risk identification, risk assessment, risk analysis, risk management planning, and risk management implementation. It also provides objective guidance that can be applied to various types and sizes of rapid renewal projects, as well as other rehabilitation efforts.

### Exhibit 1.1–E RISK MANAGEMENT PROCESS



The R09 Guidebook includes the following implementation tools:

1. Spreadsheets that lead the user through a risk analysis process.
2. Two-day Train the Facilitator training course that includes instruction on the risk management process, and helps participants apply the principles in a case study activity.

The guidelines and training materials provide agencies with a greater understanding of potential risks associated with rapid renewal projects, and possible mitigation strategies. Training materials will assist transportation agencies with integrating this planning approach on a broader scale.

This product can be applied to highway projects of varying sizes and types to help managers proactively identify, plan for, assess, and manage their project risks to meet schedule and budget goals.

A better understanding of the potential risks leads to:

- Better financial management of agency capital budgets.
- Fewer changes due to unanticipated issues.
- More disciplined decision making regarding crucial project matters in the context of all other risks.

The R09 product will help transportation agencies better anticipate and understand the range of performance outcomes that may occur during a project's life cycle.

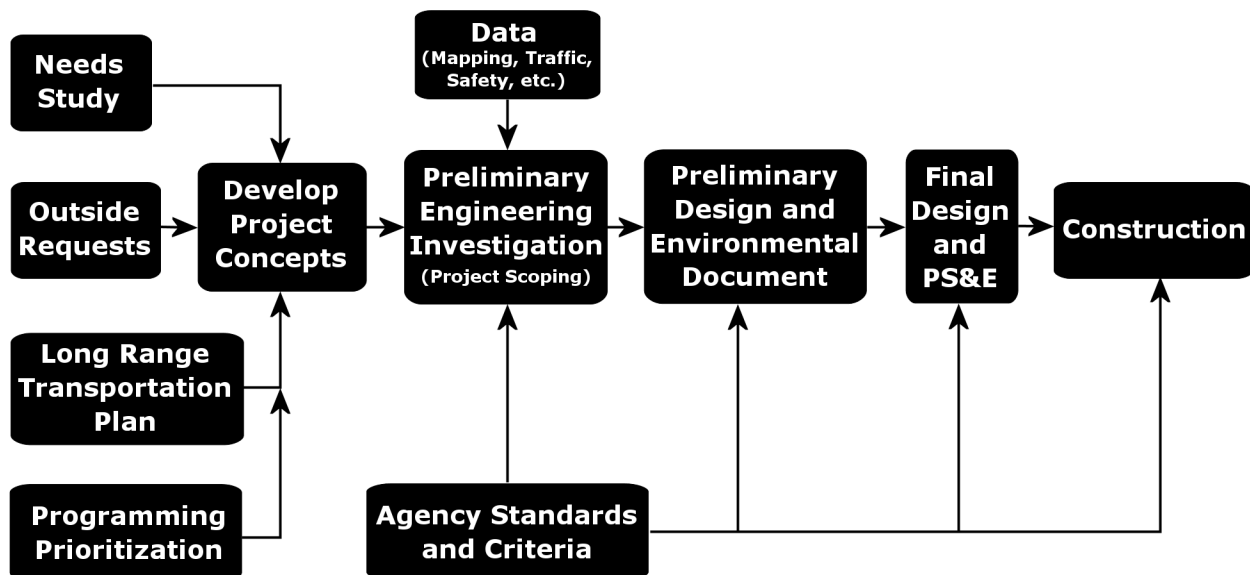
### 1.1.4 FORMAT

The *PDDM* is divided into thirteen chapters, each dealing with a major category of project development work. See [Exhibit 1.1–F](#) for a diagram of the project development work process. Each chapter has its own table of contents and is subdivided into sections. Policy and criteria are presented in each chapter as they relate to the specific subject matter. Links are provided to outside resources throughout the manual. Links with a [solid underline](#) identify links to a resource or chapter outside the current chapter of the *PDDM*. Links with a [dotted underline](#) identify a link to another portion of the current chapter which may also be a consolidated listing of outside resources.

The manual is available in electronic format for [download](#) from the Internet either in its entirety or by individual chapter. The electronic version of the *PDDM* and its revisions will be considered the official document in contracts with A/E consultants.

The manual is published in US Customary (English) units followed by SI (metric) units in square brackets. All design work is to be produced in units as specified by the partner agency. The decision on which units to use will be project specific and determined at the time the project is programmed.

**Exhibit 1.1–F PROJECT DEVELOPMENT WORK PROCESS**



### 1.1.5 REVISIONS AND UPDATES

The FLH Discipline Champions (the “Champions”) are responsible for maintaining the *PDDM* and its contents. Periodically, chapters will be reviewed for adequacy and need for revision. As changes in policies, standards and/or criteria occur, modifications will be made electronically.

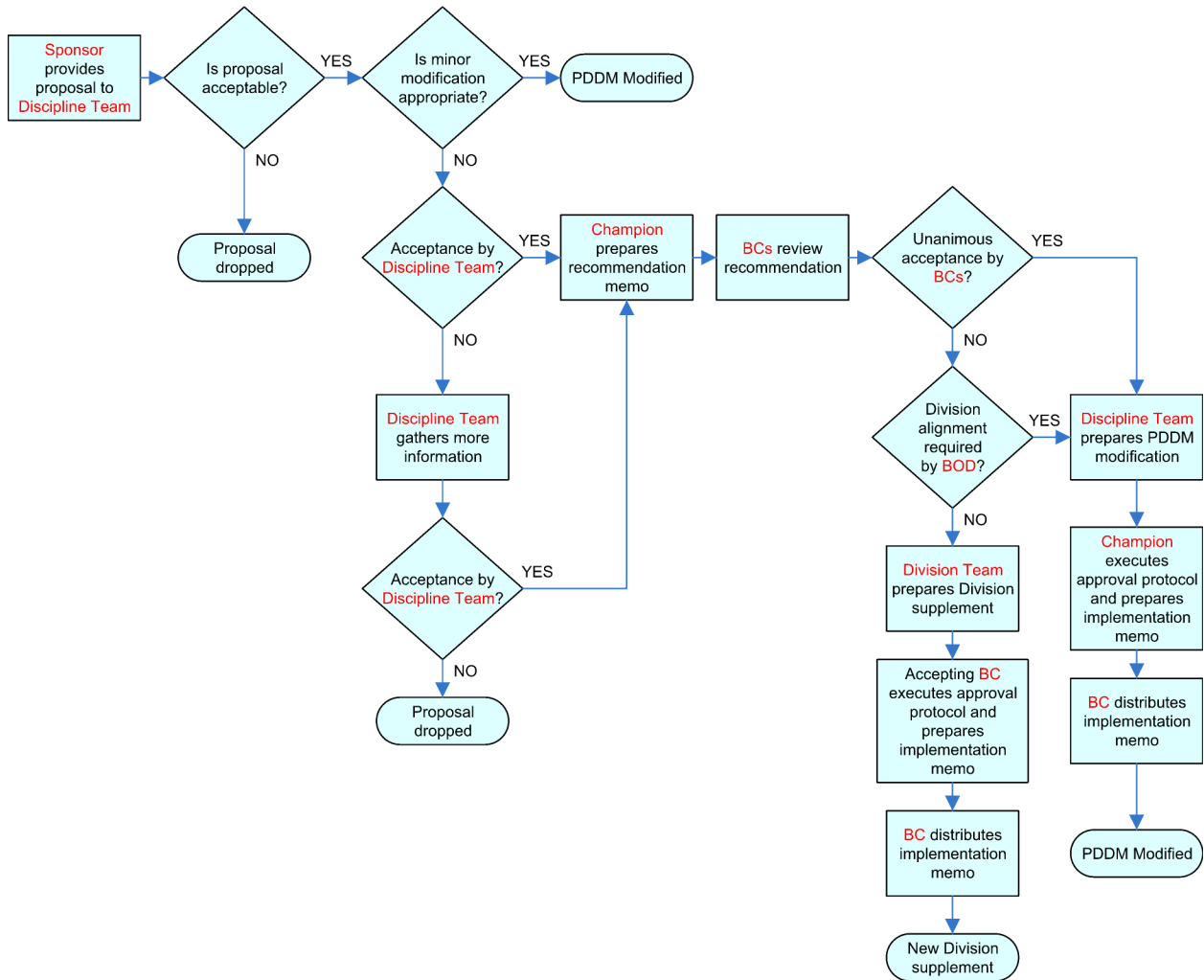
Each *PDDM* user may contribute to its continuing improvement and is encouraged to [submit suggestions](#) to make it more useful and practical. Provide the appropriate Champion and associated team with a reason why the change is needed, what precipitated the change, and provide a description of the change either with new text or redline/strikeout of existing text and/or exhibits, links, etc.

Minor modifications such as adding links to new FHWA guidance, improving linkages between chapters, and other minor content or editorial changes that have full support of the affected disciplines, will be processed by the Champion with no additional approvals required.

Otherwise, the discipline team evaluates the proposed change by looking at the consequences of the change, including its conflicts, benefits, risks, cost and feasibility. In some cases, the team may not have enough information to decide on the change. The team may then have to determine the in-house and contract resources, funding, and time required to develop needed information and provide recommendations. When the discipline team has reached agreement to make the change, the Champion prepares a recommendation memorandum via e-mail to all the effected Branch Chiefs for their review and approval. Once approved by the Branch Chiefs (BC) the Champion prepares the modification and distributes the *PDDM* Modification Approval Form for signatures and final approval by the Office of Federal Lands Highway. See [Exhibit 1.1–H](#) for an example modification approval form completed by the Hydraulics Champion. The Branch Chiefs then notify their staff that a *PDDM* modification has been implemented. For the rare occasion where the Branch Chiefs do not agree on a modification the Board of Directors (BOD) will determine if the modification is required FLH-wide for Division alignment. If the Board of Directors determines alignment is not necessary, those Branch Chiefs in agreement with the modification prepare Division Supplements to the manual. See [Exhibit 1.1–I](#) for the detailed process and [Exhibit 1.1–G](#) for a flowchart summarizing the modification development process.

When revisions are made, the [PDDM Revisions Log](#) will be updated. All revised material will be indicated by a change line in the *PDDM*. The change lines within any given chapter will remain until the next revision, at which time all change lines in that chapter will be removed. The Champions and their respective teams will check all external links on an annual basis to ensure they are still accurate. Internal links will be checked when there is a significant addition or deletion (i.e., new page, deleted section) from the manual. The manual will have either a publication date or revision date on each page to allow the user to determine if they are using the most recent document.

**Exhibit 1.1–G PDDM MODIFICATION DEVELOPMENT PROCESS**





### Exhibit 1.1–H PDDM MODIFICATION APPROVAL

**Discipline:** Planning

**Section / Subsection(s):** Chapter 12 – Right-of-Way and Utilities

**Reason for modification:** Updated to amend new program requirements; update technical references for regulations, manuals, websites, etc.; revise process flow charts; correct and clarify grammar and other miscellaneous revisions.

**Expected consequences:** The updated Chapter will provide current and consistent guidance to all Survey, Mapping Right-of-Way, Utilities and Highway Design staff.

**Modification Text:**

See PDDM Chapter 12, attached

**Completed Coordination:**

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> Highway Design Branch Chiefs     | <input checked="" type="checkbox"/> Construction Branch Chiefs       |
| <input checked="" type="checkbox"/> Technical Services Branch Chiefs | <input type="checkbox"/> Project Management Branch Chiefs            |
| <input type="checkbox"/> Bridge Discipline Champion                  | <input type="checkbox"/> Planning & Programming Branch Chiefs        |
| <input checked="" type="checkbox"/> Design Discipline Champion       | <input type="checkbox"/> Safety Discipline Champion                  |
| <input type="checkbox"/> Geotechnical Discipline Champion            | <input checked="" type="checkbox"/> Construction Discipline Champion |
| <input type="checkbox"/> Hydraulics Discipline Champion              | <input type="checkbox"/> Project Manage. Discipline Champion         |
| <input type="checkbox"/> Materials Discipline Champion               | <input type="checkbox"/> Environmental Discipline Champion           |
| <input type="checkbox"/> Pavements Discipline Champion               | <input type="checkbox"/> Planning Discipline Champion                |

**Certification:** I certify to the following:

- Above coordination was completed and all comments / concerns have been addressed and resolved in a manner satisfactory to all applicable parties. Comments and resolutions are on file with FLH Discipline Champion.
- All research and development documentation needed to support above modification(s) is on file with certifying FLH Discipline Champion.

\_\_\_\_\_  
FLH Discipline Champion

\_\_\_\_\_  
Date

**Approval:** The above described modification(s) is approved for immediate implementation:

\_\_\_\_\_  
Chief of Engineering, Eastern Federal Lands

\_\_\_\_\_  
Date

\_\_\_\_\_  
Chief of Engineering, Central Federal Lands

\_\_\_\_\_  
Date

\_\_\_\_\_  
Chief of Engineering, Western Federal Lands

\_\_\_\_\_  
Date

\_\_\_\_\_  
Director, Office of Program Development

\_\_\_\_\_  
Date

### Exhibit 1.1-I DEVELOPMENT PROCESS FOR PDDM MODIFICATIONS

**Source** - Person with the idea.

**Sponsor** - Person that champions idea/develops Justification for Review.

Suggested content of Sponsor Justification for Review:

- Describe change to discipline practice, standard, etc. Why is it needed, what precipitated the change?
- Propose revised text and/or exhibits, links, etc. using redline/strikeout.
- Describe expected impacts of change (e.g., conflicts with current operations).

**Level 1 Review:** Discipline Team (lead by Sponsor with Discipline Champion support) evaluates proposed change and recommends future actions/time frames, including need for Level 2 review.

Suggested Level 1 Review Process Objectives:

- Identify affected disciplines and coordinate with Discipline Champions and appropriate others
- Identify conflicts, benefits, risks, other consequences of change
- Judge feasibility/cost-effectiveness of implementing change
- Thumbs up/down on pursuing
- Determine if streamlined process\* is appropriate.

#### Level 1 Result

Acceptance: Discipline Champion prepares Recommendation Memo to discipline BC(s), or under streamlined process, Discipline Champion prepares and implements PDDM modification.

Rejection: Drop Idea

Split: Sponsor initiates Level 2 Review

(Acceptance/Rejection > two-thirds majority; Split: > 50/50 acceptance, but less than two-thirds majority. Quorum needed for a valid vote to be defined by discipline-specific charter.)

**Level 2 Review:** Discipline Team (lead by Sponsor with Discipline Champion support) prepares scope of work; defines level of effort, sources (in-house: Discipline Champions, FA; contract: Industry, Academia, Individual), necessary funding and funding sources (e.g., TD), and time required to develop needed information and provide recommendations; coordinates with affected Discipline Champions and appropriate others.

#### Level 2 Results

Acceptance/Split: Discipline Champion prepares Recommendation Memo to discipline BCs

Rejection: Drop idea

Recommendation Memo - Discipline Champion conveys justification and support for change (via email) to discipline BC(s), including results of Level 2 analysis, if applicable.

#### BC Feedback

Unanimous Approval: Discipline Team (led by Sponsor with Discipline Champion support) prepares PDDM modification. Discipline Champion executes approval protocol and prepares Implementation Memo on behalf of HQ.

Unanimous Disapproval: Drop Idea (expected to be a very rare occurrence at this stage).

Not Unanimous: Escalate to BOD for decision on Division alignment.

#### **Escalation Decision:**

Division Alignment Required: Discipline Team (led by Sponsor with Discipline Champion support) prepares PDDM modification. Discipline Champion executes approval protocol and prepares Implementation Memo on behalf of HQ.

Division Alignment Not Required: Division Discipline Team Leader(s) in favor of change prepares Division Supplement. Discipline BC(s) in favor of change executes approval protocol and prepares Implementation Memo on behalf of HQ.

**Approval Protocol** - Reference "PDDM Modification Approval" form.

Implementation Memo - Upon receiving Headquarters' approval, appropriate BC(s) notify Division Staffs of effective change to PDDM (via email). (Under streamlined process\* changes will be documented per PDDM revision process.)

\*The streamlined process is appropriate for changes such as adding links to new FHWA guidance, improving linkages between chapters, and other minor content or editorial changes that have full support at the technical level for all of the affected disciplines. No approvals are required.

### 1.1.6 DIVISION SUPPLEMENTS

It is a FLH goal to have alignment between Divisions whenever it is practical. However, the Divisions do have differences in organizational structure and each has its own base of institutional experience developed through years of work within its region of the country, with state and county partners, and with the regional representation of the Federal Land Management Agencies. Each Division has unique project planning, management and scheduling tools, and has minor variations in the utilization and management of contracted A/E consultant services. The Division Supplements listed throughout the PDDM detail the differences in practice among the Divisions. These references and supplements should be used within the Divisions and by their consultants whenever applicable.

Supplements will be issued by the appropriate Division office in a compatible format to this manual. Links to the Division Supplements are provided when available at the end of each major section. The electronic versions will be identified by Division's reference at the bottom of each page as noted below:

- Eastern Federal Lands Highway Division, (EFLHD),
- Central Federal Lands Highway Division, (CFLHD), and
- Western Federal Lands Highway Division, (WFLHD).

Informational electronic copies of Division Supplements should be distributed to the other Division offices and appropriate Champions on a routine basis upon issuance.

■ Refer to [[EFLHD](#) – [CFLHD](#) – [WFLHD](#)] Division Supplements for more information.

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## 1.2 GUIDANCE AND REFERENCES

The *PDDM* supplements Federal laws and regulations relative to the development and design of highways. It is intended to be used in conjunction with current engineering practices and procedures issued by the Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), State highway agencies, Federal land management agencies and other select organizations. Applicable laws are set forth in [Title 23, United States Code \(USC\) “Highways”](#). The governing regulations are found in Title 23, Code of Federal Regulations (CFR). As described below, additional guidance on applicable policy and standards may be found in the *Federal-aid Policy Guide*, the *Federal Lands Highway Manual*, national and project interagency agreements and AASHTO or other recognized publications.

Other acceptable guides and publications may be referenced in specific chapters. Publications referenced in this manual are available for use by each Division office, as appropriate.

### 1.2.1 CODE OF FEDERAL REGULATIONS (CFR)

The *Code of Federal Regulations* is a codification of the general and permanent rules published in the *Federal Register* by agencies of the Federal Government. The code is divided into 50 titles representing broad areas of Federal regulations. [Title 23 CFR “Highways”](#) is the volume representing those current regulations applicable to FHWA and the FLH Program. The following are the parts of 23 CFR that are most relevant to the development and design of highways:

- Part 620, Subpart A. Highway Improvements in the Vicinity of Airports.
- Part 625, Design Standards for Highways.
- Part 626, Pavement Policy.
- Part 627, Value Engineering.
- Part 630, Preconstruction Procedures.
- Part 636, Design-Build Contracting.
- Part 650, Bridges, Structures and Hydraulics.
- Part 652, Pedestrian and Bicycle Accommodations and Projects.
- Part 655, Traffic Operations.
- Part 660, Special Programs (Direct Federal) Forest Highways and Defense Access Roads.
- Part 668, Subpart B, Emergency Relief Program: Procedures for Federal Agencies for Federal Roads.
- Part 752, Landscape and Roadside Development.
- Part 771, Environmental Impact and Related Procedures.
- Part 772, Procedures for Abatement of Highway Traffic and Construction Noise.

- Part 777, Mitigation of Impacts to Wetlands and Natural Habitat.
- Subchapter L, Federal Lands Highways.

### **1.2.2 FEDERAL-AID POLICY & GUIDANCE**

The [Federal-aid Highway Program Policy & Guidance Center \(PGC\)](#) provides a central location for laws, policies, and guidance about the Federal-aid Highway Program, including legal documents, links to relevant legislation, memos, [directives](#), and guidance to support the Federal Highway Administration's mission and goals. The PGC also contains program directives relative to administration of the Federal Lands Highway Program (FLHP).

### **1.2.3 NATIONAL INTERAGENCY AND PROJECT AGREEMENTS**

Agency agreements are required whenever FHWA performs work for another agency or when work is performed by another agency with funds administered by FHWA. National agreements have been executed between FHWA and principal Federal land management agencies (i.e., National Park Service (NPS), Forest Service (FS), Bureau of Indian Affairs (BIA), Fish and Wildlife Service (FWS). Project agreements are executed between Division offices and another agency to detail project specifics that cannot be covered by a national agreement (e.g., project funding, geometrics, right-of-way acquisition, utility relocation, construction, and maintenance responsibilities). Tribes may also enter into TTP agreements directly with FHWA. These are developed and overseen by the Office of Federal Lands Highway. If a tribe requests design work to be conducted by FLH, a project agreement between the Tribe and the FLH Division will be required. Agreements are discussed in [Chapter 2](#).

### **1.2.4 AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO) POLICY AND GUIDES**

AASHTO was organized in 1914 and is composed of representatives from all 50 State highway transportation agencies, the Commonwealth of Puerto Rico and the Northern Mariana Islands, the District of Columbia, six Canadian Provinces and two Territories and the Federal Highway Administration.

The organization brought together Federal, State and other highway engineers for discussion of problems, planning of concerted action and adoption of uniform practices. Its avowed objective is to foster the development, operation and maintenance of a nationwide integrated system of highways to adequately serve the transportation needs of our country.

AASHTO publishes recommended specifications, guides and standards on highway design and construction that generally prescribe good practices or criteria considered adequate to provide safe and cost-effective highway facilities. These approved standards and guides as listed herein

may be used in conjunction with this manual. Design standards for highways are listed in [23 CFR Part 625](#).

AASHTO publications may be purchased [online](#).

### 1.2.5 FEDERAL LANDS HIGHWAY POLICY REFERENCES

1. [FLH Policy and Guidance Center](#) Collection of documents related to Federal Lands Highway and Tribal Transportation programs.
2. [FLH Safety Philosophy](#)
3. FP-XX [Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects](#), DOT, FHWA. Current Edition.
4. EFLHD LOSS Eastern Federal Lands Highway Division [Library of Supplemental Specifications](#)
5. CFLHD SCR Central Federal Lands Highway Division [Library of Special Contract Requirements](#)
6. WFLHD LOSS Western Federal Lands Highway Division [Library of Supplemental Specifications](#)
7. Standard Drawings [Federal Lands Highway Standard Drawings](#), current edition.
8. EFLHD Details Eastern Federal Lands Highway Division [Detail Drawings](#)
9. CFLHD Details Central Federal Lands Highway Division [Detail Drawings](#)
10. WFLHD Details Western Federal Lands Highway Division [Detail Drawings](#)
11. Materials Manual [Field Materials Manual](#), Federal Lands Highway, current edition.
12. [Construction Manual](#)
13. [Park Road Standards](#), US Department of the Interior, National Park Service, 1984.
14. 25 CFR 170 [Tribal Transportation Program](#) Final Rule
15. SHS [Standard Highway Signs](#), DOT, FHWA. Current Edition.
16. MUTCD [Manual on Uniform Traffic Control Devices for Streets and Highways](#), DOT, FHWA. Current Edition
17. Green Book *A Policy on Geometric Design of Highways and Streets*, AASHTO. Current Edition.

18. RDG *Roadside Design Guide*, AASHTO. Current Edition.
19. Special Report 214 [\*Designing Safer Roads. Practices for Resurfacing, Restoration and Rehabilitation\*](#), TRB, 1987.
20. *Materials Manual*, Parts I and II, AASHTO, Current Edition.
21. AASHTO HDG AASHTO Highway Drainage Guidelines, Current Edition.
22. AASHTO MDM AASHTO *Model Drainage Manual*, Current Edition.
23. [\*Government Printing Office Style Manual\*](#).
24. 23 USC 203 [Federal lands transportation program](#)
25. 23 USC 204 [Federal lands access program](#)
26. 23 USC 202 [Tribal transportation program](#)
27. 23 USC 308 [Cooperation with Federal and State agencies and foreign countries](#)



### 1.3 PARTNERS, PROGRAMS, AND PLANNING

Federal Land management agencies are Federal agencies established under laws and regulations and delegated the authority to administer and manage the vast national resources on federally owned or controlled lands within the United States and its territories. They have the responsibility for constructing and maintaining a public roads system within these lands. See [FLH Partners](#) for information about our partners.

FLH also works, with other Federal and State government agencies upon request.

FLH's mission when working with these land management agencies usually entails all phases of project development and design. See [FLH Programs](#) for information about authorizing language supporting the range of Federal lands programs. [23 USC 308](#) contains authorizing language that allows FLH to deliver engineering services.

Project development begins with planning and programming. See [FLH Planning Programs](#) for information about these focus areas.

## 1.4 GLOSSARY

### 1.4.1 ABBREVIATIONS

Whenever these abbreviations are used, they will have the following meaning:

- 3R** Resurfacing, Restoration and Rehabilitation (RRR)  
**4R** Resurfacing, Restoration, Rehabilitation, and Reconstruction Projects

- A -

- A/E** Architectural and Engineering Consultant  
**AA** Aluminum Association  
**AADT** Annual Average Daily Traffic  
**AASHTO** American Association of State Highway and Transportation Officials  
**A CHP** Advisory Council on Historic Preservation  
**ACI** American Concrete Institute  
**ACSM** American Congress on Surveying and Mapping  
**ADA** Americans with Disabilities Act  
**ADAAG** Americans with Disabilities Act Accessibility Guidelines  
**ADT** Average Daily Traffic  
**AISI** American Iron and Steel Institute  
**AMF** Accident (or Crash) Modification Factor  
**AMG** Automated Machine Guidance  
**ANSI** American National Standards Institute  
**ARTBA** American Road and Transportation Builders Association  
**ASCE** American Society of Civil Engineers  
**ASLA** American Society of Landscape Architects  
**ASPRS** American Society of Photogrammetry and Remote Sensing

**ASTM** American Society for Testing and Materials

**AWPA** American Wood Preservers' Association

**AWS** American Welding Society

**AWWA** American Water Works Association

**- B -**

**BIA** Bureau of Indian Affairs

**BIP** Bridge Inspection Program

**BLM** Bureau of Land Management

**BMP** Best Management Practice

**- C -**

**CAA** Clean Air Act

**CAAA** Clean Air Act Amendments

**CADD** Computer Aided Design and Drafting

**CBA** Choosing by Advantage

**CE** Categorical Exclusion

**CEQ** Council on Environmental Quality

**CERCLA** Comprehensive Environmental Response, Compensation, and Liability Act

**CFLHD** Central Federal Lands Highway Division

**CFR** Code of Federal Regulations

**CFT** Cross Functional Team

**CMF** Crash (also Accident) Modification Factor

**CNMI** Commonwealth of the Northern Mariana Islands

**CO** Carbon Monoxide

**CSD** Context Sensitive Design

**CSS** Context Sensitive Solutions

**CWA** Clean Water Act

**CZMA** Coastal Zone Management Act

**- D -**

**DAB** Development Advisory Board

**DAR** Defense Access Road

**DHV** Design Hourly Volume

**DO-12** Director's Order 12 (National Park Service)

**DOI** Department of the Interior

**DOQQ** USGS Digital Ortho Quarter Quadrangle maps

**DOT** United States Department of Transportation

**DPG** Design Procedures Guide

**DSD** Decision Sight Distance

**DSR** Damage Survey Report

**DTM** Digital Terrain Model

**- E -**

**EA** Environmental Assessment

**E-CAL** Electronic Centralized Agreement Library

**EDM** Electronic Distance Measuring

**EDTS** Environmental Document Tracking System

**EFH** Essential Fish Habitat

**EFLHD** Eastern Federal Lands Highway Division

**EIS** Environmental Impact Statement

**EO** Executive Order

**EPA** Environmental Protection Agency

**ERFO** Emergency Relief of Federally Owned Roads Program

**ESA** Endangered Species Act

**- F -**

**FAA** Federal Aviation Administration

**FAPG** Federal-Aid Policy Guide

**FAQ** Frequently Asked Questions

**FAR** Federal Acquisition Regulations

**FDR** Forest Development Roads

**FEMA** Federal Emergency Management Agency

**FHWA** Federal Highway Administration

**FLH** Federal Lands Highway

**FLHO** Office of Federal Lands Highway

**FLHP** Federal Lands Highway Program

**FLMA** Federal Land Management Agency

**FONSI** Finding of No Significant Impact

**FPPA** Farmland Protection Policy Act

**FP-xx** Book of Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects (The year of issuance 19xx or 20xx)

**FS** United States Department of Agriculture Forest Service

**FTA** Federal Transit Administration

**FWS** United States Fish and Wildlife Service

**- G -**

**GCDB** Geographic Coordinate Data Base

**GEOPAK** Software program for interactive highway design

**GIS** Geographic Information System

**GNSS** Global Navigation Satellite System

**GPS** Global Positioning System

**GSA** General Services Administration

**- H -**

**HAL** High Accident Location

**HCM** Highway Capacity Manual

**HEC** Hydraulic Engineering Circular

**HES** Homestead Entry Survey

**HOV** High Occupancy Vehicle

**HUD** Housing and Urban Development

**- I -**

**IDT** Interdisciplinary Team

**IHSDM** Interactive Highway Safety Design Model

**ISD** Intersection Sight Distance

**ITE** Institute of Transportation Engineers

**ITS** Intelligent Transportation System

**- L -**

**LiDAR** Light Detection and Ranging

**LHSS** Local Highway Safety Study

**LOS** Level of Service

**LWCF** Land and Water Conservation Fund

**- M -**

**MOA** Memorandum of Agreement

**MOU** Memorandum of Understanding

**MUA** Multi-attribute Utility Analysis

**MUTCD** Manual on Uniform Traffic Control Devices for Streets and Highways

**- N -**

<b>NAAQS</b>	National Ambient Air Quality Standards
<b>NCHRP</b>	National Cooperative Highway Research Program
<b>NEPA</b>	National Environmental Policy Act
<b>NGS</b>	National Geodetic Survey
<b>NHPA</b>	National Historic Preservation Act
<b>NHS</b>	National Highway System
<b>NHTSA</b>	National Highway Traffic Safety Administration
<b>NIST</b>	National Institute of Standards and Technology
<b>NMFS</b>	National Marine Fishery Service
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>NPDES</b>	National Pollutant Discharge Elimination System
<b>NPS</b>	National Park Service
<b>NR</b>	National Register
<b>NRCS</b>	Natural Resources Conservation Service
<b>NRHP</b>	National Register of Historic Places
<b>NRPP</b>	Natural Resources Preservation Program
<b>NWS</b>	National Weather Service

**- O -**

<b>OCRM</b>	Office of Ocean and Coastal Resource Management
<b>OSHA</b>	Occupational Safety and Health Administration

**- P -**

<b>PCA</b>	Portland Cement Association
<b>PCI</b>	Precast/Prestressed Concrete Institute
<b>PDDM</b>	Project Development and Design Manual

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<b>PDG</b>	Office of Real Estate Services Project Development Guide
<b>PE</b>	Preliminary Engineering
<b>PIH</b>	Plan in Hand
<b>PL</b>	Public Law
<b>PLSS</b>	Public Land Survey System
<b>PMIS</b>	Program Management Information System
<b>PRMS</b>	Program and Resource Management System
<b>PRP</b>	Park Roads and Parkway Program (may also be PRPP or § PRA)
<b>PRT</b>	Perception Reaction Time
<b>PS&amp;E</b>	Plans, Specifications and Estimates
<b>PSD</b>	Passing Sight Distance

- Q -

<b>QA</b>	Quality Assurance
<b>QC</b>	Quality Control

- R -

<b>RDG</b>	Roadside Design Guide, AASHTO
<b>RGL</b>	Regulatory Guidance Letter
<b>RIP</b>	Road Inventory Program
<b>ROD</b>	Record of Decision
<b>RPM</b>	Raised Pavement Marker
<b>RRP</b>	Refuge Roads Program
<b>RSA</b>	Roadside Safety Audit
<b>RSRAP</b>	Roadside Safety Resource Allocation Program

- S -

<b>SADT</b>	Seasonal Average Daily Traffic
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<b>SARA</b>	Superfund Amendments and Reauthorization Act
<b>SCR</b>	Special Contract Requirement
<b>SDDC</b>	Surface Deployment and Distribution Command
<b>SDWA</b>	Safe Drinking Water Act
<b>SEE</b>	Social, Economic and Environmental
<b>SHA</b>	State Highway Agency
<b>SHPO</b>	State Historic Preservation Office
<b>SHS</b>	Standard Highway Signs
<b>SI</b>	International System of Units (also referred to as Metric)
<b>SIP</b>	State Improvement Plan
<b>SSD</b>	Stopping Sight Distance
<b>SSPC</b>	The Society for Protective Coatings
<b>STARS</b>	Service-wide Traffic Crash Reporting System
<b>SUE</b>	Subsurface Utility Engineering
<b>SWPPP</b>	Stormwater Pollution Prevention Plan

- T -

<b>T&amp;E</b>	Threatened and Endangered
<b>TAM</b>	Department of Transportation Acquisition Manual
<b>TAR</b>	Department of Transportation Acquisition Regulations
<b>TCP</b>	Traffic Control Plan
<b>TE</b>	Transportation Enhancement
<b>TFHRC</b>	Turner Fairbank Highway Research Center
<b>TGM</b>	Technical Guidance Manual
<b>THPO</b>	Tribal Historic Preservation Officer
<b>TMDL</b>	Total Maximum Daily Load

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<b>TMP</b>	Transportation Management Plan
<b>TNM</b>	Traffic Noise Model
<b>TRB</b>	Transportation Research Board
<b>TSM</b>	Transportation System Management
<b>TTC</b>	Temporary Traffic Control
<b>TTP</b>	Tribal Transportation Program
<b>TWLTL</b>	Two-Way Left Turn Lane

**- U -**

<b>USACE</b>	United States Army Corps of Engineers
<b>USC</b>	United States Code
<b>USCG</b>	United States Coast Guard
<b>USDA</b>	United States Department of Agriculture
<b>USFS</b>	United States Forest Service
<b>USFWS</b>	United States Fish and Wildlife Service
<b>USGS</b>	United States Geological Survey

**- V -**

<b>VA</b>	Value Analysis
<b>VE</b>	Value Engineering
<b>VLVLR</b>	Very Low Volume Local Road
<b>VPH</b>	Vehicles per Hour

**- W -**

<b>WFLHD</b>	Western Federal Lands Highway Division
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## 1.4.2 DEFINITIONS

Many of the following terms are used throughout the *PDDM*:

### - A -

**Acceleration Lane** – A speed change lane to enable a vehicle entering a roadway to increase its speed to merge with through traffic.

**Accuracy** – The degree of agreement between a measured value and its established true value.

**Aeolian Deposits** – Wind-deposited material (e.g., dune sands, loess deposits).

**Aesthetics** – A branch of philosophy dealing with beauty and the beautiful and judgments of taste concerning them. In highway engineering, aesthetic judgments have to do primarily with the highway as a whole and the roadsides, and includes screening out unpleasant views.

**Aggradation** – General and progressive raising of the streambed by deposition of sediment.

**Alkalinity** – The degree of strength of an alkali. A liquid is said to be alkaline if it has a pH factor greater than seven.

**Alluvium** – Deposits of silts, sands, gravels, cobbles, boulders, and other non-cohesive sediments that have been transported by running water.

**Angle of Internal Friction** – The angle whose tangent is the ratio between the resistances offered to slide along any plane in the soil and the component of the applied force acting normal to that plane. Values are given in degrees.

**Angle of Repose** – The angle between the horizontal and the maximum slope that a soil assumes through natural processes.

**Anhydrous** – Free from water.

**Arbitrary Coordinate System** – A system of coordinates based upon an arbitrarily chosen origin. Used when established coordinate systems are not available. Sometimes called assumed coordinate system.

**Architectural Features** – As used in roadside enhancement, these may include stepped retaining walls to minimize the visual impact of massive walls, rock sculpturing to blend disturbed areas into the natural terrain, and special treatment of bridge abutments and culvert headwalls to blend them into the landscape.

**Asphalt** – A dark brown to black cementitious material in which the predominate constituents are bitumens which occur in nature or are obtained in petroleum processing.

**Automated Machine Guidance (AMG)** – Use of survey-grade position sensors and on-board computers to guide the operator or control the hydraulics of construction equipment.

**Auxiliary Lane** – The portion of the roadway adjoining the traveled way for weaving, truck climbing, speed changing or for other purposes supplementary to through-traffic movement.

**Average Daily Traffic (ADT XXXX)** – (1) The current or projected average two-way daily traffic for a specified year. (2) (ADT YY) The projected average two-way daily traffic for a specified future period, usually 20 years after the anticipated completion of construction.

**Average Highway Speed** – The weighted average of the design speeds within a highway section based on each subsection's proportional contribution to total distance, when each subsection has an individual design speed.

**Average Initial Horizontal Illuminance** – The average level of horizontal illuminance in the pavement area of a traveled way at the time the lighting system is installed, when lamps are new and luminaires are clean. This level is expressed in lux (lumens per square meter of horizontal surface).

**Average Running Speed** – The average speed of all vehicles over a specified highway section, which is the sum of the distances traveled by vehicles on the highway section during a specified time period divided by the sum of their running times.

**- B -**

**Backfill** – Material used to replace, or the act of replacing material removed during construction; also denotes material placed or the act of placing material adjacent to structures.

**Backslope** – In cuts, the slope from the bottom of the ditch to the top of the cut.

**Base Course** – The layer, or layers, of specified or selected material of designed thickness placed on a subbase or a subgrade to support a surface course.

**Basic Capacity** – The maximum number of passenger cars that can pass a given point on a lane or roadway during one hour under the most nearly ideal roadway and traffic conditions that can be attained.

**Bedrock** – Rock of relatively great thickness and extent in situ.

**Bench Mark** – A temporary or permanent marker of known elevation with reference to a specific datum plane.

**Bitumen** – A class of black or dark colored cementitious substances, natural or manufactured composed principally of high molecular weight hydrocarbons, of which asphalts, tars, pitches and asphaltites are typical.

**Bituminous** – Containing or treated with bitumen (e.g., bituminous pavement, bituminous concrete)

**Brake Reaction Distance** – The distance traversed by the vehicle from the instant the driver sights an object necessitating a stop to the instant the brakes are applied.

**Braking Distance** – The distance required to stop the vehicle from the instant brake application begins.

**Breakaway (Yielding) Supports** – A support for a roadside device that yields or collapses readily when struck by a vehicle.

**Bridge** – A single or multiple span structure, including supports, erected over a depression or an obstruction (e.g., water, highway, railway) and having an opening measured along the center of the roadbed of more than 20 ft [6 m].

**Broken Back Curve** – An arrangement of curves in which a short tangent separates two curves in the same direction.

**Bypass** – A highway that permits traffic to avoid part or all of an urban area.

- C -

**Cadastral** – Pertaining to extent, value and ownership of land. Cadastral maps show property corners and property boundaries.

**Cadastral Survey** – A survey made to determine the lengths and directions of boundary lines and the area of land bounded by these lines. It may also be a survey made to establish these boundary lines on the ground. Also known as a Property Survey.

**Calcareous** – Material containing or similar to calcium carbonate or lime.

**Calendar Day** – Any day shown on the calendar, beginning and ending at midnight.

**California Bearing Ratio (CBR)** – The ratio of the force required to penetrate a soil mass with a circular piston to the force required to penetrate a mass of high quality crushed stone with the same piston. The rate of penetration in both cases is identical.

**Camber** – A slight arch designed or built into a structure to compensate for the natural deflection after loading.

**Capillary Moisture** – Moisture that clings to soil particles by surface tension and reaches the particles by surface tension either when free water passes through the soil or by capillary attraction from a wetter stratum. Within limits, it can move in any direction.

**Centerline** – For a two-lane highway the centerline is the middle of the traveled way, and for a divided highway the centerline may be the center of the median. For a divided highway with independent roadways, each roadway has its own centerline.

**Channel** – A course along which water flows. The course can be natural or artificial, open or closed. The flowing water can be confined by soil-based bed and banks, such as those in a natural river or stream or in an artificial ditch or canal; or by an artificial conduit, such as a pipe or flume.

**Channelization** – The separation of traffic flow into definite paths, by means of traffic markings or islands.

**Channelized Intersection** – A grade intersection where traffic is directed into definite paths by islands.

**Clay** – A fine-textured soil, usually plastic and sticky when wet, which usually breaks into hard lumps when dry. When the moist soil is pinched between the thumb and finger, it will form a long, flexible ribbon.

**Clear Zone** – That area along the side of the traveled way (including the shoulder) that is available for recovery of an errant vehicle.

**Climbing Lane** – An additional traffic lane provided for slow moving vehicles on the up-grade side of a highway.

**Cohesionless Soil** – A soil that, when unconfined, has little or no strength when air-dried, and little or no cohesion when submerged. Sand is an example of cohesionless soil.

**Cohesive Soil** – A soil that when unconfined has considerable strength when air-dried and that has significant cohesion when submerged.

**Compressibility** – The property of a material that enables it to remain compressed after compaction.

**Compressive Stress** – The stress produced in a member when the forces acting on it tend to push the particles together.

**Construction Limits** – The limits on each side of the project that establish the area disturbed by construction operations and beyond which no disturbance is permitted.

**Construction Survey** – A survey executed to locate or lay out engineering works. In highway construction applications, this survey is used to set grading elevation stakes, reference points, slope stakes and other such controls.

**Contour** – A line that depicts equal elevation on a land surface. The line representing this on a map.

**Contour Grading Plan** – A drawing showing an arrangement of contours intended to integrate construction and topography, improve appearance, reduce erosion and improve drainage.

**Contour Interval** – The elevation difference between adjacent contours.

**Contract Document Hierarchy** – There are five essential parts to a contract and a requirement occurring in one is as binding as if occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, numerical dimensions will prevail over scaled dimensions and the parts of the contract will prevail in the following order:

- Contract Clauses, 48 CFR, Chapters 1 and 12;
- Special Contract Requirements;
- Plans;
- Supplemental Specifications; and
- Standard Specifications (FP-XX).

**Control Data** – The horizontal and vertical values used to define the relative position of a control point.

**Control Point** – An established point on the ground with known horizontal and vertical positioning. This point is normally used as a basis for gathering field measurements and placing construction stakes.

**Control Survey** – A survey made to establish the horizontal and vertical positions of a series of control points. In highway applications, a control survey is generally the first survey performed on a project. Other aspects of the surveying process base their measurements on the control points established during the control survey.

**Cooperator** – A State or local government agency that has jurisdiction over and/or maintenance responsibility for highways.

**Coordinates** – A set of numbers used in describing the location of a point on a surface or in space.

**Corridor** – A strip of land between two termini within which traffic, topography, environment and other characteristics are evaluated for transportation purposes.

**Countermeasure** – A measure, commonly used in a hydraulic environment, intended to prevent, delay, or reduce the severity of a problem.

**Crashworthy** – A highway feature is crashworthy if it was successfully crash tested under the NCHRP Report 350, *Recommended Procedures for the Safety Performance Evaluation of Highway Features* or earlier comparable criteria or if it was accepted through analysis by FHWA, based on similarity to other crashworthy features.

**Crash Cushion (Impact Attenuator)** – A device placed in front of a fixed roadside object to absorb and dissipate collision energy.

**Creep** – The slow movement of a material under stress, usually imperceptible except to observations of long duration.

**Crest Vertical Curve** – A vertical curve having a convex shape in profile.

**Critical Length of Grade** – That combination of gradient and length of grade that will cause a designated vehicle to operate at some predetermined minimum speed.

**Cross Section** – A vertical section of the ground, roadway or structure perpendicular to the centerline or baseline of the roadway or other work.

**Crosswalk** – Any portion of a roadway at an intersection or elsewhere distinctly indicated for pedestrian crossing by signs and by lines or other markings on the surface.

**Crossing Sight Distance** – A distance along an intersection approach leg such that vehicle operators can see other vehicles on crossroads in time to avoid collision.

**Crown** – The highest point of the surface of a tangent traveled way in cross section.

**Crushed Gravel** – The product resulting from the crushing of ordinary gravel with substantially all fragments having one or more faces resulting from fracture.

**Crushed Stone** – The product resulting from the crushing of fragments of bedrock or large stones with all fragments having all faces resulting from fracture.

**Culture or Cultural Features** – General term used in mapping to describe manmade features.

**Culvert** – A structure that provides an opening through an earthen embankment and does not meet the definition of a bridge.

**Curb** – A structure with a vertical or sloping face placed on roadways to form islands, gutters, etc. and to protect pavement edges.

**Curve Widening** – The widening of the highway traveled way on sharp curves to compensate for the fact that the rear wheels of a vehicle do not follow exactly in the track of the front wheels.

**Curvilinear Alignment** – A flowing alignment in which the majority of its length is composed of circular and spiral curves.

- D -

**Data Collector** – A recording device that electronically records surveying measurements and field notes. The information stored in these collectors is downloaded into a computer for later processing.

**Datum Plane** – A reference plane to which vertical measurements and elevations are referred. Usually the datum plane (elevation 0.000) used is mean sea level.

**Deadman** – A buried object serving as an anchor (e.g., a cable-guardrail guy anchors).

**Deceleration Lane** – A speed-change lane that enables a vehicle to slow to a safe exit speed when making an exit turn.

**Decibel (Db)** – The unit for measuring the intensity of sound. When A-weighting is used, this unit is abbreviated as dBA.

**Deciduous** – Having leaves that are shed at the end of the growing season; opposite of evergreen.



**Degradation** – General and progressive lowering of the longitudinal profile of a channel by erosion.

**Delineator** – A visual device for defining the alignment of a roadway.

**Dense Graded** – A well-graded aggregate with sufficient fine material to nearly fill all voids.

**Depletion** – The progressive withdrawal of water from surface or ground water reservoirs at a rate greater than that of replenishment.

**Design Capacity** – The practical capacity or lesser value determined for use in designing the highway to accommodate the design volume.

**Design Discharge** – The volume rate of runoff that a hydraulic structure is designed to safely pass. The rate depends on the characteristics of the watershed and the flood frequency selected for the design, which in turn, depends on the importance of the roadway, and the risk of failure one is willing to accept.

**Design Headwater** – The elevation of the water surface above a structure inlet, for a given structure type, size and design discharge.

**Design Hourly Volume (DHV)** – The future two-way hourly traffic volume for use in design, usually the 30<sup>th</sup> highest hourly volume of the design year (30 HV).

**Design Lane** – The lane on which the greatest number of equivalent 18,000 lbs [80 kN], single-axle loads is expected. Normally, this will be either lane of a two-lane highway or the outside lane of a multilane highway.

**Design Load** – The loads that must be supported by a structure.

**Design Noise Levels** – The noise levels that represent the upper limit of acceptable traffic noise established for various activities or land uses. These levels are used to determine the degree of impact of traffic noise on human activities.

**Design Speed** – A selected speed used to determine the various geometric features of the roadway.

**Design Thickness** – The total thickness of the pavement structure determined from the thickness design charts as adequate for a given total 18,000 lbs [80 kN] equivalent single-axle loads soil strength value.

**Design Vehicle Turning Radius** – The turning radius of a design vehicle used primarily to determine the minimum radius used in the design of turning and intersecting roadways.

**Design Year** – The future year used to estimate the probable traffic volume for which a highway is designed. A time ten to 20 years from the start of construction is usually used.

**Direct Shear Test** – A shear test in which soil under an applied normal load is stressed to failure by moving one section of the soil container relative to the other section.

**Divided Highway** – A highway with separated roadways for traffic in opposite directions.

**Divisional Island** – A longitudinal island to separate opposing traffic, to provide protection for left turn bays and to channel traffic into the proper approach paths at skewed intersections.

**Division Standard Details** – Division-specific drawings that are used on a repetitive basis within each FLH Division. These are issued by Division offices for routine use on projects within the Division, and may be used individually or to supplement applicable FLH Standard Drawings.

**Division Supplements** – Supplements to this manual detailing differences in practice among the Divisions. These are issued by Division offices for use within the Divisions and by their consultants, whenever applicable.

**Dormant Stage** – The period in plant life when seasonal growth ceases.

**Drainage Basin** – The area of land contributing surface runoff to a given location. Large basins are commonly referred to as watersheds.

**Driveways** – Minor roadway connections that fall into three categories:

- Private,
- Commercial, and
- Public.

- E -

**Ecology** – The branch of science concerned with the relationship of organisms and their environment.

**Elastic Limit** – The greatest stress that a material is capable of sustaining without any permanent deformation remaining upon complete release of the stress.

**Elasticity** – That property of a material that permits it to return approximately to its original dimensions upon the removal of an applied load.

**Electronic Distance Measuring Instrument (EDM)** – A device that transmits and receives a modulated microwave, infrared or visible light signal and, by measuring phase differences between modulations of transmitted and reflected or retransmitted signals, computes the distance between the instrument and the reflector or retransmitter.

**Elevation** – The vertical distance of a point above mean sea level or above another datum.

**Elongation** – The increase in gage length of a tension test specimen, usually expressed as a percentage of the original gage length.

**Embankment** – A raised earth structure on which the roadway pavement structure is placed.

**Embankment Foundation** – The material below the original ground surface, the physical characteristics of which affect the support of the embankment.

**Emergency Vehicle** – (1) A vehicle belonging to the armed forces, civil defense, police. (2) Any ambulance rescue unit vehicle. (3) Any designated vehicle used for answering emergency calls for assistance.

**Empirical** – Developed from experience or observations without regard to science and theory.

**Emulsified Asphalt** – A mixture of asphalt cement and water mixed with an emulsifying agent.

**Emulsified Asphalt Treated Base** – A base consisting of a mixture of mineral aggregate and emulsified asphalt spread on a prepared surface to support a surface course.

**Energy Dissipator** – A structure placed at a drainage outfall to dissipate the energy of flowing water in order to reduce scour and erosion of the receiving channel bed and/or banks.

**Environment** – The totality of man's surroundings (i.e., social, physical, natural, manmade).

**Environmental Design** – The location and design of a highway that includes consideration of the impact of the facility on the community or region based on aesthetic, ecological, cultural, sociological, economic, historical, conservation and other factors.

**Equivalent Single-Axle Load (EAL)** – The effect on pavement performance of any combination of axle loads of varying magnitude, equated to the number of reference single-axle loads required to produce an equivalent number of repetitions of an 18,000 lb [80 kN] single axle.

**Erosion** – The progressive removal of a surface by the action of wind or water.

**Estuary** – That portion of a river channel occupied at times or in part by both sea and river flow in appreciable quantities. The water usually has brackish characteristics.

**Excavation** – (1) The act of taking out material. (2) The materials taken out. (3) The cavity remaining after materials have been removed.

**Expressway** – A multilane, divided highway designed to move large volumes of traffic at high speeds under free-flow conditions. Expressways have full control of access with grade-separated interchanges.

**Expropriation** – Acquisition of property for highway purposes by the right of eminent domain.

- F -

**Federal Lands Highway Division** – A Federal Lands Highway field office, responsible for the administration of the Federal Lands Highway program within a predetermined geographic area. See [Exhibit 1.1-A](#).

- The Eastern Federal Lands Highway Division (EFLHD) office headquartered in Sterling, Virginia.
- The Central Federal Lands Highway Division (CFLHD) office headquartered in Lakewood, Colorado.

- The Western Federal Lands Highway Division (WFLHD) office headquartered in Vancouver, Washington.

**Flexible Base** – A base with low resistance to bending, enabling it to stay in contact with the underlying structure. This type of base distributes loads to the subbase. Examples are dense-graded aggregate bases and asphalt-treated bases.

**Flexible Pavement** – A pavement structure that maintains intimate contact with and distributes loads to the subgrade, and depends on aggregate intergranular particle friction and cohesion for stability.

**Flood** – (1) An overflow or inundation that comes from a river or other body of water and causes or threatens damage. (2) A relatively high streamflow overtopping the natural or artificial banks in any reach of a stream. (3) A relatively high flow as measured by either gage height or discharge quantity.

**Flood Frequency** – The average interval of time, based on the period of record, between floods equal to or greater than a specified discharge or height. Generally, this frequency is expressed in years.

**Flood Plain** – Normally dry land areas that are adjacent to a natural stream or watercourse and that are temporarily inundated during floods.

**Flow Line** – The lowest flow path through a designed channel, culvert, or other engineered conveyance structure.

**Footing** – Portion of the foundation of a structure that transmits loads directly to the soil or bedrock.

**Foreslope** – The slope from the edge of the surfaced shoulder to the top of the subgrade or the bottom of the ditch in cuts.

**Foundation** – Lower part of a structure that transmits loads directly to the soil or bedrock.

**Free Water** – Water that can move through the soil by force of gravity.

**Freeboard** – The vertical distance between the level of the water surface at design flow and a specified point (e.g., a bridge beam, levee top, location on a highway grade).

**Friable Soil** – A soil that can be easily broken and crushed by moderate finger pressure.

**Frontage Road** – A road contiguous to a controlled access highway, so designed as to (1) intercept, collect and distribute traffic desiring to cross, enter or leave the controlled access highway, and (2) furnish access to adjacent property.

**Functional Classification** – The grouping of individual roads in a road system according to their purpose and the type of traffic they serve.

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- G -

**Gaging Station** – A location on a stream where measurements of stage or discharge are customarily made.

**Geodetic Control** – Monument points of known horizontal and/or vertical position established by other agencies and published by NGS.

**Geographical Coordinates** – a spherical coordinate system for defining geographical locations using latitude, longitude, and an elevation relative to a reference ellipsoid, or a defined geoid surface, or a datum plane.

**Geometric Design** – The arrangement of the visible elements of a road (e.g., alignment, grades, sight distance, widths, slopes).

**Global Navigation Satellite System (GNSS)** – A system of navigation that uses a global network of satellites to provide autonomous geospatial positioning. The network of satellites includes the United States' GPS system, Russia's GLONASS, and will include China's BeiDou and Europe's Galileo.

**Global Positioning System (GPS)** – A system of satellites that are used with accurate receiving equipment to determine survey coordinates.

**Gradation** – A general term used to describe the composition of an aggregate, soil or other granular material. Gradation is usually expressed as the proportions (percents) of the aggregate that will pass each of several sieves of different sizes.

**Grade** – (1) The profile of the center of the roadway or its rate of ascent or descent. (2) To shape or reshape an earth road by means of cutting or filling. (3) To arrange according to size. (4) Elevation.

**Grade Contour** – The trace of a predetermined grade plotted on a topographic map or traced on the ground by an Abney Level Line. For example, if the contour interval is 5 ft [2 m] and the gradient five percent, the grade contour intersections with successive contours would be 100 ft [40 m] apart.

**Grade-Controlled Location** – A section of highway where the highway route is controlled by the maximum allowable gradient and the difference in elevation between termini.

**Grade Intersection** – An intersection where all roadways join or cross at the same level.

**Grade Separation** – A structure that provides for highway traffic to pass over or under another highway or the tracks of a railroad.

**Gradient** – The rate of rise or fall with respect to the horizontal distance.

**Grading** – (1) Construction of the earthwork portion of the highway; (2) planing or smoothing the surface of various parts of a roadbed.

**Gravel** – Aggregate composed of hard, durable stones or pebbles, crushed or uncrushed, often intermixed with sand.

**Ground Control** – An accurate ground survey of targets or other features visible in aerial photographs to ensure the accuracy of photogrammetric mapping.

**Ground Cover** – Herbaceous vegetation and low-growing woody plants that form an earth cover.

**Ground Water** – Free water contained in the zone below the water table. The source of water in wells, springs, etc.

**Grout** – Mortar, composed of sand, cement and water, of a consistency that it can be easily worked.

**Guardrail** – A protective cable or rail device placed along the roadway edge for the purpose of redirecting vehicles that have left the roadway at a point of hazard.

**Gunite** – A type of Portland cement mortar blown into place by compressed air. The materials are mixed while being forced through a nozzle.

**Gutter** – A paved and generally shallow waterway provided for carrying surface drainage.

#### - H -

**Hardpan** – A layer of extremely dense soil.

**Headwall** – A wall or structure constructed at the end of a culvert to prevent earth from spilling into the channel.

**Herbaceous** – Vegetation that is nonwoody.

**Hinge Point** – The point where the slope rate changes.

**Horizon (Soils)** – One of the layers (strata) of the soil profile, distinguished principally by its texture, color, structure and chemical contents.

**Horizontal Curve** – A circular or transitional curve by means of which a highway can change direction to the right or left.

**Hot Mix** – A general term used for hot plant mixed asphalt concrete mixtures manufactured and laid at temperatures ranging from 200°F to 320°F [95°C to 160°C].

**Humidity (Relative)** – The amount of moisture in the air compared with the amount that the air could hold if saturated at that temperature.

**Humus** – A brown or black material formed by the partial decomposition of vegetable or animal matter; the organic portion of soil.

**Hydrated Lime** – A dry powder obtained by treating quick-lime with enough water to satisfy its chemical affinity for water under the conditions of its hydration.

**Hydraulics** – The physical characteristics that describe the movement or flow of water, oil or other liquid, over, through, in, or around any surface.

**Hydrograph** – A graph showing stage, discharge, velocity or other property of surface water, with respect to time, for a given location.

**Hydrology** – (1) The science encompassing the behavior of water as it occurs in the atmosphere, on the surface of the ground and underground. (2) The scientific study of the properties, distribution and effects of water on the earth's surface, in the soil and underlying rocks and in the atmosphere.

- I -

**Igneous Rock** – Those rocks formed by the cooling and consolidation of complex silicious solutions (magma) newly risen from some deeper level.

**Impact Attenuator** – A device placed in front of a fixed roadside object to absorb and dissipate collision energy.

**Impervious** – Resistant to the penetration of a liquid or gas.

**Independent Alignments** – Each roadway of a divided highway is designed and located to take full advantage of the terrain. The median need not be of uniform width, and the two roadways need not be at the same level.

**Indigenous** – Produced, growing or living naturally in a particular region or environment.

**Infiltration** – The flow of a fluid into a substance through pores or small openings. It connotes flow into a substance in contradistinction to the word percolation, which connotes flow through a porous substance.

**Interchange** – A system of interconnecting roadways in conjunction with one or more grade separations, providing for the movement of traffic between two or more roadways on different levels.

**Internal Friction** – The resistance to sliding within the soil mass.

**Intersection** – The area common to two or more highways that come together at an angle.

**Intersection Angle** – The angle between two intersection legs.

**Inundate** – To cover or fill, as with a flood.

**Invert** – The lowest point of the internal cross section of a closed conduit or channel.

**- K -**

**Karst Topography** – Irregular topography characterized by sink holes, streamless valleys and streams that disappear into the underground, all developed by the action of surface and underground water in soluble rock (e.g., limestone).

**- L -**

**Landscaping** – Enhancing the natural features of the land through the design and use of vegetation and other materials.

**LandXML** – A data exchange format based on XML (extensive markup language) for horizontal construction data that provides support for surface, alignment, cross-section, pipe network, and point data types.

**Lane** – A portion of the traveled way providing for a single line of traffic in one direction.

**Left-Turn Lane** – A traffic lane within the normal surfaced width of a roadway, or an auxiliary lane adjacent to or within a median, reserved for left-turning vehicles at an intersection.

**Leveling Course** – The layer of material placed on an existing surface to eliminate irregularities prior to placing an overlaying course.

**Level of Detail (LOD)** – A measure of the extent to which the design intent is reflected in the 3D model. The LOD typically refers to the design features that are included in the 3D model, the types of 3D model entities that represent the features, and the density of data points along the features at which the intended location is accurately depicted.

**Lime** – A general term that includes the various chemical and physical forms of quicklime, hydrated lime and hydraulic lime used for any purpose.

**Lithology** – A geological term dealing with the physical properties of rocks and their structure.

**Loam** – A mixture of sand, silt or clay, or a combination of any of these with organic matter. It is sometimes called topsoil in contrast to the subsoils that contain little or no organic matter.

**Loess** – A uniform windblown deposit of silty material having an open structure and relatively high cohesion due to cementation of clay or calcareous material at grain contacts.

**- M -**

**Matting** – Material used as a surface protector in conjunction with seeding that protects the surface until vegetation becomes established.

**Median** – The portion of a divided highway separating the traveled ways for traffic in opposite directions.

**Median Barrier** – A longitudinal system used to prevent an errant vehicle from crossing the median of a divided highway.



**Median Lane** – A speed-change lane within the median to accommodate left-turning vehicles.

**Mineral Filler** – A fine inert mineral matter (e.g., limestone dust, portland cement) used in asphalt concrete mixtures.

**Minimum Turning Path** – The path of a designated point on a vehicle making its sharpest turn.

**Minimum Turning Radius** – The radius of the path of the outer front wheel of a vehicle making its sharpest turn.

**Modulus of Elasticity** – The ratio of stress to strain for a material under given loading conditions.

**Modulus of Rupture** – A measure of the strength of concrete when it is broken by bending.

**Moisture Content** – The percentage, by mass, of water contained in soil or other material, usually based on the dry mass.

**Monument or Reference Point** – A permanent or semi-permanent reference point set during the survey or construction of a highway so that the survey can be reestablished later.

**Mortar** – A mixture of cement, sand, lime/fly ash and water.

**Muck** – An organic soil of very soft consistency.

**Mudflow** – A well-mixed mass of water and alluvium that, because of its high viscosity and low fluidity as compared with water, moves at a much slower rate, usually piling up and spreading over the fan like a sheet of wet mortar or concrete.

**Mulch** – Material placed on exposed earth to provide more desirable moisture and temperature relationships for plant growth. It is also used to control the occurrence of unwanted vegetation.

- N -

**National Geodetic Vertical Datum of 1929** – The average of the heights of the surface of the sea at all stages of the tides.

**Noise Barrier** – A barrier of earth, stone, concrete or wood placed adjacent to the highway to reduce the noise level on abutting property.

**Noise Level** – The sound level obtained through the use of A-weighting according to ANSI Standard 1.4. The unit of measure is the decibel (dB), commonly referred to as DBA when A-weighting is used.

**- O -**

**Office of Federal Lands Highway (FLHO)** – A FHWA headquarters office located in Washington, DC with the responsibility for the direct Federal program that is administered through division field offices.

**Open-Graded Aggregate** – A graded aggregate, containing little or no fines, with a high percentage of aggregate voids.

**Operating Speed** – The speed at which drivers are observed traveling in fair weather during off-peak, free-flow conditions.

**Optimum** – The best quantity, number or condition.

**Overburden** – The mass of soil that overlies a source of rock, gravel or other road material. This material is removed before the materials are quarried to avoid contamination.

**Overlaying Course (Overlay)** – An asphalt surface course, either plant mixed or road mixed.

**Overlook (Scenic Overlook)** – A roadside area provided for motorists to stop their vehicles primarily for viewing the scenery.

**Overpass** – A grade separation where the highway passes over an intersecting highway or railroad.

**- P -**

**Parcel** – A tract of private or public land of variable size required for the right-of-way for a highway.

**Passing Opportunity** – A section of two-lane highway where the clear passing sight distance allows a safe passing maneuver to be performed.

**Passing Sight Distance** – Minimum sight distance on two-lane highways sufficient to enable the driver of one vehicle to pass another safely and comfortably, without interfering with the speed of an oncoming vehicle traveling at the design speed should it come into view after the overtaking maneuver is started.

**Pavement Structure** – The combination of subbase, base course and surface course placed on a subgrade to support the traffic load and distribute it to the roadbed.

**Peat** – A fibrous mass of organic matter in various stages of decomposition.

**Pedestrian Crossing (Crosswalk)** – An area reserved and clearly marked for the passage of pedestrians at street junctions or other locations where drivers must yield the right-of-way by stopping to enable pedestrians to cross safely.

**Pedestrian Overpass (Underpass)** – A facility for pedestrian crossings justified by the following:

- Pedestrian crossing volumes,
- Type of highway to be crossed, and
- Location of adjacent crossing facilities and predominating type and age of persons who will utilize the facility.

**Perception Reaction Time** – The time required by a driver to perceive and react that a speed change or stop is necessary.

**Permeability** – The properties of a soil that permit the passage of any fluid and depend on grain size, void ratio, shape and arrangement of pores.

**Pervious** – A layer of material, through which water will move under ordinary hydrostatic pressure.

**pH** – A scale of numbers from 0 to 14 that indicate the acidity or alkalinity of a solution. Numbers below seven indicate acidity and numbers above seven indicate alkalinity.

**Phase** – A part of a signal cycle during which a specific traffic movement (and concurrent nonconflicting movements) receives the right-of-way. It includes the change and clearance intervals associated with those movements.

**Photoelectric Device** – Where detection is accomplished by the vehicle passing between a source of light and a photocell that is capable of distinguishing between light and lack of light.

**Photogrammetry** – The science and art of obtaining reliable measurements by use of photographs. It produces dimensional data for mapping, cadastral purposes, design and computation of quantities.

**Physiographic Region** – A geographic area whose patterns of landforms differ significantly from that of adjacent regions.

**Pigment** – Any substance used to impart color; specifically, an insoluble, dry coloring matter that, when mixed with a suitable medium, forms a paint.

**Plane Coordinate System** – A cartographic projection that, by accepting small variations of scale, permits describing the position of points on the surface of the earth by their plane coordinates on a cylindrical or conical surface.

**Planimetric Map** – A map that presents horizontal but not vertical data for the features represented. Drainages, coastlines, cover and culture are usually shown.

**Planimetrics** – All features both manmade and natural of significant value to the design of a proposed highway.

**Plans (Drawings)** – The approved plans (drawings), profiles, typical cross sections, working drawings and supplemental drawings, or exact reproductions thereof that show the location, character, dimensions and details of the work.

**Pollution** – Contamination of any component of the total environment by harmful substances, sounds, smells or sights degrading or injurious to humans and other living organisms.

**Pool** – A small and rather deep body of quiescent water (e.g., as a pool in a stream).

**Porous** – Having many small openings, through which liquids may pass.

**Portable Traffic Control Signal** – A signal that is designed to be moved as a unit to the site and be operated for a limited time. (It normally consists of the necessary signal faces on poles attached to moveable bases, a control unit, the necessary electrical cables and a power supply).

**Portland Cement** – Hydraulic cement consisting of compounds of silica, lime and alumina; so called from its resemblance in color, when set, to the Portland stone of England.

**Precision** – The variance of repeated measurements of a characteristic from their average.

**Prestressed Concrete (Pretensioned)** – Reinforced concrete in which base, wires or cables are held in a stretched condition during placing of the plastic concrete until the concrete has hardened. Then as the tension on the reinforcing steel is released, it compresses the concrete.

**Prestressed Concrete (Post-tensioned)** – Reinforced concrete in which the prestressing wires or tendons are placed in tubes before the concrete is cast. After the concrete has hardened, the wires or tendons are stretched to a predetermined tension by jacking and are wedged in this position. The tubes may also be pressure-grouted.

**Prime Coat** – An asphalt material applied to an absorbent surface, preparatory to any subsequent treatment, for the purpose of hardening or toughening the surface and promoting adhesion between it and the superimposed construction.

**Profile** – A longitudinal section of a highway, drainage course, etc.

**Profile Grade** – The trace of a vertical plane intersecting a particular surface of the proposed road construction located as shown on the plans; usually along the longitudinal centerline of the roadway at the top of finished pavement. Profile grade means either elevation or gradient of such trace according to the context.

- R -

**Radial Survey** – A method of ground surveying in which the instrument is placed on a point of known horizontal and vertical position and all required features are located by direction, distance and elevation difference from the instrument point.

**Railroad Grade Crossing** – The intersection of a highway and a railroad at the same elevation.

**Reaction Time** – The time required for a driver to apply foot pressure to the brake after perception that a stop must be made.

**Reclamation** – The restoration of borrow and aggregate pits to a natural form that may include replacement of topsoil and vegetation (seeding).

**Recurrence Interval (Return Period)** – The average interval of time within which the given flood will be equaled or exceeded once.

**Refuge Island** – (1) An island in a wide intersection to provide refuge for pedestrians. (2) A place for transit passengers to load and unload from a bus.

**Regional Factor** – A numerical factor expressed as a summation of the values assigned for precipitation, elevation and drainage. This factor is used to adjust the structural number.

**Reinforced Concrete** – Concrete where steel reinforcement is embedded so that the steel and concrete act together in resisting stress.

**Residential Area** – That portion of a municipality or an area within the influence of a municipality in which the dominant land use is residential development, but where small business areas may be included.

**Rest Area** – A roadside area with parking facilities separated from the roadway providing motorists with opportunities to stop and rest for short periods.

**Resurfacing** – The placing of one or more new courses on an existing surface.

**Reverse Curve** – A curve consisting of two arcs of the same or different radii curving in opposite directions and having a common tangent or transition curve at their point of junction.

**Right-of-Way (R/W)** – (1) Land generally publicly owned, acquired for and devoted to transportation purposes. (2) The privilege of the immediate use of the highway. The right of one vehicle or pedestrian to proceed in a lawful manner in preference to another vehicle or pedestrian.

**Right-Turn Lane** – An auxiliary lane or designated lane provided at grade intersections for right-turn movements.

**Riparian** – Pertaining to the banks of a stream.

**Ripple** – (1) The light fretting or ruffling of the water surface caused by a freeze. (2) Undulating ridges and furrows or crests and troughs formed by action of the flow.

**Riprap** – A protective covering of graded stones, with or without mortar, to prevent erosion.

**Road (Highway)** – A general term denoting a public way for purposes of vehicular travel including the entire area within the right-of-way.

**Road Approaches** – Rural and suburban minor connections to a highway or frontage road from adjoining properties. These approaches can be private, public or commercial.

**Roadbed** – The graded portion of a road or highway (usually considered as the area between the intersection of top and side slopes) upon which the base course, surface course, shoulders and medians are constructed; the top of the subgrade.

**Road Mix** – A method of combining surfacing materials (e.g., mineral aggregate combined with liquid asphalt) in which the materials are mixed on the road using discs, harrows, blades or other approved means.

**Roadside** – That portion of the right-of-way outside the roadway.

**Roadside Barrier** – A longitudinal system used to shield vehicles from hazards on the roadside.

**Roadside Development (Roadside Enhancement)** – Treatment of the roadside to (1) conserve, enhance and effectively display the natural beauty of the landscape through which the highway passes; (2) provide safety, utility, economy and highway-related recreation facilities by means of proper location, design, construction and maintenance of highways.

**Roadside Hazards** – The following are all potential roadside hazards for out-of-control vehicles:

- Embankments;
- Ditches and rock cut slopes;
- Side road intersections; and
- Narrow medians.
- Fixed objects (e.g., trees, boulders, drainage structures, signs, bridge parapets, barrier ends, poles);

**Roadway** – The portion of a highway, including shoulders, for vehicular use. (A divided highway has two or more roadways.)

**Roadway Prism** – The volume typically defined by the end areas between the original terrain cross-sections and the design subgrade cross-sections, for successive sections that are averaged and multiplied by the horizontal distance along the centerline of the roadway between the sections.

**Rounding** – The removal of the angle where cut and fill slopes intersect the natural ground, and the substitution of a gradual transition or rounded surface.

**Rumble Strip** – A rough textured surface, constructed for the purpose of causing the tires of a motor vehicle driven over it to vibrate audibly as a warning to the drivers.

**Runoff** – That part of the precipitation that appears in surface streams. It is the same as stream flow unaffected by artificial diversions, storage or other works of man in or on the stream channels.

**Running Speed** – The speed over a specified section of highway, equal to the length of the highway section divided by the running time, or the time that a vehicle is in motion to travel through the section.

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- S -

**Sag Vertical Curve** – A vertical curve having a concave shape in profile.

**Scale** – The ratio of the size of the image or representation of an object on a map or photograph to its true size. Scale may be expressed as a representative fraction (1/10,000) or ratio (1:10,000) or as the number of units on the ground represented by the same type of units on the map or photograph (1 in to 100 ft [1 m to 1000 m] or 1:1200 [1:1000]).

**Scour** – The result of erosive action of running water primarily in streams, excavating and carrying away material from the bed and banks.

**Screening** – The use of trees, shrubs, fences or other materials to obscure an objectionable view or to reduce an objectionable sound.

**Seal Coat** – An asphalt coating, sometimes with cover aggregate, applied to the surface of a pavement for the purpose of waterproofing and preserving the surface, altering the surface texture of the pavement or providing resistance to traffic abrasion.

**Sediment** – Fragmentary material that originates from weathering of rocks and is transported by, suspended in, or deposited by water.

**Sedimentation** – The action or process of depositing particles of waterborne or windborne soil, rock or other materials.

**Sediment Discharge** – The rate at which dry mass of sediment passes a section of a stream or is the quantity of sediment, as measured by dry mass or by volume that is discharged in a given time.

**Seismic Wave** – A gravity wave caused by an earthquake.

**Service Road** – A road, generally unimproved, used to transport personnel, materials or equipment for the operation or maintenance of utilities located on a highway right-of-way.

**Serviceability** – A concept where pavements are judged on their ability to serve traffic. Longitudinal smoothness is a primary factor in this judgment.

**Shoaling** – Deposition of alluvial material resulting in areas with relatively shallow depth.

**Shoulder** – The portion of the roadway contiguous to the traveled way for accommodation of stopped vehicles, for emergency use, and for lateral support of base and surface courses.

**Shrub** – A small, woody multi-stemmed plant.

**Side Slopes** – Slopes along the side of the roadway identified by their distance from the traveled way, their slope rate and their height.

**Sidewalk** – That portion of a street or highway between the curb line or edge of the roadway, and the adjacent right-of-way line constructed specifically for pedestrians.

**Sight Distance** – The length of roadway ahead, visible to the driver.

**Signal System** – A system of visual signals used to control the movement of traffic, usually on city streets.

**Silt** – Material passing a 3-in [75-mm] sieve that is non-plastic or very slightly plastic, and exhibits little or no strength when air dried.

**Site Map** – A large-scale map of a specific small area (e.g., bridge site).

**Skew** – Oblique, not at right angles.

**Skew Angle** – The complement of the acute angle between two centerlines that cross.

**Sliver Fill** – A thin embankment slope that is roughly parallel to the natural slope of the hillside. Sliver fills that are very high in proportion to their thickness, are difficult to compact and should be avoided.

**Slope** – Any ground whose surface creates an angle with the plane of the horizon.

**Slope Rate** – The steepness of the slope - usually the ratio of the vertical change divided by the horizontal distance.

**Slump** – The measure of the consistency of portland cement concrete by consolidating in a slump cone, removing the cone and allowing the concrete to settle under its own mass.

**Soil** – Sediments or other unconsolidated accumulation of solid particles produced by the natural physical and chemical disintegration of rocks, and which may or may not contain organic matter.

**Soil Classification** – The arrangement of soils into classes according to their physical properties.

**Soil Stabilization** – Measures taken to eliminate or minimize the erosion of soil or to improve its supporting capacity.

**Spalling** – Chipping along the edges, as at joints in concrete pavement and structures.

**Special Details** – Project-specific special drawings included in the plans to describe items of the work, consistent with the FP-XX. Special Details can be used individually, or to supplement applicable FLH Standard Drawings, or Division Standard Details, or both.

**Specifications** – The compilation of provisions and requirements for the performance of the prescribed work.

- Standard Specifications. The book of Standard specifications for construction of roads and bridges on Federal Highway projects issued periodically and designated as [FP-XX](#) (e.g., FP-03, or simply FP).



- **FLH Supplemental Specifications.** Additions and revisions to the *Standard Specifications* that have been approved by the Federal Lands Highway Office (FLHO) for use on all FLH projects, or all FLH projects with a particular item or character of work. FLH Supplemental Specifications normally consist of the same standard language in all the Divisions' Libraries of Specifications.
- **Division Supplemental Specifications.** Additions and revisions to the Standard or FLH Supplemental Specifications that have been approved by a Division. Division Supplemental Specifications consist of standard language that is not to be revised without approval.
- **Library of Supplemental Specifications (LOSS).** The compilation of all FLH Supplemental Specifications and Division Supplemental Specifications. Each Division maintains its own LOSS.
- **Unique Project Specifications.** Additions and revisions to the Standard Specifications or Library of Specifications that are developed and used on an individual project basis. Unique Project Specifications are normally written by the project designer to address a unique requirement for a single project.
- **Special Contract Requirements (SCRs).** All additions and revisions to the *Standard Specifications* and Supplemental Specifications used on an individual project. The SCRs are included in the contract for a project and include all FLH Supplemental Specifications, Division Supplemental Specifications, and Unique Project Specifications applicable to that project.

**Spillway** – A surface apron or trough for conducting water down a relatively steep slope.

**Stabilization** – Modification of soils or aggregates by incorporating materials that will increase load-bearing capacity, firmness and resistance to weathering or displacement.

**Stage** – The height of a water surface above an established datum plane; also gage height.

**Stage Construction** – The construction of a highway by stages or increments.

**Standard Drawings** – Drawings issued by the Federal Lands Highway Office and approved for repetitive use.

**State Plane Coordinates** – A system of plane rectangular coordinate zones, which are defined individually for each state or zone within a state. Within each state plane zone a cartesian (x,y) coordinate system describes geographic locations at a datum plane.

**Station** – (1) A measure of distance used for highways and railroads. A Metric station is equal to 1000 m. A US Customary station is equal to 100 ft. (2) A precise location along a survey line.

**Stereoplotter** – A photogrammetric instrument (often simply called a plotter) used for measuring and mapping from aerial photographs. The instrument provides analogical solutions for object point positions from their corresponding image positions on overlapping pairs of photographs. The primary use of stereoplotters is in the compilation of topographic maps and digital terrain models.

**Stockpass** – A culvert of a size large enough for the passage of domestic and wild animals.

**Stone** – Rock material produced from a quarry (i.e., nongravel material).

**Stop Line** – A white line placed transversely on the pavement (at an intersection) to indicate where the vehicle must stop when obeying a traffic signal or stop sign.

**Stopping Sight Distance** – The distance required by a driver of a vehicle, traveling at a given speed, to bring the vehicle to a stop after an object on the roadway becomes visible. It includes the distance traveled during the perception and reaction times, as well as the vehicle braking distance.

**Storm Drain** – A system of catch basins and underground conduits for collecting, concentrating and conveying water to a disposal point.

**Stratigraphy** – The study of rock strata, generally by analyzing rock outcrops or drill cores.

**Stress-Strain Diagram** – A diagram where corresponding values of the stress and strain are plotted.

**Subbase** – The layer or layers of specified or selected material of designed thickness placed on a subgrade to support a base course.

**Subgrade** – The top surface of a roadbed upon which the pavement structure and shoulders are constructed.

**Superelevation** – The elevation of the outside edge of a curve to partially offset the centripetal force generated when a vehicle rounds the curve.

**Superelevation Runoff** – The transition distance between a section with level cross slope on half, or the entire, roadway and the fully superelevated roadway.

**Surface Course** – One or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion and the disintegrating effects of climate. The top layer is sometimes called wearing course.

**Surface Treatment** – An application of asphalt material and cover aggregate.

**Sustained Grade** – A continuous highway grade of appreciable length and consistent or nearly consistent gradient.

- T -

**Tack Coat** – An application of asphalt material to an existing surface to provide bond with a superimposed course.

**Target (Aerial)** – A contrasting symmetrical pattern centered around a point on the ground to facilitate locating and measuring to the image of the point in a photograph.

- Terrain** – The topographic and physical features of a tract of land, geographic area or territory.
- Toe of Slope** – The intersection of a roadway embankment side slope with the original ground surface.
- Topographic Map** – A planimetric map with an added expression of topography, usually contours.
- Topographic Survey** – A survey conducted to determine the configuration of the ground.
- Topsoil** – A surface soil that is predominately a loose, friable, free draining sandy loam, which is free of subsoil, refuse, stumps, roots and rocks larger than 2 in [50 mm] in diameter, but containing some organic matter.
- Total Station** – A vertical and horizontal angle-measuring theodolite with an electronic distance measuring instrument attached to or integral with the theodolite's telescope. The theodolite generally has the ability to convert angular measurements into a digital form. Such theodolites display the slope and horizontal distance as well as the elevation difference between the instrument point and a remote point. Some models are able to retain horizontal coordinates. Often a data-recording device is offered as optional equipment.
- Traffic Actuated Signal** – A type of traffic control signal in which the length of most intervals and the cycle and, in some types the sequence of phasing, are varied by the demands of traffic.
- Traffic Barriers** – Roadside barriers, median barriers, crash cushions and bridge parapets intended to guide or protect traffic from roadside hazards, including collision with other vehicles.
- Traffic Control Devices** – Signs, signals, markings and devices placed or erected for the purpose of regulating, warning or guiding traffic.
- Traffic Island** – An island provided in the roadway to separate or direct streams of traffic; includes both divisional and channelizing islands.
- Traffic Lane** – That portion of the traveled way for the movement of a single line of vehicles.
- Traffic Markings** – A traffic control device consisting of lines, patterns, words, symbols or colors on the pavement.
- Traffic Noise Impacts** – Impacts that occur when the predicted traffic noise levels approach or exceed the design noise levels, or when the predicted traffic noise levels substantially exceed the existing noise levels.
- Traffic Volume** – The number of vehicles passing a given point during a specific period of time.
- Transition** – A section of variable pavement width required when changing from one width of traveled way to a greater or lesser width; or a section of variable cross slope such as from normal crown to full superelevation.

**Transition Curve (Spiral)** – A curve of variable radius intended to effect a smooth transition from tangent to curved alignment.

**Transverse** – At right angle to the longitudinal direction.

**Traveled Way** – The portion of the roadway for the movement of vehicles, exclusive of shoulders.

**Traverse** – In surveying, a series of interconnected straight lines. The lengths of the lines and the angles of deviation between them are measured as the traverse develops.

**Triaxial Shear Test** – A test in which a cylindrical specimen of soil, encased in an impervious membrane, is subject to a confining pressure and then loaded axially to failure.

**Trigonometric Leveling** – Determining elevation difference by measuring the slope distance, vertical angle and difference in instrument heights between two points.

**Turning Track Width** – The radial distance between the turning paths of the outside of the outer front tire and the outside of the rear tire that is nearest the center of the turn.

- U -

**Underdrain** – Porous or perforated pipe or graded aggregate installed under a roadway or shoulder to provide subsurface drainage.

**Underpass** – A grade separation where the highway passes under an intersecting highway or railroad.

- V -

**Vertical Curve** – A parabolic curve on the longitudinal profile of a road to provide for change of gradient.

**Vista** – A distant view seen from a highway. A moving vista is a view observed from a moving vehicle. A stationary vista is a view seen from a fixed place (e.g., rest area, scenic overlook).

- W -

**Water-Cement Ratio** – The ratio of the mass of water, exclusive only of that absorbed by the aggregates, to the mass of cement in a concrete or mortar mixture.

**Water Table** – The top of the zone of permanent soil saturation. The water table may rise or fall seasonally, or it may be drawn down by removal of water.

**Weathering** – The decomposition of rock, shale, etc., resulting from any chemical or mechanical process caused by exposure to weather.

**Weephole** – A hole through an abutment or retaining wall to relieve hydrostatic pressure.

**Working Drawings** – Stress sheets, shop drawings, erection plans, falsework plans, framework plans, cofferdam plans, bending diagrams for reinforcing steel or any other supplementary plans or similar data.