VDOT POST-AWARD SCHEDULING GUIDE

(DRAFT RELEASE 3 – October 5, 2012)

GUIDELINES FOR ESTABLISHING & MAINTAINING

SCHEDULE CONTROL ON PROJECTS

DURING THE CONSTRUCTION PHASE

CONSTRUCTION DIVISION

(SCHEDULING & CONTRACTS)

TABLE OF CONTENTS

SECTION I

VDOT POST-AWARD SCHEDULING

1. Introduction
2. VDOT Post-Award Scheduling
3. Why is Scheduling Relevant
4. Project Management Objectives
5. Project Categories

SECTION I

1. INTRODUCTION

The VDOT Post-Award Scheduling Guide is a reference document that is intended to complement the VDOT Progress Schedule specifications to expound on the general requirements contained in the specifications. The scheduling guide is also intended to serve as the VDOT Recommended Practice for project scheduling during the construction phase. It is aimed at establishing good and consistent planning and scheduling practices to ensure that proper scheduling methods are used in preparing and maintaining schedules. And that the schedules are used effectively to establish and maintain schedule control on projects during the construction phase. The guide also provides basic scheduling knowledge and concepts on project scheduling; as well as general guidelines on planning the Work and developing and maintaining a project schedule.

The VDOT Post-Award Scheduling Guide is broken down into the following sections:

- Section I: VDOT Post-Award Scheduling Process – Describes the VDOT Post-award Scheduling process and provides background information pertinent to post-award project scheduling.
- Section II: Concepts on Fundamentals on Project Scheduling – Provides basic scheduling knowledge and concepts on project scheduling.
- Section III: Planning and Scheduling – Provides general concepts on planning the Work and developing and maintaining a project schedule.
- Section IV: Progress Schedules – Provides detailed requirements and guidelines to expound on the general requirements provided in the Progress Schedule specifications.
- Section V: Schedule Management and Control – Provides guidelines on the VDOT scheduling process for managing contractor provided schedules and using the schedules to establish and maintain schedule control on the project.
- Section VI: Changes, Delays, Time Extensions, and Compensation – Provides guidelines on managing time-related changes, performing a Schedule Impact Analysis (SIA), and dealing with delay issues concerning time extensions and additional compensations for delay damages.

2. VDOT POST-AWARD SCHEDULING PROCESS

The VDOT post-award scheduling process is an iterative process that involves three major steps as depicted in Figure 1-1 below. The process involves developing a baseline schedule to establish schedule control at the beginning of the project. Once the project is underway, the schedule is updated and used to monitor the project and assess current status of the project on a monthly basis. And when changes occur that impacts the schedule significantly, the schedule is then revised accordingly to ensure that the schedule continues to accurately reflect the current status of the project and the current plan to complete the Work. The process begins as soon as the Contractor is notified of intent to award and continues until the project is completed.

Figure 1-1: The VDOT Post-award Scheduling Process

A. Establish Schedule Control – Prior to commencing the Work a baseline schedule is prepared by the Contractor to communicate his/her intentions and initial work plan to accomplish the Work. The baseline schedule is then submitted to the Department for review and acceptance to establish an "agreed to plan" on how the Work will be accomplished and when the individual activities that make the project will be completed. Once the schedule is agreed upon by the Contractor and Department, the schedule then becomes the Schedule of Record (SOR). The SOR serves as the one and only schedule, with which all work required to complete the project will be planned, scheduled, and controlled. The process of establishing schedule control involves the following primary steps:

i) The Department and Contractor should hold a joint scheduling conference prior to beginning the Work to discuss the overall plan to accomplish the Work; any start-up issues that will impact the schedule; any project-specific information needed to facilitate preparation of the baseline schedule; and the detailed short-term schedule for work planned during the initial start-up period, if required.

ii) Contractor prepares and submits a Baseline Progress Schedule, as required.

iii) The Department reviews the Baseline Progress Schedule submission for *completeness, conformance, and reasonableness*. Upon acceptance by the Engineer, the baseline schedule becomes the SOR.

iv) The SOR is then communicated to all involved parties to establish the SOR as the only schedule, with which all work will be planned and scheduled, and against which progress will be measured.

B. Monitor and Assess Progress – Once the work is underway, the Progress Schedule is updated regularly to provide current status of the activities and the project. The Progress Schedule is also routinely maintained to ensure that the schedule accurately reflects the current plan to

accomplish the Work. The process of monitoring and assessing progress involves the following primary steps:

i) Progress information is gathered for each activity or event as it occurs.

ii) Contractor prepares and submits a monthly schedule update, if required.

iii) The Department reviews the updated schedule submittal for accuracy, conformance, and reasonableness; as well as to determine if the schedule reflects reality or if changes are needed. If changes are needed, determine if the changes are minor or major. Determine whether or not the Contractor should make modifications to the schedule and resubmit or if the modifications should be made for the next submission.

iv) Determine if progress is satisfactory or if corrective actions are needed.

v) Conduct monthly progress meeting to discuss progress of the Work and plan for completing the remaining work.

vi) Upon acceptance by the Engineer, communicate the updated schedule to all involved parties to establish the updated schedule as the current plan, with which all remaining work will be planned and scheduled. The currently updated schedule also provides contemporaneous information with which subsequent time-related issues will be evaluated.

C. Maintaining Schedule Control – When changes occur or the Contractor proposes major changes that significantly impact the schedule or the Department determines that major changes are required or the schedule has deviated significantly from the SOR, then the schedule is revised accordingly, to establish the accepted revised schedule as the new SOR. This process is also known as re-baselining, which provides a new baseline schedule, at that point in time, to complete the remaining work. This process re-establishes schedule control and involves the following primary steps:

i) Contractor prepares and submits a Revised Progress Schedule, as necessary or as required;

ii) The Department reviews the Revised Progress Schedule submittal for accuracy, reasonableness, and conformance;

iii) Upon acceptance by the Engineer, communicate the Revised Progress Schedule to all involved parties to establish the Revised Progress Schedule as the current SOR, with which all remaining work will be planned and scheduled, and progress will be measured against.

3. WHY IS SCHEDULING RELEVANT

A schedule is a project management and communication tool that allows all parties involved to know when their work must be performed to ensure that the project is completed successfully. Planning and scheduling is a forward-looking process necessary to ensure that the Work can be completed within the time, resources, and budgetary constraints. Furthermore, scheduling is relevant for the following reasons:

A. Relevance of Scheduling to the Contractor – Scheduling is relevant to the Contractor because it:

i) Promotes a detailed and forward thinking approach that allows the Contractor to determine the most feasible, safe, and cost effective work plan to complete the project.

ii) Establishes the overall sequence and when all work must be accomplished. A schedule can be used to coordinate the Work and to communicate to all involved parties who is doing what, where, and when, including:

a) When the Department must provide access to the Work area;

b) When suppliers must prepare submittals and fabricate/deliver materials;

c) When the Department must perform its work including reviews, mobilization of construction and inspection personnel, and any preparatory work;

d) When utilities or other third party must perform their work;

e) When sub-contractors must mobilize and when their work must be completed.

iii) Provides a means to estimate the amount of time needed to perform a task and to predict when the task can and must be completed.

iv) Provides a means to maximize production through efficient utilization of available resources throughout the project. Plan for efficient and continuous work flow to avoid delays and periods of inactivity, improve productivity, and increase profits.

v) Provides a means to plan and manage resources for the project and the company as a whole by balancing available resources with need.

vi) Provides a means to plan for and manage potential time-related risks on the project.

vii) Provides a forward-looking tool to make timely informed decisions to avoid or mitigate delays when unforeseen time-related changes or delay events occur.

viii) Provides a means to identify/quantify schedule impacts due to changes in the Work or conditions or delays on the project, including delays caused by others.

ix) Provides a means to monitor and assess progress of the Work to determine whether the project is ahead, on time, or behind.

x) Provides a means to plan for efficient use of time and other valuable resources. *Time is money.*

B. Relevance of Scheduling to the Department – Scheduling is relevant to Department for much of the same reasons scheduling is relevant to the Contractors. Moreover, the Department require schedules to:

i) Ensure that the Contractor has a reasonable plan to execute the Work in accordance with the requirements of the Contract.

ii) Ensure that the Contractor coordinates its work with the work by other involved parties, including sub-contractors, utilities, and the Department.

iii) Provide a time-based frame-work with which to plan and balance the Department's available resources and expenditures with current and projected needs for the project and the program as a whole.

iv) Identify when and where to concentrate the Department's forces to facilitate construction.

v) Monitor progress of the Work and identify deviations from scheduled performance to determine if and when corrective actions are necessary.

vi) Provide a means to evaluate the status of milestones, incentives, disincentives, A plus B, or other contract requirements.

vii) Identify and address potential schedule-related project risks before they become problems.

viii) Evaluate the effects of time-related changes to Work or conditions or delay events to make timely and informed decisions on how to proceed.

ix) Resolve time-related the issues in a fair and timely manner.

x) Ensure that the project is completed on-time.

4. PROJECT MANAGEMENT OBJECTIVES

Project management can be defined as a process of managing all aspects of a project to ensure successful completion of the project within the project constraints. Scope, time, and cost are often viewed as the primary project constraints and objectives that must be met to ensure success of a project. However, scope, time, and cost are not the only project management objectives that must be met to ensure that a project is completed successfully.

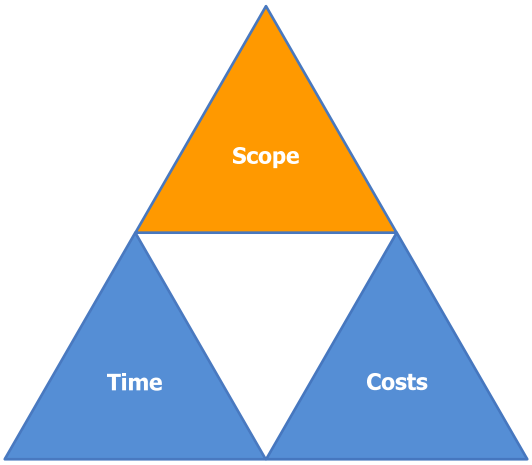


Figure 1-2: Project Triple Constraints

Success of a construction project depends heavily on properly managing all aspects of a project including, scope, time, resource, cost, safety, quality, and risk. When planning and scheduling a project, it is of utmost importance that the work plan and schedule balances the triple constraints of scope, time, and cost. It is also important that the resources needed to perform the Work, safety of the workers and the traveling public, and quality of the Work are considered. The following are various project management objectives that must be met when planning and scheduling a project:

A. Scope – Scope is the overall objective of the project. The Scope of Work should be managed very carefully to ensure that the project's objectives are met and deviations or changes are monitored and controlled. When preparing a work plan, schedule, or cost estimate, it is essential that the Scope of Work is clearly understood to ensure that the plan and cost consider the entire scope. And as scope changes, any impact to the work plan, schedule, or costs should be properly documented and evaluated at the time of the change to allow the project manager and the Department to make timely and informed decisions on how to proceed. The inability or failure to properly manage scope may result in unanticipated schedule delays and possible cost overruns.

B. Time – Time is a primary objective of the project that involves completion of the project within a time constraint. When planning the Work it is essential that the work plan takes into account the amount of time and logical sequence of all time consuming tasks required to accomplish the entire Scope of Work. It is also of utmost importance that the schedule is founded on the most feasible work plan that considers all known and foreseeable project constraints. The inability or failure to properly plan or manage time may result in schedule delays, quality and safety issues, and possible cost overruns.

Figure 1-3: Project Management Objectives

C. Cost – Cost is a primary objective of the project that involves completion of the project within an established budgetary constraint. When the work plan does not consider cost, the project may experience unnecessary unanticipated cost overruns that may result from lack of proper planning. On the contrary, when cost is a driving factor on a project, more emphasis is placed on reducing project costs. Therefore, time, quality, or safety is often compromised in the interest of reducing cost, which typically results in schedule delays or possible quality or safety issues on the project.

D. Resource – Resource planning is a primary objective of the project that involves planning and scheduling of available resources to maximize their use in successfully accomplishing the Work. A work plan that is based on an optimal resource usage plan, which balances available resources with project needs, provides the schedule with a structured frame-work with which to establish the necessary network logic to ensure that the resources are available when the work is planned. This approach is necessary to avoid under utilization of available resources or possible schedule delays due to unavailability of resources. When time is of the essence on a project, the primary objective is to get the job done as quickly as possible. Therefore, at the expense of meeting the time constraint, more resources are applied or more resource hours are expended, which typically results in loss productivity and possible cost overruns.

E. Quality – Quality involves completion of the project in accordance with the standards and requirements of the contract plans and specifications. Planning and scheduling allows for adequate time to plan for and perform the work to ensure that the required standards are met and to avoid rework. When time or cost becomes the driving factor on a project, the primary objective is to get the job done as quickly or less costly as possible; therefore, less attention is

given to quality of the work. Proper planning and scheduling is necessary to reduce the potential for rework and to ensure that there are no conflicts with overlapping activities that may compromise quality of the work.

F. Safety – Safety is a very important aspect of a project that must also be considered when planning and scheduling the Work. When planning and scheduling a project safety of the workers and the traveling public must be considered. Potential safety hazards or scheduling conflicts that may result from different trades working on concurrent activities within a limited space must be identified and corrected. When time or cost becomes the driving factor on a project, the primary objective is to get the job done as quickly or less costly as possible; therefore, less attention is given to safety, which may result in safety issues, fatality, schedule delays, and/or possible cost overruns.

G. Risk – Risk management is a primary objective of the project that involves a process of identifying, developing mitigation strategies, and addressing potential issues in a timely manner before they become problems. Planning and scheduling provide the forward thinking approach in which the project schedule can be used to identify potential issues that may result in schedule delays, cost overruns, safety, or quality problems. By identifying these issues early, mitigation strategies can then be developed to mitigate or avoid such issues. A proactive rather than a reactive approach to managing risks is a less costly alternative in managing risks simply because it typically allows for adequate time and opportunity to mitigate or avoid project risks.

5. PROJECT CATEGORIES

Projects undertaken by VDOT vary in size, complexity, and risk; therefore, a one-size fits all approach to project management is unsuitable. Hence, a project ranking system has been defined to group projects by category based primarily on level of complexity and risk. The categorization of projects allows for a statewide consistent approach to scheduling and to ensure that the appropriate scheduling provision is applied. This is necessary to ensure that the appropriate level of scheduling efforts needed to establish and maintain schedule control on the project is applied.

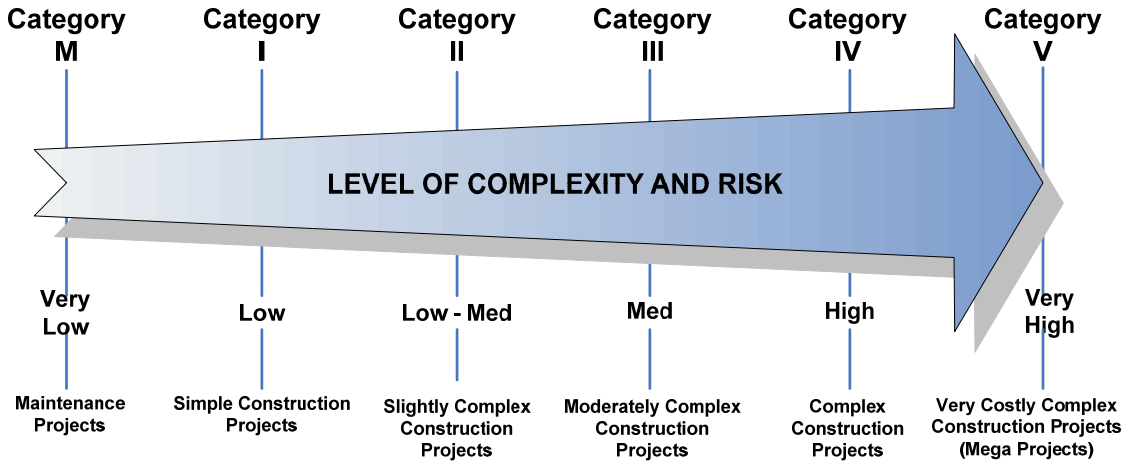


Figure 1-4: Project Category – Level of Complexity and Risk

The VDOT project ranking system consists of six categories representing varying levels of complexity and risk ranging from very low to very high. Category M is the lowest, which represents typical maintenance projects and schedule type work. Categories I through V represent typical construction projects ranging from simple to very complex. Characteristics of each project category are described as follows:

1. **Category M –** Category M is the lowest level of the project ranking system, which represents typical maintenance contracts and seasonal schedule type work of very low complexity and risk. For such projects, specific timeframes for accomplishing the work is not a major constraint. Generally, a full construction season is given to allow for flexibility in planning and scheduling the Work. Therefore, Category M projects do not require the level of scheduling efforts typically needed for construction projects.

   A. Criteria for Category M Projects – Category M projects must generally meet the following criteria:

   i) Typical seasonal maintenance and schedule type work generally with contract duration of one construction season or less (Time is not a major constraint); or

   ii) Simple repairs or straight-forward maintenance work; and

   iii) Minimal traffic impact or limitations to the Work; and

iv) No involvement with other major construction or improvement projects.

B. Examples of Category M Projects – The following are typical Category M projects:

- Pavement schedules (Asphalt overlay, surface treatments & slurry seals);
- Bridge joint repairs;
- Bridge painting (minimum traffic impact);
- Guardrail improvements;
- Curb and gutter repair/replacement;
- Raised pavement marker installation, lens replacement;
- Pavement marking schedules;
- Minor Bridge repair (District wide, minor miscellaneous);
- Rumble strip installation;
- Slope slide repair, scour repair;
- Ground mounted sign maintenance/replacement;
- Incidental concrete repair;
- Pipe culvert rehabilitation;
- Retaining wall/ Sound wall repair;
- Signal maintenance & repair (District wide).

C. Category M Scheduling Requirements – Category M scheduling requirements are based on the basic scheduling information necessary for the Department to coordinate all work required to complete the Contract and to communicate with the public. The schedule information will also be used to plan for and manage the Department's cash flow, resources, and traffic. The Category M Schedule of Operations submission requirements are as follows:

i) An Initial Plan of Operations in the form of a written narrative to provide a description of the overall plan and intended sequence of progress.

ii) An Initial Schedule of Operations showing in a tabular format, the period of time within which work at each location, route, or segment of Work as delineated in the contract will be accomplished. A bar-chart or CPM schedule may be substituted, at the Contractor's option.

iii) Every week, on a day agreed to by the Contractor and the Engineer, the Contractor is required to provide a Two-week Look-ahead (TWLA) schedule to show the detailed schedule of work planned for the following two weeks. The TWLA schedule may be provided in a tabular or bar-chart format.

2. **Category I –** Category I is the lowest level of the project ranking system for typical construction projects, which represents small, simple, low risk, and short duration construction projects. Such projects involve limited and straight-forward operations with limited project constraints and minimal or no traffic impact.

   A. **Criteria for Category I Projects –** Category I projects must generally meet the following criteria:

      i) Contract duration of one construction season or less (typically short durations); or

      ii) Estimated contract value of $1 million or less; and

      iii) Limited items of work; and

      iv) Simple operations in familiar and favorable conditions; and

      v) Minimal traffic impact or limitations to the Work; and

      vi) Does not include utility adjustments or relocations; and

      vii) Contract does not contain any Special Provisions for special time-related conditions, such as Interim Contract Milestones, A+B Bidding, Insensitive/Disincentive, or Lane Rental; and

      viii) Project has no major materials delivery restrictions, environmental impacts, delayed right-of-way acquisitions or access, or other similar constraints and restrictions.

   On a case by case basis, certain single-season simple and low risk projects with estimated contract value greater than $1M that generally meet the criteria listed above may qualify as Category I, as determined by the Area Construction Engineer (ACE);

   On a case by case basis, certain Federal Oversight (FO) maintenance projects or time sensitive maintenance projects with traffic impact may qualify as Category I, as determined by the ACE. Such projects may include concrete pavement repairs or overlay work on major corridors or certain relatively complex time sensitive maintenance projects that are involved with major construction or improvement projects. In such cases, the ACE should consult with the State Construction Scheduler for concurrence.

   B. **Examples of Category I Projects –** The following are typical Category I projects:

      — Rural grade, drain, & pave of unpaved roads (may include minor horizontal & vertical alignment changes and rural rustic projects with drainage work);

      — Minor bridge deck repair & concrete overlay (may include multiple bridges);

      — Break, seat, & overlay concrete pavement;

      — Spot improvements (multiple locations any of: incidental concrete, minor widening, enhanced pavement marking, & sign installation);

      — Building demolition in advance of construction projects;

      — Retaining wall installation or extensive repair;

      — Minor bridge substructure repairs (with traffic impact);

- Bridge painting (multiple locations or with traffic impact);
- Minor urban reconstruction & improvement (could include curb & gutter and sidewalks; new or extended turn lanes);
- Surface reclamation, sub-grade stabilization & overlays;
- Bridge steel repair (with traffic impact);
- Signal installation – Site specific (w/o intersection improvements, no regional on-call installations);
- Overhead sign installation & lighting installations (multiple locations & or significant amount of lighting);
- Simple concrete pavement repair and/or asphalt overlay (major corridor, minimum traffic impact).

C. Category I Scheduling Requirements – Category I scheduling requirements are based on the basic scheduling information needed to communicate the Contractor's work plan and to assess progress of the Work. The schedule information will also be used to plan for and manage the Department's resources, expenditures, traffic, as well as to communicate with the general public. The Category I Progress Schedule submission requirements are as follows:

i) A written Baseline Progress Schedule Narrative describing the Contractors initial proposed sequence and work plan.

ii) A Baseline Progress Schedule showing in a tabular format, the times within which the individual activities that make up the project will be accomplished. A bar-chart or CPM schedule may be substituted, at the Contractor's option.

iii) A Progress Earnings Schedule (Form C-13C) to show the planned progress for each month in terms of percent complete. Percent complete is based on cumulative anticipated earnings relative to the total contract value.

iv) A two-week look-ahead schedule due every week to show the detail schedule for work planned for the following two weeks.

v) A revision of the Baseline Progress Schedule is required when the schedule has been significantly impacted by a change in the Work or condition or the Contractor has deviated significantly from his baseline plan or schedule.

3. Category II – Category II represents slightly complex and relatively small to medium size construction projects that are typically completed in one or two construction seasons. Category II projects typically involve a limited number of straightforward contiguous, linear, or repetitive operations with typical project constraints and minimal traffic impact. Category II may also include certain multi-season low risk projects with minimal constraints or traffic impact. Such projects may involve simple repetitive or linear operations performed at multiple locations. They may also involve typical low risk widening projects in a rural setting, involving a limited number of straightforward contiguous or linear operations.

A. Criteria for Category II Projects – Category II projects must generally meet the following criteria:

i) Contract duration of one construction season or less (may be two construction seasons, but involve simple linear or repetitive operations); or

ii) Estimated contract value generally less than $3 million; and

iii) Limited number of straightforward contiguous or linear operations; and

iv) Low to medium traffic impact; and

v) Typical conditions and limitations to the work; and

vi) May include minimal utility adjustments; and

vii) Contract does not contain Special Provisions for special time-related conditions, such as Contract interim milestones, Incentives/Disincentives, A+B bidding, or Lane Rental, etc.; and

viii) Project has no major materials delivery restrictions, environmental impacts, right-of-way acquisitions, or other similar constraints and restrictions.

On a case by case basis, certain slightly complex and low to medium risk projects with estimated contract value over $3M that generally meet the criteria listed above may qualify as Category II, as determined by the ACE.

On a case by case basis, certain high-volume Federal Oversight (FO) maintenance projects or relatively complex maintenance projects that involve multiple items of work, multiple schedule constraints, or significant traffic impact may qualify as Category II, as determined by the ACE. Such projects may include concrete pavement repairs or overlay work on major corridors or certain relatively complex time sensitive maintenance projects that are involved with major construction or improvement projects. In such cases, the ACE should consult with the State Construction Scheduler for concurrence.

B. Examples of Category II Projects – The following are typical Category II projects:

— Urban grade, drain, & pave projects of low to medium complexity;

— Rural new construction or reconstruction grade separation roadway and bridge projects (low to medium size and complexity);

— Complex reconstruction and improvements, including widening and multiple turn lanes that may include utility adjustments;

— Major bridge substructure repairs (with low to medium traffic impact);

— Bridge deck replacements, such as multi-span or over railroads;

— Major bridge deck repair & concrete overlay (multi-span or over railroads);

— Intersection improvements with lighting and/or signal installation;

— Bridge & drainage structure replacements (frequently single span with limited approach work);

- Major drainage improvements;
- Complex concrete pavement repair and/or asphalt overlay (major corridor, significant traffic impact);
- Multi-season bridge painting (with low to medium traffic impact).

C. Scheduling Requirements for Category II – As the amount of work, project duration, or level of complexity and associated risks increases, a scheduling tool that can graphically depict the sequence and timing of the activities in a time-scale format is required to effectively communicate the Contractor's plan of operations and the intended sequence of progress. The Category II Progress Schedule submission requirements are as follows:

i) A written Baseline Progress Schedule Narrative describing the Contractors initial proposed sequence and work plan.

ii) A Baseline Progress Schedule showing in a bar-chart format, the times within which the individual activities that make up the project will be accomplished. A CPM schedule may be substituted, at the Contractor's option.

iii) A Progress Earnings Schedule (Form C-13C) to show the planned progress for each month in terms of percent complete. Percent complete is based on cumulative anticipated earnings relative to the total contract value.

iv) A monthly update of the Progress Schedule and Progress Earnings Schedule is required to show the actual progress and the current plan to complete the remaining work.

v) A revision of the Baseline Progress Schedule is required when the schedule has been significantly impacted by a change in the Work or condition or the Contractor has deviated significantly from his baseline plan or schedule.

4. Category III – Category III represents moderately complex, medium risk, and medium-size projects that are typically completed within two or three construction seasons. Category III projects typically involve a limited number of concurrent operations with typical project constraints and/or traffic impact. Category III projects may also include certain medium to large size multi-season low risk projects of relative complexity. Such as limited span bridge widening or interchange projects in a rural setting with typical constraints and minimal traffic impact.

A. Criteria for Category III Projects – Category III projects must generally meet the following criteria:

i) Med-size projects with contract duration generally spanning 2-3 construction seasons; or

ii) Estimated contract value generally between $3M and $10M; and

iii) Limited number of concurrent work-paths; and

iv) Medium limitations to the work and traffic impact; and

v) Limited number of utility adjustments; and

vi) Contract does not contain Special Provisions for special time-related conditions, such as Contract interim milestones, Incentives/Disincentives, A+B bidding, or Lane Rental, etc.; and

vii) Project has no major materials delivery restrictions, environmental impacts, right-of-way acquisitions, or other similar constraints and restrictions.

On a case by case basis, certain moderately complex and medium risk projects with estimated contract value over $10M that generally meet the criteria listed above may qualify as Category III, as determined by the ACE.

On a case by case basis, certain high-volume Federal Oversight (FO) maintenance projects or relatively complex maintenance projects that involve multiple items of work, multiple schedule constraints, and/or significant traffic impact may qualify as Category III, as determined by the ACE. Such projects may include major concrete pavement repairs or overlay work on major corridors or certain relatively complex time sensitive maintenance projects that are involved with major construction or improvement projects. In such cases, the ACE should consult with the State Construction Scheduler for concurrence.

B. Examples of Category III Projects – The following are typical Category III projects:

- Intersection improvements, including widening and multiple turn lanes with utilities, lighting and/or signal installation (with medium complexity and traffic impact);
- New roadway/bridge construction or extension projects (medium size, complexity, and traffic impact);
- Bridge deck replacements (multi-span, medium traffic impact);
- Bridge & drainage structure replacements (limited span with approach work);
- Bridge reconstruction/widening projects (medium size, complexity, and traffic impact).

C. Scheduling Requirements for Category III – As the number of operations or level of complexity and associated risks grow a scheduling tool that allows for adequate planning and scheduling of multiple concurrent activities with considerations for associated project constraints is needed to execute and control the Work. Such scheduling method will require that sufficient details and activity relationships are added to establish inter-dependencies between related activities to form network paths, with which the activities are scheduled. This is necessary to aid the project staff in efficiently planning and managing the Work and available resources. It is also necessary that the project critical path and the minimum time needed to complete the project are established. The Category III Progress Schedule submission requirements are as follows:

i) A Preliminary Progress Schedule to provide a start-up schedule to execute and monitor the Work for the first sixty (60) calendar days.

ii) A written Baseline Progress Schedule Narrative describing the Contractors initial proposed sequence and work plan.

iii) A Baseline Progress Schedule showing in a CPM format, the times within which the individual activities that make up the project will be accomplished.

iv) A Baseline Progress Earnings Schedule (Form C-13C) to show the planned progress for each month in terms of percent complete. Percent complete is based on anticipated earnings relative to the total contract value.

v) A monthly update of the Progress Scheduleand Progress Earnings Schedule is required to show the actual progress and the current plan to complete the remaining work.

vi) A revision of the Baseline Progress Schedule is required when the schedule has been significantly impacted by a change in the Work or condition or the Contractor has deviated significantly from his baseline plan or schedule.

5. **Category IV –** Category IV represents complex, high risk, and medium to large size projects that are typically completed within three or more construction seasons. Category IV projects typically involve multiple concurrent operations with substantial project constraints and/or traffic impact. Such projects include, but are not limited to new, reconstruction, extension, or widening/improvements of medium to large roadway/bridge projects with substantial constraints and/or traffic impact. Category IV projects may also include certain med-size high-risk projects of relative complexity that include provisions for special time-related constraints or conditions as described below.

   A. Criteria for Category IV Projects – Category IV projects must generally meet the following criteria:

   i) Medium to large size projects with contract duration generally spanning 3 or more construction seasons; or

   ii) Estimated contract value generally between $10M and $75M; or

   iii) Contract contain Special Provisions for special time-related conditions, such as Contract interim milestones, Incentives/Disincentives, A+B bidding, or Lane Rental, etc.; and

   iv) Multiple concurrent work-paths; and

   v) Complex construction staging, phasing, or MOT issues; and

   vi) Complex constructability issues; and

   vii) Substantial traffic impact and limitations to the work; or

   viii) May include major utility relocation/adjustments; and

   ix) Project has no major materials delivery restrictions, environmental impacts, right-of-way acquisitions, or other similar constraints and restrictions.

   On a case by case basis, certain relatively complex and high risk projects with estimated contract value less than $10M that generally meet the criteria listed above may qualify as Category IV, as determined by the ACE. In such cases, the ACE should consult with the State Construction Scheduler for concurrence.

   On a case by case basis, certain relatively complex and high risk projects with estimated contract value over $75M that generally meet the criteria listed above may qualify as Category IV, as determined by the ACE.

B. Examples of Category IV Projects – The following are typical Category IV projects:

- Major urban intersection improvements, including widening and multiple turn lanes with utilities, lighting and/or signal installation (medium to large size, complex, and significant traffic impact);
- Rural/Urban new construction or reconstruction grade separation roadway and bridge projects (medium to large size, complex, major corridor);
- Major bridge deck replacements (substructure repairs, multi-span, multi-lane, major corridor, with significant traffic impact);
- Major bridge & drainage structure replacements (multi-span with extensive approach work);
- Major widening projects (medium to large size and complexity, major corridor, with significant traffic impact).

C. Scheduling Requirements for Category IV – As the size, complexity, and associated risks grow, a scheduling tool that allows for adequate planning and scheduling of multiple concurrent operations is needed to execute and control the Work. For such projects, a tool that allows for an accurate assessment of the reasonableness of the schedule and current status of the activities and the project based on costs is also needed to control the project and to manage schedule-related risks on the project. The Category IV scheduling and Progress Schedule submission requirements are based on the Category III requirements with additional requirements as described below:

i) A Preliminary Progress Schedule to provide a start-up schedule to execute and monitor the Work for the first ninety (90) calendar days.

ii) A written Baseline Progress Schedule Narrative describing the Contractors initial proposed sequence and work plan.

iii) A cost-loaded Baseline Progress Schedule showing in a CPM format, the times within which the individual activities that make up the project will be accomplished. The cost-loaded schedule will be used to generate the time-distributed cost data on which the Progress Earnings Schedule is based.

iv) A Baseline Progress Earnings Schedule (Form C-13CPM) based on time-distributed cost data generated from the cost-loaded schedule to show the planned progress for each month in terms of percent complete. Percent complete is based on anticipated earnings relative to the total contract value.

v) A 30-day look-ahead schedule to depict work planned for the next period.

vi) A monthly update of the Progress Schedule is required to show the actual progress and the current plan to complete the remaining work.

vii) A revision of the Baseline Progress Schedule is required when the schedule has been significantly impacted by a change in the Work or condition or the Contractor has deviated significantly from his baseline plan or schedule.

6. **Category V –** Category V is the highest level of the project ranking system for typical construction projects, which represents very complex and very costly mega-projects that are typically completed within four or more construction seasons. Category V projects typically involve very large multiple multi-phased contracts with substantial project constraints and/or significant traffic impact. Such projects typically involve major roadway/bridge construction/widening, very complex multiple-span bridges, tunnels, or major interchange work on major corridors.

   A. Criteria for Category V Projects – Category V projects must generally meet the following criteria:

      i) Very large projects with contract duration generally spanning 3 or more construction seasons; or

      ii) Estimated contract value generally greater than $75M; and

      iii) Contract contain Special Provisions for special time-related conditions, such as Contract interim milestones, Incentives/Disincentives, A+B bidding, or Lane Rental, etc.; and

      iv) Considerable number of concurrent work-paths; and

      v) Complex construction staging, phasing, or MOT issues; and

      vi) Complex constructability issues; and

      vii) Substantial traffic impact and limitations to the work; and

      viii) Substantial number of right-of-way acquisitions and/or relocations; or

      ix) Major material delivery restrictions; or

      x) Significant utility relocation/adjustments; or

      xi) Major environmental or community impact.

   On a case by case basis, certain relatively complex and very high risk projects with estimated contract value less than $75M that generally meet the above listed criteria may qualify as Category V, as determined by the ACE. In such cases, the ACE should consult with the State Construction Scheduler for concurrence.

   B. Examples of Category V Projects – The following are typical Category V projects:

      — Major rural/urban new construction or reconstruction grade separation roadway and bridge projects (large size, complex, major corridor, significant traffic impact);

      — Major widening projects (large size, complex, major corridor, significant traffic impact);

      — Major interchange projects (large size, complex, major corridor, significant traffic impact);

      — Major bridge deck replacement projects (large size or multiple bridges, complex, major corridor, significant traffic impact);

— Individual Category III or IV level projects that are part of a multi-phased mega-project involving multiple contracts (e.g. Woodrow Wilson, Springfield Interchange, etc.).

C. Scheduling Requirements for Category V – As the size, complexity, and associated risks grow, a scheduling tool that will allow for adequate planning and scheduling of multiple concurrent operations, projects, manpower, equipment, and expenditures is required to accomplish the Work. Such scheduling tool should also allow for an accurate assessment of the status of the individual activities and the project; as well as progress of selected major operations that will have the greatest influence on the schedule.

The Category V scheduling and Progress Schedule submission requirements are based on the Category IV requirements with additional requirements as described below:

i) A qualified and dedicated project scheduler/coordinator to coordinate all scheduling meetings and issues.

ii) Contractor's working on a Category V project will be required to develop and maintain their schedules in a collaborative environment within the VDOT scheduling database.

iii) A written Baseline Progress Schedule Narrative describing the Contractors initial proposed sequence and work plan.

iv) A Preliminary Progress Schedule to provide a start-up schedule to execute and monitor the Work for the one hundred and twenty (120) calendar days.

v) A cost-loaded and resource-loaded Baseline Progress Schedule showing in a CPM format, the times within which the individual activities that make up the project will be accomplished. The cost-loaded schedule will be used to generate the time-distributed cost data on which the Progress Earnings Schedule is based.

vi) A Baseline Progress Earnings Schedule (Form C-13CPM) based on time-distributed cost data generated from the cost-loaded schedule to show the planned progress for each month in terms of percent complete. Percent complete is based on anticipated earnings relative to the total contract value.

vii) A Commodity Progress Report (Form C-13COM) to show the anticipated progress of selected items of work, whose rate of progress are expected to drive the schedule.

viii) A weekly four-week look-ahead schedule detailing work planned for the next four weeks.

ix) A monthly update of the Progress Schedule is required to show the actual progress and the current plan to complete the remaining work.

x) A revision of the Baseline Progress Schedule is required when the schedule has been significantly impacted by a change in the Work or condition or the Contractor has deviated significantly from his baseline plan or schedule.

SECTION II

CONCEPTS AND FUNDAMENTALS ON PROJECT SCHEDULING

1. Introduction
2. Scheduling Techniques
3. Work Breakdown Structure (WBS)
4. Basic Activity Properties
5. Relationship Concepts and Properties
6. Critical Path Method (CPM) Network Properties
7. Methods for Calculating CPM Network Properties
8. Advanced Scheduling Concepts and Properties

SECTION II

1. INTRODUCTION

This section provides fundamental project scheduling knowledge needed to understand how to develop or use schedules effectively. It provides general knowledge and guidelines on the various elements of a schedule and scheduling techniques, concepts, and properties used in preparing schedules for projects of various sizes and complexities.

2. SCHEDULING TECHNIQUES

The following are various scheduling techniques that can be used, depending on size and complexity to prepare and communicate the Work plan and schedule for a project:

A. Schedule Narrative – A schedule narrative is a written document that is used to communicate the overall plan to accomplish the Work. In essence, a narrative provides an outline of the plan on which the schedule is based. A schedule narrative should describe, as appropriate:

i) The proposed overall approach and sequence of Work;

ii) Project milestones (major events such as completion of stages or phases of the Work);

iii) Proposed means and methods (procedures);

iv) Resource plan (manpower and equipment needed and how the Contractor plans to meet the resource requirements);

v) Planned working calendar, shift, and work hours;

vi) Planned quantities of major operations;

vii) Planned production rates for major operations;

viii) Scheduling assumptions (considerations for known and foreseeable constraints or restrictions such as weather, traffic, environmental, utility, safety, etc.);

ix) Work performed this period and work planned during the next period;

x) Issues encountered this period or any known or foreseeable issues that will impact the schedule; as well as actions taken or needed to avoid or mitigate the effects.

B. Monthly/Yearly Calendar – A basic scheduling technique that involves the use of available monthly or yearly calendars to plan the Work and to determine the proposed start and finish dates of activities. This method can be used to generate the schedule information for simple and short duration projects, which can then be presented in a tabular or bar-chart format.

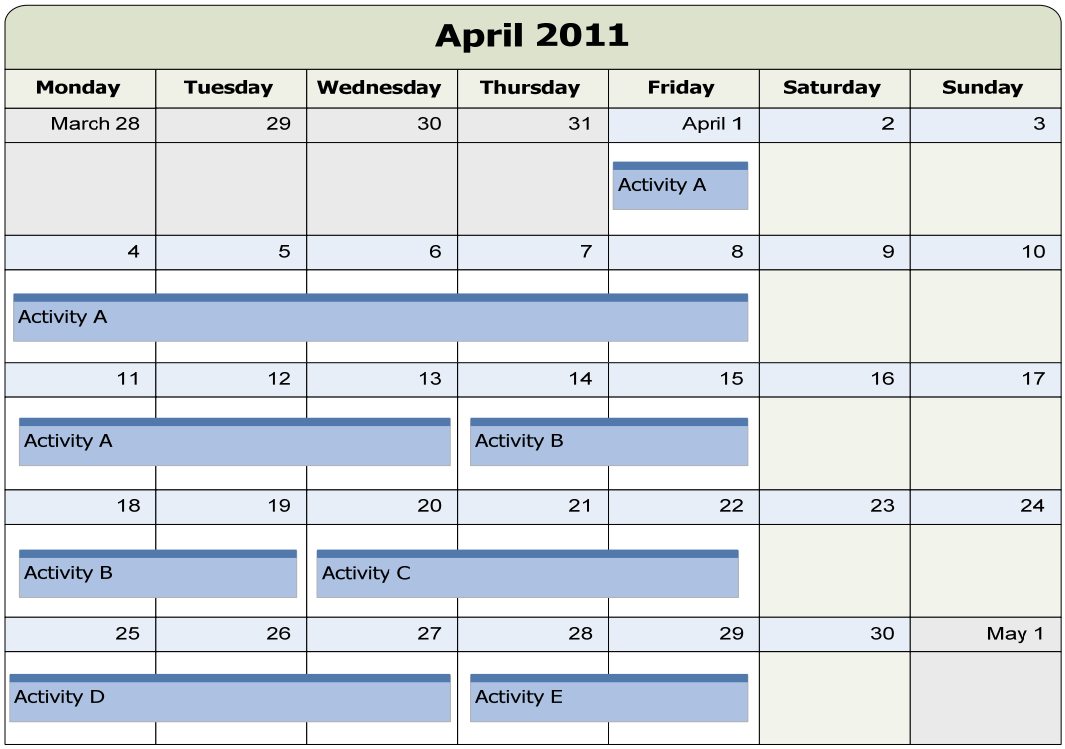


Figure 2.1: Example of a Monthly Calendar Schedule

C. Tabular Schedule – A scheduling method that utilizes an activity table to show the project activities in a tabular format. A Tabular Schedule shows the Activity ID, Activity Name, Activity Duration, and the Start and Finish dates. Activities are listed in the order in which the work will be performed.

Activity ID	Activity Name	Duration	Start	Finish
10	Activity A	10d	4/01/11	4/14/11
20	Activity B	15d	4/15/11	5/05/11
30	Activity C	20d	4/20/11	5/17/11
40	Activity D	18d	5/06/11	5/31/11
50	Activity E	10d	6/01/11	6/14/11

Table 2.1: Example of a Tabular Schedule

D. Bar-Chart Method – A bar-chart method (also known as a Gantt chart) is a scheduling technique that is used to graphically depict, in a time-scaled bar-chart format, the sequence and specific dates on which activities that make up the project will be performed. A bar-chart schedule consist of an activity table and a bar-chart area as further described below:

i) Activities that make-up the project are listed in an activity table in the order in which the work will be performed.

ii) The activities are represented by horizontal bars plotted in the bar-chart area in a time-scaled format to show when the work will be performed.

iii) The length of each bar is based on the duration of the activity. And the overall project duration is based on the start date of the earliest activity and the finish date of the latest activity.

iv) Unlike a critical path method (CPM) schedule, a bar-chart schedule only shows when an activity must be started and finished, but does not show the relationships between the activities. Thus, the inter-dependencies between the activities, project network logic, critical path, and total float are not defined. Therefore, it is difficult to determine the effect of a delay of one activity on another or the overall time impact on the project.

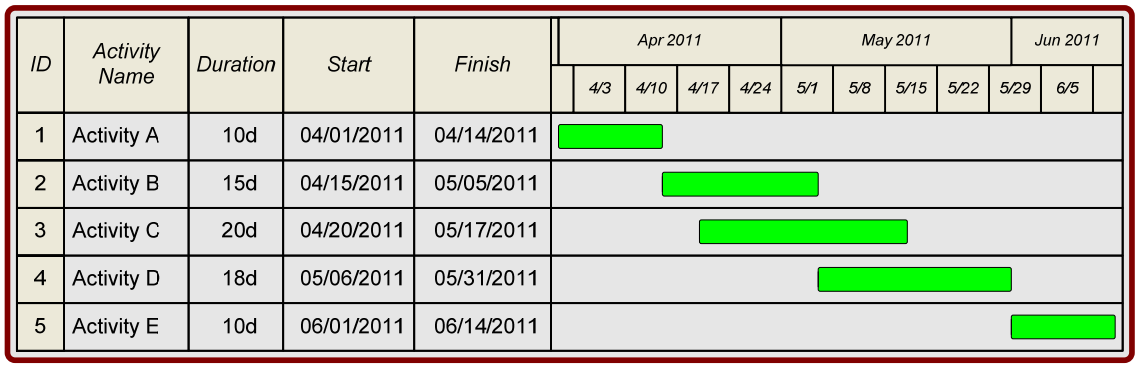


Figure 2.2: Example of a Bar-Chart Schedule

E. Critical Path Method (CPM) – The critical path method (CPM) is a scheduling technique that utilizes activity durations and network logic to calculate the schedule for an entire project. A CPM schedule is a network-based schedule that graphically depicts the timing of activities, inter-relationships between the activities, and the project critical path. Every project, regardless of size or complexity, has a critical path; however, only a critical path schedule identifies the critical path. Furthermore, a CPM schedule:

i) Is based on the Precedence Network Diagram Method (PDM), which is used to link related activities in order of precedence to create the project network logic.

ii) Calculates the earliest and latest possible dates within which an activity can be performed based on its position within the network.

iii) Defines the inter-relationships between the activities; therefore, the project network logic and critical path critical path (also known as the Longest Path) are defined. Any delay to an activity on the critical path will delay completion of a related interim milestone or the project, as applicable.

iv) Can be used to depict activities in either a time-scaled bar-chart format or network logic diagram with connecting lines depicting the inter-relationships between the activities.

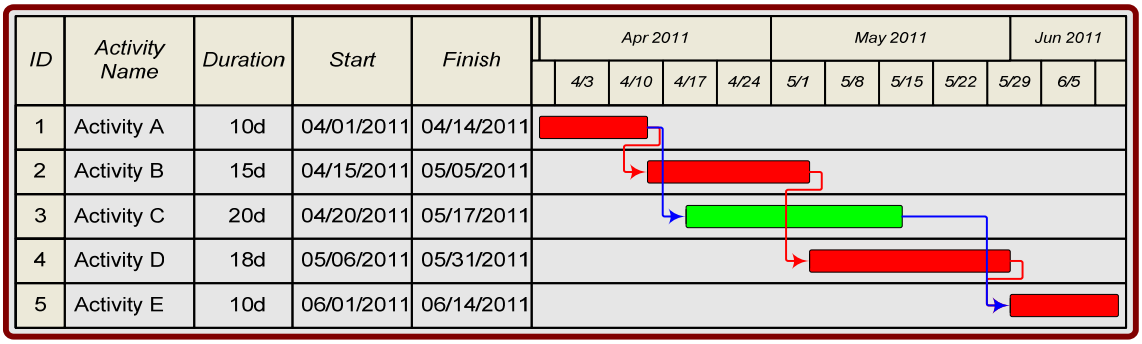


Figure 2.3: Example of a Critical Path Method (CPM) Schedule

3. WORK BREAKDOWN STRUCTURE (WBS)

A Work Breakdown Structure (WBS) is a fundamental element of a schedule that provides a hierarchically-structured grouping of the project elements. WBS can also be defined as a deliverable-based hierarchical structure, in which each division of the Work is further decomposed into an increasingly greater level of detail. WBS provides a structured framework with which to breakdown a project into meaningful and manageable parts. WBS also provides a means to organize and summarize the individual activities that make up a project in a hierarchical format. The highest level of the WBS represents the project and lowest level represents the measurable work packages.

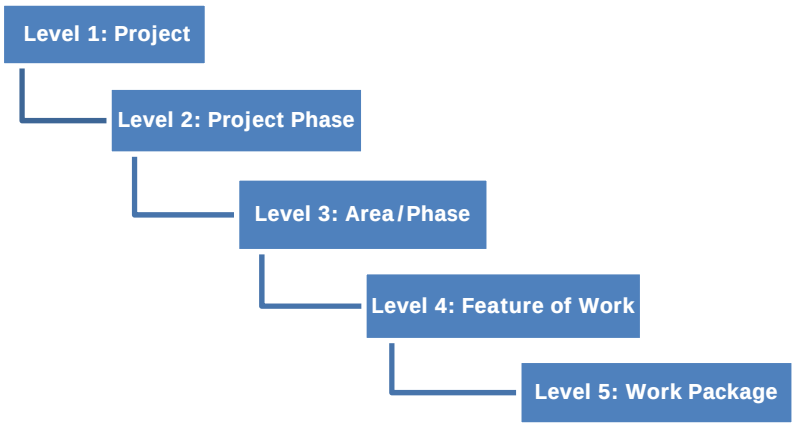


Figure 2-4: WBS Example – Hierarchical Breakdown by Level

A. WBS Level 1 – Level 1 is the root node, which represents the project.

B. WBS Level 2 – Level 2 is a subordinate node of level 1, which represents the first division of the project into phases, segments, or other major aspects of Work based on the Scope of Work. For example, Level 2 can be used to decompose the project into major phases of the project (i.e. Project Management, Design, ROW, Environmental, Procurement, Utility, Construction, etc.) as shown in Figure 2-5 below.

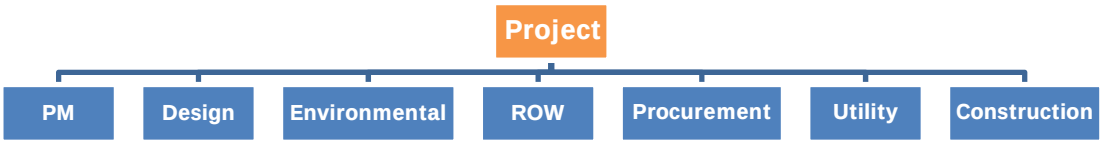


Figure 2-5: WBS Example – Breakdown by Major Phases of the Project

C. WBS Level 3 – Level 3 is a subordinate node of level 2, which represents a breakdown of elements of level 2 into their respective subordinate parts as appropriate. For example, the PM element can be decomposed into various project management elements (i.e. Milestones, Administrative Tasks, etc.). The Construction element can be decomposed into major segments of the project or construction phases/stages, as appropriate. If the project involves a sequence of construction that is broken down by construction phases or stages, then level 3 can be used to breakdown the Work accordingly into phases or stages (i.e. Phase 1, Phase 2, Stage 1, Stage 2, etc.). Likewise, if the project is divided geographically into segments due to physical constraints or multiple working fronts, then level 3 can be used to breakdown the Work accordingly into segments (i.e. Segment 1 – Eastern Approach, Segment 2 – River Crossing, Segment 3 – Western Approach, etc.), as shown in Figure 2-6 below.

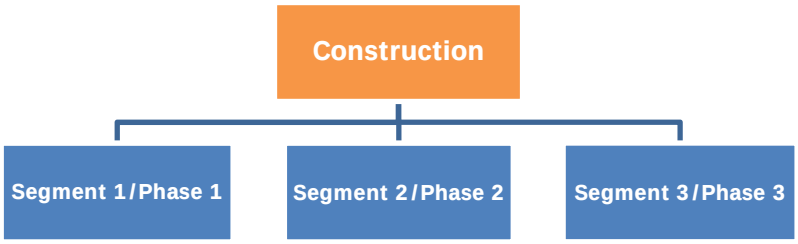


Figure 2-6: WBS Example – Breakdown by Segments or Phases

D. WBS Level 4 – Level 4 is a subordinate node of level 3, which represents a breakdown of elements of level 3 into their respective subordinate parts, as appropriate. For example, each Phase or Segment can be decomposed into associated features of Work, as applicable (i.e. Roadway 1, Roadway 2, Bridge 601, Ramp A, Ramp B, SWMB #1, SWMB #2, Overhead Sign Structures, Traffic Signal Structures, etc.), as shown in Figure 2-7 below.

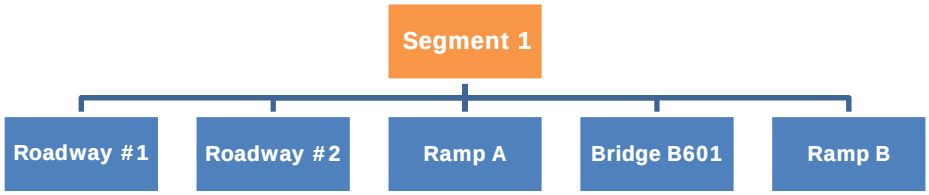


Figure 2-7: WBS Example – Breakdown by Feature of Work

E. WBS Level 5 – Level 5 is a subordinate node of level 4, which represents a breakdown of elements of level 4 into their respective subordinate parts or work packages, as appropriate. For example, a Feature of Work such as a bridge structure can be sub-divided into sub-features (i.e. Sub-structure, Superstructure, etc.), which can then be further decomposed into specific elements of the structure (i.e. Abut A, Pier 1, Span A, etc.). Likewise a roadway feature of Work can be sub-divided into major work types (i.e. Earthwork, Drainage, Paving, Incidentals, Traffic Control, etc.), as shown in Figure 2-6 below.

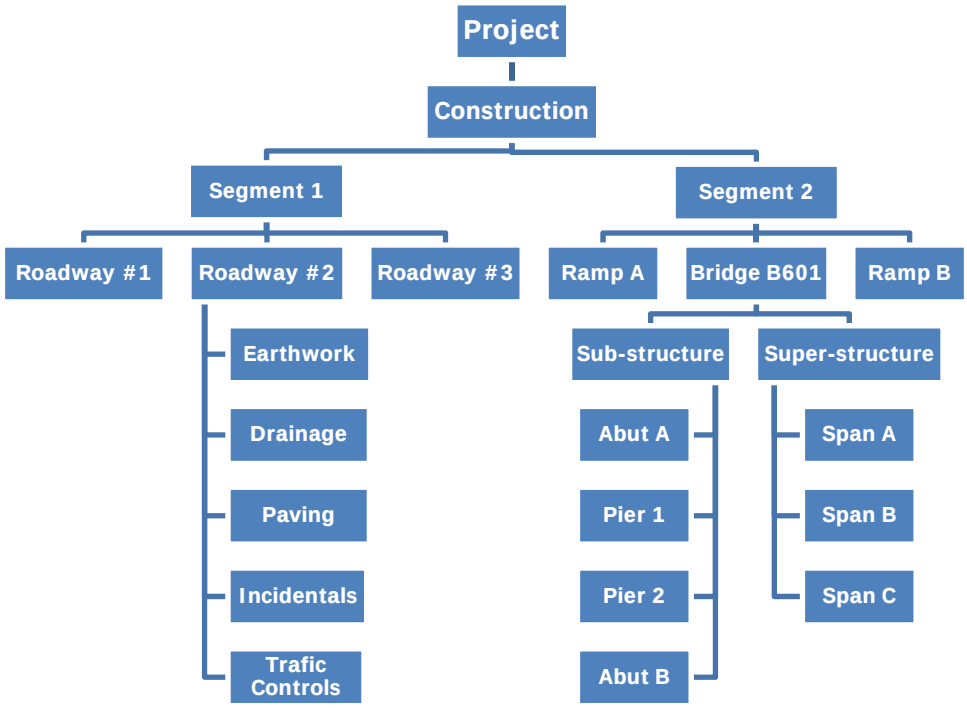


Figure 2-8: WBS Example – Breakdown by Phase / Segment / Feature / Major Work Type or Sub-feature

4. BASIC ACTIVITY PROPERTIES

Activities are the lowest level of the WBS that represents the smallest sub-division of the Work that the project manager needs to plan, manage, and control the project. Activities are vital elements of a schedule that drive the schedule. Activities can be used to define work packages, work items, events, or other time consuming tasks that must be completed to accomplish the Work. Activities have durations and definable start and finish dates. The following are basic activity properties that must be defined when preparing a schedule:

A. Activity ID – An alphanumeric ID code assigned to an activity that is used to uniquely identify the activity. Activity IDs may be defined based on the WBS and may consist of an alphanumeric code that comprises of the entity responsible for performing the work, type of work, and/or phase in which the activity occurs. When assigning activity IDs considerations should be given by assigning activity IDs in increments of 10 to allow for new activities that may be added in between existing activities. Once a baseline schedule is agreed upon, the activity ID must remain unchanged for the remainder of the project. The following are examples of Activity IDs:

i) AC01000;

ii) VDOT100;

iii) AC02000;

iv) AC11100;

v) AC23000.

B. Activity Name – A concise description assigned to an activity that is used to uniquely describe the work or event that the activity represents. Activity name must clearly describe the work being performed and the specific location or limit of the work. The following are examples of Activity Names for the following associated activities:

i) AC01000 – Acme Construction Receive Notice to Proceed;

ii) VDOT100 – VDOT Review B601 Structural Steel Shop Drawings;

iii) AC02000 – Fabricate/Deliver Structural Steel Girders;

iv) AC11100 – PH-1: B601: Form/Rebar/Place Pier 1 Foundation;

v) AC23000 – Ph-2: Grade Roadway 1: Sta. 100+25 to 550+80.

C. Activity Duration – The amount of time (typically expressed in workdays) required to complete an activity. Scheduling software such as Primavera P6 uses different types of activity durations to calculate the schedule depending on the current status of the activity:

i) Original Duration (OD): The amount of time (workdays) originally planned to complete an activity before the activity begins.

ii) Actual Duration (AD): The calculated number of actual workdays expended on an activity, as of the data date. (If the activity is complete, then the AD is the difference between the actual start date and the actual finish date plus 1 day, excluding all non-workdays, as defined in the assigned calendar).

iii) Remaining Duration (RD): The amount of time (workdays) needed to complete an activity, as of the data date. For activities that have not started, the RD is equal to the OD. For completed activities the RD is zero (0).

iv) At Completion Duration (ACD): The total amount of time (workdays) required to complete an activity. For activities that have not started, the ACD is equal to the OD and RD. For on-going activities the ACD is equal to the sum of the AD and RD. For completed activities the ACD is equal to the AD.

D. Activity Dates – Activity date properties include:

i) Planned Start: The date an activity is scheduled to begin.

ii) Actual Start: The date an activity actually started.

iii) Planned Finish: The date an activity is scheduled to finish.

iv) Actual Finish: The date an activity was actually completed.

E. Activity Codes – User-defined codes that are assigned to activities to allow for filtering, sorting, or grouping activities by categories. The following are commonly used activity code categories:

i) Project Phase: Project phase codes are typically used for projects that involve multiple phases and multiple parties such as design/build projects. Project phase activity codes may include, but are not limited to Project Management, Design, ROW, Environmental, Procurement, Utility, and Construction.

ii) Responsibility: Entity responsible for performing the work (i.e. VDOT, Contractor, sub-Contractors, suppliers, utility companies, etc.).

iii) Area: Major area or segment of the project in which the activity occurs (i.e. Segment 1: Rte. 293/41/265 Intersection, Segment 2: Rte. 265 ML Sta. 100+00 – 500+25, Segment 3: Rte. 265/29 Interchange, etc.).

iv) Phase: Construction phase in which the activity occurs (i.e. Ph-1, Ph-2, etc.).

v) Stage: Stage in which the activity occurs (i.e. Stage 1, Stage 2, etc.).

vi) Feature of Work: Major components of the Work. A feature of Work is essentially what is being constructed (i.e. Road, Bridge, Ramp, Guardrail, SWMB, Overhead Sign Structure, Traffic Signal System, etc.)

vii) Location: Specific location in which the activity occurs (i.e. Sta. 100+25, Pier 1 or Bent 1, Span 1 or Unit 1, Abut A, etc.).

viii) Type of Work: Category of work (i.e. MOT, Grading, Drainage, Piling, Concrete, Paving, Guardrail, Signing, Striping, Lighting, Landscaping, etc.).

ix) Crew: Crew assigned to the work (i.e. Grading Crew #1, Drainage Crew #2, Pile Driving Crew, Concrete Crew, Paving Crew, Striping Crew, Signing Crew, etc.).

x) Contract Modification: Contract changes to the Work (i.e. WO #1, WO #2, etc.).

F. Calendars – Calendars define available working hours and workdays within which an activity can be completed. The following are examples of calendars that can be defined for use on a project:

i) Standard 5-Day Work Calendar: A standard calendar that defines the normal working schedule for each day, week, and month for use as the default working calendar for majority of the activities on the project. The standard work calendar may be defined in terms of a standard 5-day or 6-day workweek schedule, excluding as applicable, non-workdays for week-ends and holidays. When a 5-day or 6-day calendar is assigned to an activity, the activity duration must be specified in workdays.

ii) Standard 7-Day Work Calendar: A standard calendar that defines the normal working schedule for each day, week, and month for use on activities that are not constrained by weekends, holidays, weather, or other non-workday restrictions. Such activities may included, but are not limited to procurement/fabrication of long lead materials, curing, load test, settlement or surcharge periods, WBS summary, or level of effort. A 7-day calendar will also be used when the Contract specifies calendar day durations for certain activities. When a 7-day calendar is assigned to an activity, the activity duration must be specified in calendar days.

iii) Standard 5-Day Weather Calendar: A standard calendar that defines the normal working schedule for each day, week, and month for use on activities that may be affected by adverse weather. The standard weather calendar may be defined in terms of a standard 5-day or 6-day workweek schedule, excluding as applicable, non-workdays for week-ends and holidays. Additionally, the number of workdays available each month will be reduced for the number of estimated weather days (days lost due to weather) anticipated each month by randomly changing available workdays to non-workdays.

In lieu of a weather calendar, a weather contingency activity may be added to the schedule for the total number of estimated weather days anticipated over the duration of the project. The weather contingency activity will then be linked between the project completion milestone activity and the last activity on the critical path that may be affected by adverse weather. An adjustment will be made each month to reduce the weather contingency activity duration by the number of weather days lost during the month.

iv) Winter Shut-down Calendar: A calendar that defines the normal working schedule for each day, week, and month for use on weather sensitive activities such as asphalt paving that cannot be performed during the winter periods due to temperature requirements. Winter shut-down calendars may be defined based on a standard work calendar or weather calendar, excluding as applicable, non-workdays for week-ends, holidays, and weather days. Additionally, available workdays during the winter shut-down periods will be changed to non-work days accordingly.

v) Special Event or Environmental Calendar: A calendar that defines the normal working schedule for each day, week, and month for use on activities with special event, environmental, or other specified time of year restriction. Special event or environmental calendars may be defined based on a standard work calendar or weather calendar, excluding as applicable, non-workdays for week-ends, holidays, and weather days. Additionally, available workdays will be changed to non-work days accordingly, for the specified time of year restriction. A separate calendar must be defined for each special event or environmental time of year restriction, if the times of year restrictions are not concurrent.

G. Constraints – An activity property that restricts the start or finish date of an activity to a specified date, as allowed by network logic or as imposed by a mandatory restriction. Constraints can be used for convenience to impose the start or finish dates of certain activities in a CPM schedule when logic alone does not reflect when the activities are expected to be performed. Also, constraints can be used in lieu of relationships to develop bar-chart schedules when relationships between activities are not required. Certain constraints such as mandatory constraints violate network logic while others affect the timing of activities and calculation of float. Thus, constraints should be used sparingly or as specified in the Contract. The following are various types of constraints available in scheduling software such as Primavera (P6):

i) Start On: A constraint that restricts the ES and LS dates of an activity to the imposed date, as allowed by network logic. This constraint can be used to calculate an activity's ES and LS dates for activities that *must begin on* a specified date. Furthermore:

   a) Unlike the "Mandatory Start" constraint, the "Start On" constraint does not violate network logic; however, it delays the ES of an activity to the imposed date, if the ES would have occurred earlier based on network logic.

   b) The "Start On" constraint also accelerates the LS of the activity to the imposed date, if the LS would have occurred later based on network logic.

   c) This constraint also sets the total float of the constrained activity to zero (0). And the total float for preceding activities on its network path are calculated based on the imposed date.

ii) Start On or After: A constraint that restricts the ES date of an activity to the imposed date, as allowed by network logic. This constraint can be used to calculate the earliest possible start date for an activity that *can begin no earlier than* a specified date. For Primavera (P3) users, this constraint is known as "Early Start". Furthermore, the "Start On or After" constraint:

   a) Does not violate network logic; however, it delays the ES of an activity to the imposed date, if the ES would have occurred earlier based on network logic.

   b) Affects the forward pass calculation of succeeding activities on the constrained activity's network path by calculating the early dates and total float based on the imposed date.

iii) Start On or Before: A constraint that restricts the LS date of an activity to the imposed date, as allowed by network logic. This constraint can be used to calculate the latest possible start date for activities that *must begin no later than* a specified date. For Primavera (P3) users, this constraint is known as "Late Start". Furthermore, the "Start On or Before" constraint:

   a) Does not violate network logic; however, it accelerates the LS of the activity to the imposed date, if the LS would have occurred later based on network logic.

   b) Affects the backward pass calculation of preceding activities on the constrained activity's network path by calculating the late dates and total float based on the imposed date.

iv) Finish On: A constraint that restricts the EF and LF dates of an activity to the imposed date, as allowed by network logic. This constraint can be used to calculate an activity's EF and LF dates for activities that *must finish on* a specified date. Furthermore:

   a) Unlike the "Mandatory Finish" constraint, the "Finish On" constraint does not violate network logic; however, it delays the EF of an activity to the imposed date, if the EF would have occurred earlier based on network logic.

   b) The "Finish On" also accelerates the LF of the activity to the imposed date, if the LF would have occurred later based on network logic.

   c) This constraint also sets the total float of a constrained activity to zero (0) and the total float for preceding activities on its network path are calculated based on the imposed date.

v) Finish On or After: A constraint that restricts the EF date of an activity to the imposed date, as allowed by network logic. This constraint can be used to calculate the earliest possible finish date for an activity that *can finish no earlier than* a specified date. For Primavera (P3) users, this constraint is known as "Early Finish". Furthermore, the "Finish On or After" constraint:

   a) Does not violate network logic; however, it delays the EF of an activity to the imposed date, if occurring earlier based on network logic.

   b) Affects the forward pass calculation of the succeeding activities within the constrained activity's network path by calculating the early dates and total float based on the imposed date.

vi) Finish On or Before: A constraint that restricts the LF date of an activity to the imposed date, as allowed by network logic. This constraint can be used to calculate the latest possible finish date for activities that *must finish no later than* a specified date. For Primavera (P3) users, this constraint is known as "Late Finish". Furthermore, the "Finish On or Before" constraint:

   a) Does not violate network logic; however, it accelerates the LF of an activity to the imposed date, if occurring later based on network logic.

   b) Affects the backward pass calculation of the preceding activities on the constrained activity's network path by calculating the late dates and total float based on the imposed date.

vii) Mandatory Start: A constraint that restricts the ES and LS dates of an activity to the imposed date, regardless of network logic. This constraint can be used to calculate an activity's ES and LS dates for activities that *must begin on* a specified date. Furthermore, "Mandatory Start" constraint:

   a) Violates network logic and sets the ES and LS dates of an activity to the imposed date, regardless of network logic.

   b) Affects the forward pass calculation of succeeding activities on the constrained activity's network path by calculating the early dates and total float based on the imposed date.

c) Affects the backward pass calculation of preceding activities on the constrained activity's network path by calculating the late dates and total float based on the imposed date.

d) Sets the total float of a constrained activity to zero (0). And the total float for preceding activities on its network path are calculated based on the imposed LS date.

viii) Mandatory Finish: A constraint that restricts the EF and LF dates of an activity to the imposed date, regardless of network logic. This constraint can be used to calculate an activity's EF and LF dates for activities that *must finish on* a specified date. Furthermore, "Mandatory Finish" constraint:

a) Violates network logic and sets the EF and LF dates of an activity to the imposed date, regardless of network logic.

b) Affects the forward pass calculation of succeeding activities on the constrained activity's network path by calculating the early dates and total float based on the imposed date.

c) Affects the backward pass calculation of preceding activities on the constrained activity's network path by calculating the late dates and total float based on the imposed date.

d) Sets the total float of a constrained activity to zero (0). And the total float for preceding activities on its network path are calculated based on the imposed date.

ix) As Late As Possible: A constraint that restricts the early dates of an activity to the latest possible dates without delaying its successors. This constraint can be used to calculate an activity's ES and EF dates for activities that *must be performed just prior to their successors*. Such activities are typically non-driving activities. Furthermore, "As Late As Possible" constraint:

a) Does not violate network logic; however, it delays the ES and EF dates of an activity as late possible, if occurring earlier based on network logic, without delaying its immediate successors.

b) Does not affect activities with zero (0) free float.

c) Consumes available free float and sets the free float of the constrained activity to zero (0).

x) Expected Finish: A constraint that restricts the EF date of an activity to the imposed date, as allowed by the network logic. This constraint can be used to calculate the EF date and duration of an activity that is *expected to finish on* a specified date. Furthermore, the "Expected Finish" constraint:

a) Does not violate network logic; however, it delays or accelerates the EF date of an activity to the imposed date accordingly, if occurring earlier or later based on network logic.

b) Adjusts the original duration of activities that have not started and remaining duration of on-going activities based on the imposed EF date.

c) Affects the forward pass calculation of succeeding activities on the constrained activity's network path by calculating the early dates and total float based on the imposed date.

5. RELATIONSHIP CONCEPTS AND PROPERTIES

Relationships are the inter-dependencies between activities that define the network logic with which the schedule is calculated. The following are scheduling relationship concepts and properties that are used to form the network logic that drives the schedule:

A. Precedence Diagramming Method (PDM) – A scheduling technique that uses relationship types such as finish-to-start (FS), start-to-start (SS), finish-to-finish (FF), start-to-finish (SF), and leads/lags to establish inter-dependencies between activities to form a network logic with which the schedule is calculated. The PDM uses boxes or rectangles as activities and lines with arrows to connect the activities thereby establishing logical relationships between the activities. Once the logical relationships between the activities are established, a precedence network logic diagram is formed and the activities are then scheduled according to their place on the network.

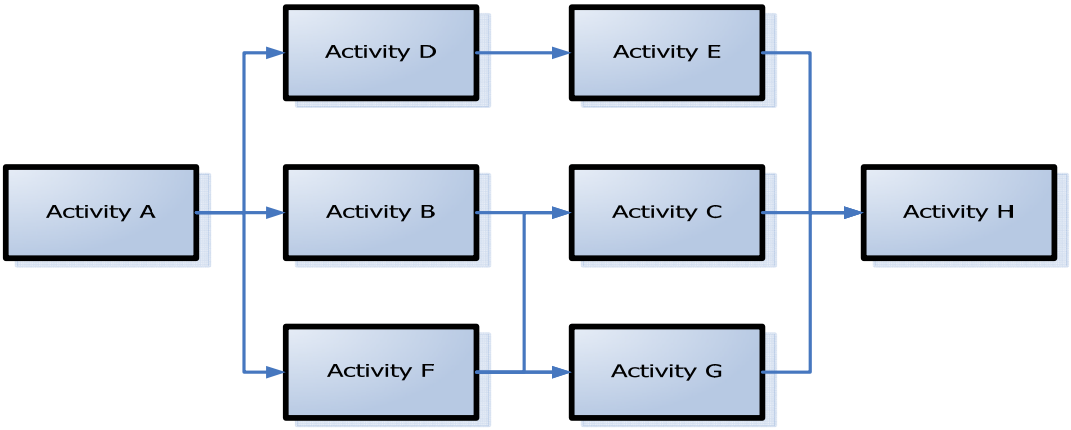


Figure 2-9: Precedence Network Logic Diagram

B. Predecessor – A predecessor is an activity that is defined by schedule logic to precede another activity. A predecessor activity controls the start or finish date of its successor(s) based on relationship type. An activity can have multiple predecessors; however, the driving predecessor is the one with the latest start or finish date depending on the relationship type. In the example shown in Figure 2.10 below, Activity A is a predecessor to both Activities B and C. Activity B is a predecessor to Activity D. And both Activities C and D are predecessors to Activity E.

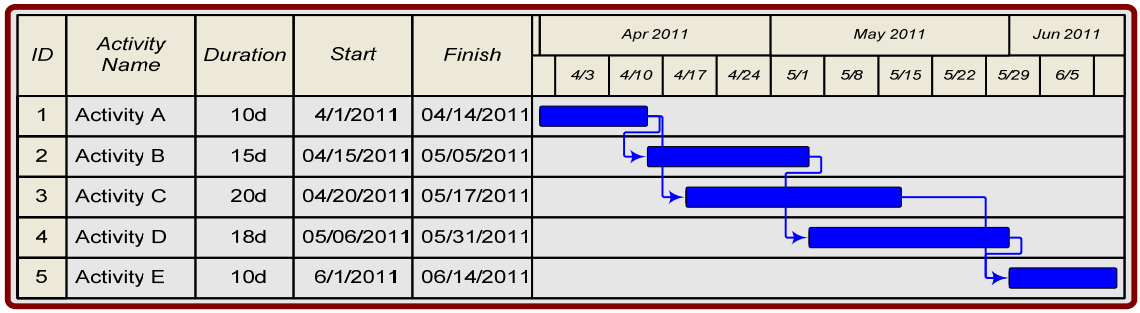


Figure 2.10: Example of Predecessor and Successor Relationships

C. Successor – A successor is an activity that is defined by schedule logic to succeed another activity. An activity can have multiple successors. The start or finish date of a successor activity depends on the start or finish of its driving predecessor(s) based on relationship type. In the example shown in Figure 2.10 above, Activities B and C are successors to Activity A, Activity D is a successor to Activity B, and Activity E is a successor to both Activities C and D, with Activity D being the driving predecessor.

D. Relationship Types – The following are four types of logic relationships that can be used to establish inter-dependencies among activities to form the schedule network logic:

i) Finish-to-Start (FS): A relationship between activities in which a predecessor activity must finish before its successor activity can begin. In the example shown in Figure 2.11 below, Activity B (successor) is scheduled to begin after Activity A (predecessor) finishes. This is the default and most commonly used type of relationship.

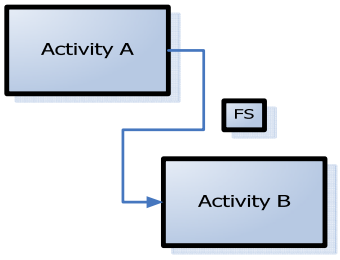


Figure 2.11: Finish-to-Start (FS) Relationship

ii) Start-to-Start (SS): A relationship between activities in which a successor activity can start when its predecessor activity begins. In the example shown in Figure 2.12 below, Activity B (successor) is scheduled to start when Activity A (predecessor) begins.

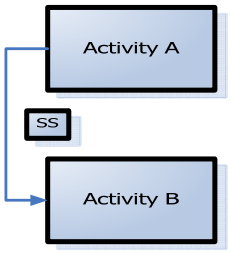


Figure 2.12: Start-to-Start (SS) Relationship

iii) Finish-to-Finish (FF): A relationship between activities in which a successor activity cannot finish until its predecessor activity finishes. In the example shown in Figure 2.13 below, Activity B (successor) is scheduled to finish when Activity A (predecessor) finishes.

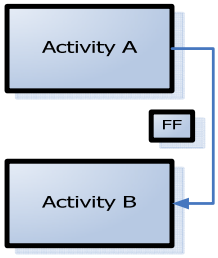


Figure 2.13: Finish-to-Finish (FF) Relationship

iv) Start-to-Finish (SF): A relationship between activities in which a successor activity cannot finish until its predecessor activity begins. Although this type of relationship is rarely used, it can be used when an activity can begin before another, but its timing is dependent on the activity that follows. In the example shown in Figure 2.14 below, Activity B is scheduled to begin before Activity A, but Activity B cannot finish until Activity A begins. Hence Activity A is a predecessor to Activity B.

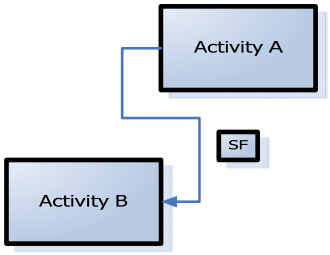


Figure 2.14: Start-to-Finish (SF) Relationship

v) Leads and Lags: A relationship property (typically expressed in workdays) that is used along with a relationship type to offset or delay the start or finish of an activity's successor activity. The terms "Leads" and "Lags" are often used interchangeably; however, by general rule a predecessor activity leads and a successor activity lags. For simplicity, all references to lags will be construed to mean either leads or lags. Lags can be positive or negative and can be used with any of the four relationship types described above. Like activities, lags consume time and are dependent on the assigned calendar, based on the software settings. In Primavera (P6), a schedule can be calculated based on any of the following lag calculation methods selected in the schedule calculation options setting "Predecessor Activity Calendar", "Successor Activity Calendar", "24 Hour Calendar", or "Project Default Calendar". Lags are often used for ease of inputting; however, they are not readily visible; therefore, should be used sparingly. Alternatively, activities may be split or extra activities may be used in lieu of lags to make the relationships more meaningful and readily apparent. In the example shown in Figure 2.15 below, Activity B lags Activity A by 5 days based on a SS+5d relationship. Therefore, Activity B cannot start until after 5 days from the start date of Activity A.

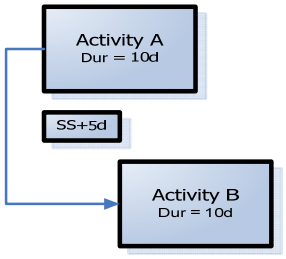


Figure 2.15: Start-to-Start (SS) Relationship with Positive Lag

In the example shown in Figure 2.16 below, Activity B lags Activity A by 5 days based on a FS-5d relationship. Therefore, Activity B cannot start until after 5 days from the finish date of Activity A. The end result is the same for both relationships from a planning perspective. However, the results may differ once the activity has started depending on progress gained. For the SS+5d relationship, the successor activity will be scheduled to start after 5 days from the date Activity A begins, regardless of amount of progress made. For the FS-5d relationship, the successor activity will be scheduled to start after 5 days from the finish date of Activity A, which is dependent on amount of progress made.

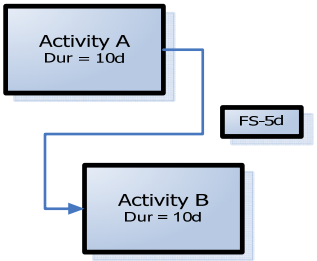


Figure 2.16: Finish-to-Start (FS) Relationship with Negative Lag

vi) Open End: A condition that exists when an activity has neither a predecessor nor successor. By general rule, all activities in a CPM schedule should be constrained with at least one predecessor and one successor except for the first activity and last activity.

vii) Loop: A logic error that occurs when an activity is both a predecessor and successor to any activity within its network path. For example, Activity A is a predecessor to Activity B and Activity B is a predecessor to Activity C; therefore, Activity C cannot be a predecessor to either Activity A or B.

6. CRITICAL PATH METHOD (CPM) NETWORK PROPERTIES

The following are basic CPM network properties:

A. Early Dates – Early dates are CPM network-calculated properties that include:

i) Early Start (ES): The earliest possible date an activity *can* begin based on the forward-pass calculation. For on-going activities, the ES date is the earliest date the activity can resume; typically, the data date.

ii) Early Finish (EF): The earliest possible date an activity *can* finish based on the forward-pass calculation.

B. Late Dates – Late date are CPM network-calculated properties that include:

i) Late Start (LS): The latest possible date an activity *must* begin to avoid delaying completion of a related interim milestone or the project. Late start dates are calculated based on the backward pass calculation.

ii) Late Finish (LF): The latest possible date an activity *must* finish without delaying completion of a related interim milestone or the project. Late finish dates are calculated based on the backward pass calculation.

C. Free Float – The amount of time (workdays) that an activity can be delayed without delaying the start or completion of its successor(s).

D. Total Float – The amount of time (workdays) that an activity can be delayed without delaying completion of a constrained milestone or the project. The following should be considered when evaluating total float:

i) By general rule and as specified in the Contract, total float is a shared commodity that is not for the exclusive use of the Department or Contractor, but can be used by either party to mitigate delays on the project on a first-come, first-serve basis.

ii) Total float is calculated relative to the specified date of a constrained activity (typically an interim milestone or project completion).

E. Negative Float – A condition that exist when an activity's scheduled early date is later than its late date. That is, the earliest that an activity can be performed is later than the date that it must be performed to avoid delaying completion of a milestone or the project. Negative float condition does not necessary indicate that the activity is on the critical path. Furthermore:

i) Negative float condition occurs only when an activity's scheduled start or finish date is later than the activity's constraint date or the constraint date of any activity on its network path.

ii) Negative float value is the number of workdays that an activity is late based on the constraint date of a related milestone or project completion.

7. METHODS FOR CALCULATING CPM NETWORK PROPERTIES

The following are methods for calculating CPM network properties:

A. Data Date – Data date is the starting point from which the schedule is calculated. Data date is also commonly referred to as the status date, which represents the date on which progress for all on-going and completed work is assessed and the schedule for all remaining work is calculated. All work to left of the data date line on a Gantt chart is considered complete and work to the right is considered remaining.

When statusing a schedule:

i) All on-going activities must be marked started with actual start dates occurring prior to the data date; otherwise, the activities will be treated as not started.

ii) All completed activities must be marked finished with actual finish dates occurring prior to or on the data date. Otherwise, the completed activities will be treated as not finished.

iii) Scheduling software such as Primavera (P6) allows for the data date to be set to a specific time of day. By general rule, the data date should be set to a time of day that represents the beginning of a typical workday as defined in the normal working calendar.

B. Forward Pass – Forward pass is a method of calculating a CPM schedule to determine the earliest possible dates that each activity on a network can be started and finished by navigating forward through the project network from the beginning to the end. Forward pass also calculates the minimum possible time required to complete the project based on the early start of the earliest activity and the early finish of the latest activity.

The following rules apply when performing a forward pass calculation:

i) Forward pass calculation assumes that all activities will start and finish as soon as possible based on network logic, duration, and imposed constraints.

ii) Forward pass calculation begins at the data date starting with activities without predecessors or the earliest activity on the network:

a) For projects that have not started, the data date is the beginning of the project; therefore, the forward pass calculation starts at the beginning of the project.

b) For on-going projects, the forward pass calculation starts at the current data date and the early start date for on-going activities is the current data date and the early finish date is based on the remaining duration as of the data date.

iii) If an activity has multiple predecessors, then its early start date is based on the early start or finish date of its latest predecessor based on network logic.

iv) Forward pass calculation formula: EF = (ES + Duration - 1)

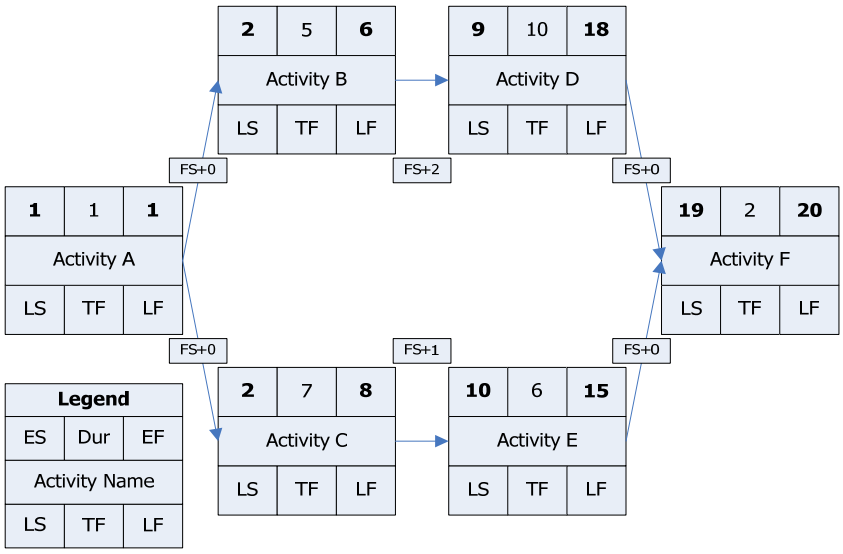


Figure 2.17: An Example of a Forward Pass Calculation

C. Backward Pass – Backward pass is a method of calculating a CPM schedule to determine the latest possible dates that each activity on a network can be started and finished by navigating backwards through the project network from the end to the beginning. Backward pass also calculates the longest possible time required to complete the project as well as the total float for each activity.

The following rules apply when performing a backward pass calculation:

i) Backward pass calculation assumes that all activities will start and finish as late as possible based on network logic, duration, and imposed constraints.

ii) Backward pass calculation begins at the end of the project or with activities without successors. For activities without successors, the LF date will be same as an imposed late finish constraint, if any, or the calculated finish date of the project.

iii) Backward pass calculation uses the EF dates calculated for the last activity in the network as the LF date from which the backward pass calculations are made. However, if the last activity is constrained with a late finish constraint, then the backwards pass calculation will begin with the imposed finish date.

iv) If an activity has multiple successors, then its LF date is based on the LS date of its earliest successor.

v) Backward pass calculation formula: LS = (LF – Duration + 1)

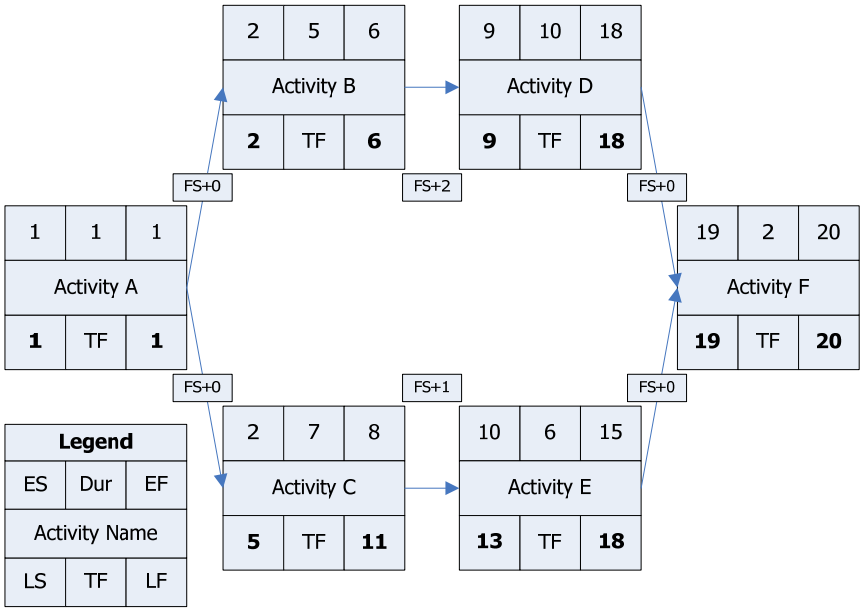


Figure 2.18: An Example of a Backward Pass Calculation

D. Total Float (TF) – Total float is calculated as the difference between the late dates and early dates. In the example shown in Figure 2.19 below, Activities A, B, D, and F all have a total float value of zero (0) and Activities C and E have total float value of three (3). In Primavera (P6), total float can be calculated based on any of the following float calculation methods selected in the schedule calculation options setting. The default and specified setting is the "Finish Float" method:

i) Start Float: Start Float is the difference between the early and late start dates:

Start Float = LS – ES.

ii) Finish Float: Finish Float is the difference between the early and late finish dates:

Finish Float = LF – EF.

iii) Most Critical Value: Most critical float value is the lower of "Start Float" and "Finish Float".

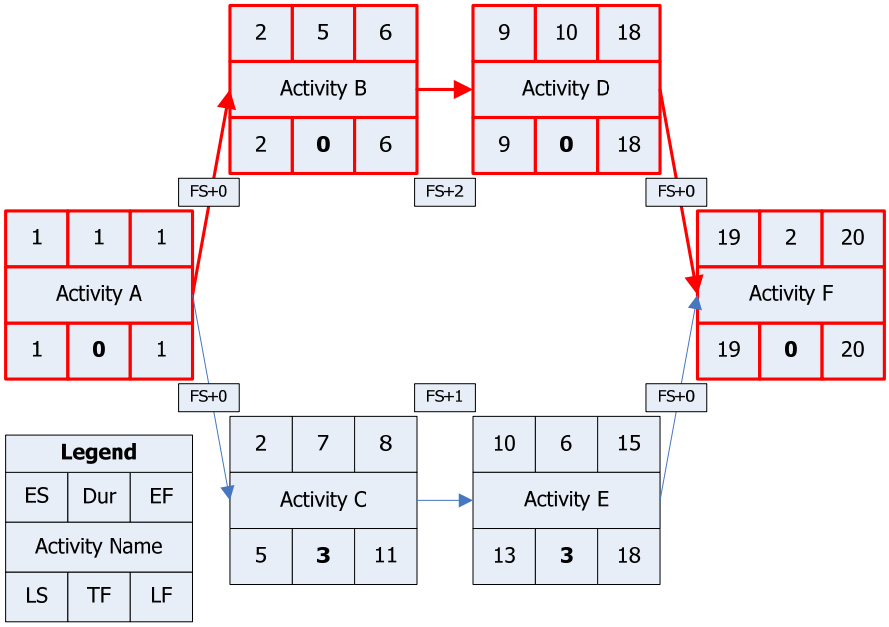


Figure 2.19: An Example of Total Float Calculation

E. Critical Path – As a general rule, the project critical path is the longest network chain of activities within the project that requires the most time to complete. Hence, the critical path is defined as the "Longest Path". The project critical path can be identified in scheduling software such as Primavera (P6) based on either the longest path or total float. However, the VDOT CPM scheduling specifications require that the critical path be defined as the longest path. In the example shown in Figure 2.19 above, the total duration of the network path A-B-D-F is twenty (20) days and the network path A-C-E-F is seventeen (17) days. The network path that requires the most time to complete is A-B-D-F therefore, the critical path. Any delay to activities A, B, D, or F will delay the project; whereas, a delay of up to three (3) days to either activities C or E will not delay the project. Coincidentally, the TF value of activities on the network path A-B-D-F is zero (0). As discussed earlier, TF can be affected by imposed constraints and an activity may have a negative float value as a result of the constraint, but the activity may not be on the longest path. Therefore, a delay to such activities will not delay the project.

8. ADVANCED SCHEDULING CONCEPTS AND PROPERTIES

The following are advanced scheduling concepts and activity properties that can be used to prepare schedules requiring resource-loading, cost-loading, or commodity tracking, as applicable:

A. Resource-Loading – Resource-loading is an advanced scheduling concept that involves a process of using the resource feature of scheduling software such as Primavera (P6) to assign resources to an activity for the purpose of defining the manpower, materials, or equipment needed to perform the work. Resource-loading establishes the inter-dependencies between activities and resources, which allow the Contractor to plan, utilize, and manage resources efficiently on a project by balancing available resources with need.

Resource-loading allows the scheduler/reviewer to determine the reasonableness of a schedule and the minimum time needed to complete a project based on resource availability. Resource-loading also allows for easy identification and correction of resource conflicts or over allocation to avoid potential schedule delays, safety, or quality issues. Lastly, resource-loading demonstrates the Contractor's ability and commitment to complete the project as planned; as well as provides a means of resolving issues on a project.

The following are resource types that can be used for resource-loading in Primavera (P6):

i) Labor: Labor resources define the manpower (people) needed to complete an activity. A labor resource may be defined in terms of a person, trade, or crew. When defining labor resources, the type and number (if multiple) should be defined for each specific labor resource. If the resource is defined by crew, then the size of the crew must be noted using the resource notes. Labor resources are time-based; therefore, when defining labor resources the *Max Units/Time* (daily availability limits) must be set for each resource to establish the maximum limit for determining resource over allocation. When assigning a labor resource to an activity the *Budgeted Units/Time* (daily usage) or *Budgeted Units* (time) must be defined to establish the daily and total units of time required to perform the activity.

ii) Non-Labor: Non-labor resources are other time-based resources needed to complete an activity such as equipment, machinery, etc. *Non-labor resource type should be used when resource loading the schedule for equipment resources*. Like labor resources, non-labor resources are time-based; therefore, when defining non-labor resources the *Max Units/Time* (daily availability limits) must be set for each resource to establish the maximum limit for determining resource over allocation. When assigning a non-labor resource to an activity the *Budgeted Units/Time* (daily usage) or *Budgeted Units* (time) must be defined to establish the daily and total units of time required to perform the activity.

iii) Materials: Material resources define the materials (supplies) needed to complete an activity. Material resources can also be used to define an output of work. When resource-loading a schedule, material resources should be defined for each consumable or re-usable item needed to accomplish the work. When cost-loading a schedule, material resources should be defined for each item of work (i.e. Regular Excavation, Concrete, etc.), as shown in the Contract Schedule of Items. When defining material resources, the type and number (if multiple), and the *Units of Measure* for each specific material resource must be defined. Also, when defining material resources, the *Max Units/Time* (daily availability limits) must be set for each resource to establish the maximum limit for determining resource over allocation. When assigning a material resource to an activity the *Budgeted Units/Time* (daily usage) or *Budgeted Units* (quantity) must be defined to establish the daily and total material units required to complete the activity.

B. Cost-loading – Cost-loading is an advanced scheduling concept that involves the assignment of budget quantity and costs to activities representing work for which money will be expended or payment will be made for the purpose of tracking costs or assessing progress on the project. For the purposes this guide, cost will be construed to mean the amount of money the Contractor will be paid to perform the work that the activity represents. Cost-loading provides a means of determining the scope, magnitude, and dollar value of work associated with an activity. Cost-loading also allows for a more accurate assessment of progress of the activity and the amount of time needed to complete the work.

Furthermore:

i) Cost-loading is only required for Category IV and V projects.

ii) At the Contractor's option, the Progress Schedule may be cost-loaded for other projects, for which cost-loading is not required. In which case, the schedule must be cost-loaded in accordance with guidelines for cost-loading a Category IV Progress Schedule, as defined herein.

iii) The "Material" resource type in Primavera (P6) must be used to cost-load activities for which payment will be made.

iv) Material resources will be defined for each corresponding item of work, as reflected on the Contract Schedule of Items. Each Material resource must have a unique ID, prefixed by the Contract ID to identify the Contract and Contract Schedule of Item.

v) The Price/Unit (bid item unit price) must be defined for each bid item, as reflected on the Contract Schedule of Items.

vi) Budgeted units (quantity) must be defined for each assigned bid item resource to define the amount of work the activity represents.

vii) A single bid item may be assigned to multiple activities or multiple bid items may be assigned to a single activity, as deemed appropriate.

viii) Cost (earnings) data generated from the schedule will be used to prepare the Progress Earnings Schedule, as required by specifications.

C. Commodity-tracking – Commodity-tracking is a scheduling concept that involves a process of utilizing the budgeted units (quantity) or costs data assigned to activities to track performance of certain aspects of the Work. Commodity-tracking provides the ability to determine the reasonableness of a schedule by correlating the amount of time needed to complete an activity based on the budgeted units and units/time (rate of production) of its driving resource. For the purposes intended, a commodity is a measurable output of work associated with a bid item or group of related bid items, whose rate of progress are expected to drive the schedule. Such commodities may include, but are not limited to earthwork, drainage, piling, precast units, structural steel, concrete, asphalt or concrete paving, or other such production-based items.

Although costs can be considered a commodity, cost-loading provides a means of tracking the overall progress of the Work, while commodity-tracking will only focus on certain aspects of the Work or operations that are expected to drive the schedule. By focusing on such aspects of the Work, negative trends in performance can be identified as early as possible to determine if corrections in performance or adjustments to the schedule are required. Failure to detect and/or correct performance deficiencies early on a project may possibly result in costly recovery efforts or irrecoverable delays. Furthermore:

i) Commodity-tracking is only required for projects that include a Category V scheduling specification. However, commodity-tracking can be performed on any project using a cost-loaded schedule. In which case, appropriate resource or activity codes must be assigned to allow for filtering and grouping of the selected resources or activities.

ii) A commodity may consist of a single bid item or group of similar bid items with the same unit of measure and anticipated rate of production. Only the bid items or group of related

items whose rate of progress will have the greatest influence on the schedule will be selected for monitoring.

iii) The budgeted units data provided as part of the cost-loading process will be used to track performance and rate of production of selected commodities; as well as to verify activity durations for the associated activities.

iv) A commodity-tracking report will be generated for each selected commodity.

SECTION III

PLANNING AND SCHEDULING

1. Introduction
2. Planning the Work
3. Scheduling the Work
4. Updating the Schedule
5. Analyzing and Revising the Schedule

SECTION III

1. INTRODUCTION

Planning and scheduling are two distinct, but related major steps necessary for successful on time completion of a project. Planning involves a forward-thinking process of determining how the work will be accomplished. Scheduling involves a process of determining when the individual activities that make up the project will be completed. Prior to beginning the Work, a work plan should be developed to determine how the work will be accomplished. A schedule should then be developed to determine when the activities must be completed. And once the work is underway, the schedule should be maintained regularly to ensure that it accurately reflects how the work is being performed. And when changes occur, the schedule should then be analyzed to determine the effects of the changes. If necessary, the schedule should be revised to incorporate the changes or to ensure that the schedule reflects a realistic plan to accomplish the remaining work. This section provides a systematic approach to planning and scheduling that can be used on projects of various sizes and complexities.

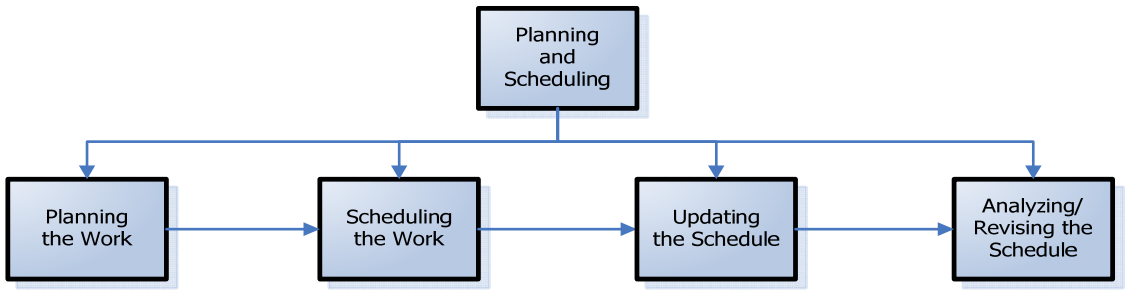


Figure 3.1: Planning and Scheduling Process

2. PLANNING THE WORK

Planning involves a detailed and forward-thinking process necessary to determine the most feasible and effective way to accomplish the Work. Regardless of how big or small or how simple or complex a project is, the first and most important step in scheduling is to determine how the Work will be accomplished. Planning establishes the *what*, *who, where, how*, and *in what order* the work will be performed. In essence, the planning process provides an outline with which the detailed activities required to complete the project are scheduled. Planning involves the following steps:

A. Establish the Project Objectives and Constraints – Review the contract documents to gather information about the project to:

i) Determine the project objectives including, as applicable:

a) Scope of Work;

b) Work by other involved parties;

c) Time;

d) Cost.

ii) Understand the contract requirements concerning, as applicable:

a) Milestones;

b) Sequence of construction, phasing, staging, etc.;

c) MOT;

d) Submittals;

e) Constructability;

f) Permits, environmental, etc.

iii) Determine project constraints or restrictions including, as applicable:

a) Physical constraints;

b) Right-of-way (ROW) or access constraints;

c) Traffic constraints;

d) Seasonal and weather constraints;

e) Time of year restrictions or environmental constraints;

f) Time of day restrictions;

g) Special events.

B. Develop a Work Breakdown Structure (WBS) – Develop a WBS to break the project down into definable, manageable, and measurable work packages, as appropriate, to allow for proper planning and sequencing of the work and resources. Depending on the Scope of Work and the Contractor's approach, the Work can be divided into major categories, phases, or features of Work, as applicable. Each category, phase, or feature can then be further decomposed into their respective sub-ordinate WBS nodes. For example:

i) Project Management: The Project Management WBS node can be decomposed into its sub-ordinate WBS nodes, including as applicable:

a) Milestones;

b) Notifications;

c) Permits;

d) Submittals.

ii) Environmental Impact Study (EIS): The EIS WBS node can be decomposed into its sub-ordinate WBS nodes, as applicable:

iii) Design: The Design WBS node can be decomposed into its sub-ordinate WBS nodes by design phase, including as applicable:

a) Preliminary Design (Site Survey, ROW Design, Geotechnical Investigation, Preliminary Design, etc.);

b) Final Design;

c) Design Packages/Construction Plans.

iv) Right-of-Way (ROW): The ROW WBS node can be decomposed into its sub-ordinate WBS nodes by property or parcel, as applicable:

v) Procurement: The Procurement WBS node can be decomposed into its sub-ordinate WBS nodes by long lead item, as applicable.

vi) Utilities: The Project Management WBS node can be decomposed into its sub-ordinate WBS nodes by type of utility, including as applicable:

a) Sewer Line Relocation/Adjustment;

b) Water Line Relocation;

c) Gas Main Relocation;

d) Telephone Line Relocation;

e) Fiber-optics Line Relocation;

f) Cable Television Line Relocation;

g) Electric Power Line Relocation.

vii) Construction: The Construction WBS node can be decomposed into its sub-ordinate WBS nodes, with each subordinate WBS node further decomposed into their respective sub-ordinate nodes, as applicable:

a) General Construction (Mobilization, MOT, Surveying, Clearing and Grubbing, Erosion and Sedimentation Control, etc.);

b) Features (Major Drainage Structures, Roadways, Bridges, Ramps, SWMB, Traffic Signals, Overhead Sign Structures, etc.);

c) Segments or Major Areas;

d) Phases (Phase 1, Phase 2, etc.);

e) Stages (Stage 1, Stage 2, etc.);

f) Punch-list/Clean-out/Demobilization.

C. Determine the Means and Methods – Once the project has been divided into manageable parts, determine the means and methods required to accomplish each major operation. Means and methods are the Contractor's resources and procedures that establish how the work will be performed. In essence, the means and methods establish the basis on which the schedule is founded. When defining the means and methods, considerations should be given to all known and foreseeable constraints, restrictions, or requirements, including as applicable:

i) Type of work;

ii) Scope of work;

iii) Contract requirements;

iv) Constructability issues;

v) Safety requirements;

D. Establish the Work Plan – Once the major work elements and means and methods have been defined, determine the most effective work plan to accomplish the Work. Develop an outline for each alternative work plan by modeling feasible alternative work sequences and means and methods to determine the preferred work plan. The work plan can be developed as follows:

i) Develop a list of summary level activities based on the WBS, including as applicable all major milestones.

ii) Sequence the activities in the order in which the work will be accomplished using the PDM or other preferred method, with considerations for all known and foreseeable constraints or requirements, including as applicable:

a) Contract requirements;

b) Work to be performed by the Department and other involved parties;

c) MOT or phasing requirements;

d) Proposed means and methods;

e) Physical or ROW constraints;

f) Constructability;

g) Structural integrity;

h) Safety requirements.

iii) Estimate activity durations for the summary-level activities based on:

a) Scope;

b) Proposed means and methods;

c) Quantity of work;

d) Productivity;

e) Project constraints;

f) Experience;

g) Historical data.

iv) Develop a summary-level planning schedule for each alternative work plan based on:

a) Sequence of construction;

b) Activity durations;

c) Calendar constraints including as applicable, seasonal, weather, local events, time of year restrictions, etc;

d) Resource requirements and availability.

v) Analyze each alternative work plan to determine the most feasible work plan that satisfies the contract requirements and project objectives, including:

a) Milestones;

b) Costs;

c) Resources;

d) Safety;

e) Quality.

vi) Communicate the preferred work plan to the project team and other involved parties including sub-Contractors, suppliers, utilities, and the Department to obtain their endorsement (buy-in).

3. SCHEDULING THE WORK

Scheduling involves a process of defining the specific details, sequence, and timing of the individual activities necessary to execute the plan. In essence, the scheduling process is about defining the individual activities that make up a project and establishing the order and times within which the activities will be completed. The scheduling process involves the following primary steps:

A. Define the Detail Activities – When developing a schedule the Work should be broken down in sufficient details to allow the schedule to be used effectively to plan, manage, and control the project; as well as to evaluate the impact of changes to the project. Define the detail activities to show the discrete work tasks and other time-based tasks necessary to complete the project. Once the activities have been defined, assign unique Activity ID's and Activity Names to the activities to avoid ambiguities and to ensure that the activities accurately reflect the work that they represent. Activities should be named to indicate the type of operation, phase, feature of work, and specific location within which the work is being performed.

As a general rule, the Work should be broken down into discrete and measurable work tasks by trade based on the Contractor's proposed means and methods. The Work should be broken down in sufficient details necessary to distinctly identify the feature, type of work, and specific location or limits of the work that the activity represents. The following are examples of a breakdown of the Work by category and further into detail activities:

i) Administrative: Define the administrative activities associated with the Work, including as applicable:

   a) Contract milestones;

   b) Key submittals such as permits, schedules, etc;

   c) Notifications such as traffic switches, utility, shutdowns, outages, etc.;

   d) Department review.

ii) Procurement: Define the individual activities associated with the procurement/delivery of long lead materials or specialty items, including as applicable:

   a) Procurement;

   b) Preparation of shop drawings, installation drawings, etc.;

   c) Fabrication;

   d) Delivery.

iii) Start-up: Define the individual activities necessary for construction start-up, including as applicable:

   a) Mobilization;

   b) Construction access, staging area, etc.;

   c) Survey, etc.

iv) Maintenance of Traffic (MOT): Define the individual MOT activities necessary for maintaining traffic, including as applicable:

a) Installation of temporary signs;

b) Installation of traffic control devices;

c) Traffic switches, etc.

v) Utilities: Define the utility relocation or adjustments activities, including as applicable:

a) Design, shop drawings, etc.;

b) Materials procurement;

c) Mobilization;

d) Shutdowns, outages, etc.;

e) Temporary relocation or adjustments;

f) Permanent relocation or adjustments;

g) Testing.

vi) Bridges and Structures: Define the individual activities necessary for constructing the bridges or structures, including as applicable:

a) Installation and removal of temporary systems or structures such as causeways, shoring, sheet piling, cofferdams, etc.;

b) Structural excavation;

c) Steel piling, concrete piling, drilled shafts, etc.;

d) Load test;

e) Form/Rebar/Place (FRP) pier footing, abutment footing, etc.;

f) Install MSE walls;

g) FRP pier column, pier caps, abutment walls, etc.;

h) Curing periods;

i) Install bearings;

j) Erect structural steel girders, precast girders, precast box girders, etc.;

k) Install overhang forms;

l) Install expansion joints;

m) FRP deck concrete;

n) FRP parapets;

o) Install bridge rails;

p) FRP Approach slabs;

q) Concrete deck overlays;

r) Bridge lighting or navigation lights;

s) Riprap or concrete slope protection;

t) Bridge fender system or dolphin construction;

u) Demolition and removal of existing structures, etc.

vii) Roadway: Define the roadway construction activities, including as applicable:

a) Clearing and grubbing;

b) Siltation and sediment control;

c) Install drainage pipes;

d) Install drainage structures;

e) Regular excavation;

f) Borrow excavation;

g) Settlement or surcharge periods;

h) Place select material;

i) Subgrade preparation;

j) Place aggregate base (subbase);

k) Install under-drains;

l) Cement or lime stabilization;

m) Asphalt-stabilized open-graded material;

n) Asphalt or concrete curb and gutter;

o) Asphalt or concrete median;

p) Place asphalt concrete base course;

q) Place asphalt concrete inter-mediate course;

r) Place asphalt concrete surface course;

s) Place Portland cement concrete pavement.

viii) Incidental Roadway Items: Define the incidental roadway construction activities, including as applicable:

a) Installation of guardrail or steel median barriers;

b) Sidewalk;

c) Retaining walls;

d) Sound barrier walls;

e) Demolition of existing pavements;

f) Fences, etc.

ix) Traffic Control: Define the traffic control activities, including as applicable:

a) Sign structures;

b) Lighting structures;

c) Signal structures;

d) Traffic signals;

e) Traffic signs and delineators;

f) Pavement markings and markers;

g) Roadway lighting, etc;

h) Traffic switches, etc.

x) Roadside Development: Define the individual roadside development activities, including as applicable:

a) Seeding;

b) Sodding;

c) Planting, landscaping, etc.

xi) Miscellaneous: Define other miscellaneous activities that consume time and are required for completion of the project, including as applicable:

a) Installation and removal of temporary systems or structures such as causeways, shoring, etc.;

b) Sampling and testing periods;

c) Acceptance testing;

d) Demolition of existing pavements;

e) Punch list and clean-up;

f) Traffic control tear-down;

g) Demobilization and move-out.

B. Determine Activity Sequence – Once the activities have been defined; determine the sequence in which the activities will be performed based on the preferred work plan established during the planning process. Depending on the scheduling method, the order in which the activities will be performed may be determined as follows:

i) For relatively simple or short duration projects requiring tabular or bar-chart schedules (Cat M, I, and II), list the activities according to the order in which the work will be performed (start dates).

ii) For relatively complex projects requiring CPM schedules (Cat III, IV, and V), use the PDM to establish inter-relationships between the activities to form the network logic with which the activities are scheduled.

C. Estimate Activity Durations – Once the detail activities and intended sequence have been defined, estimate the amount of time required to complete each activity with considerations for the following, as appropriate:

i) Quantity of work and anticipated daily rate of production;

ii) Proposed means and methods;

iii) Experience or historical performance data;

iv) Difficulty of the work;

v) Weather or seasonal constraints (if not considered in the working calendar);

vi) Traffic constraints or other applicable factors that may affect productivity.

D. Determine Activity Dates – Once the order of sequence and activity durations have been defined, determine the dates on which the activities will be performed, using an appropriate scheduling method. The timing of an activity is dependent on its duration and relationship with other activities; as well as other factors that control when the activity can be performed such as calendars and availability of resources. Depending on the scheduling method, the dates on which the activities can be completed may be determined as:

i) For simple or short duration projects, any available calendar such as a monthly/yearly calendar can be used to determine the start and finish dates for each activity based on the forward pass approach and the order in which the activities will be performed. The dates derived can then be used to develop a tabular or bar-chart schedule to show the specific order and timing of the activities.

ii) For relatively complex projects, scheduling software such as Primavera (P6) can be used to calculate the schedule based on the CPM to determine the dates within which the individual activities can be completed.

E. Review and Analyze the Schedule – Once the schedule is completed it should be reviewed and analyzed before it is submitted to the Department. The schedule should be reviewed to ensure that it is complete and that it conforms to the requirements of the Contract and specifications. The schedule should also be analyzed to ensure that the schedule reflects a realistic plan to complete the project and that the project objectives are met. Specifically, the schedule should be reviewed and analyzed to ensure that:

i) All work tasks and other necessary time-based tasks required to complete the project are included;

ii) All requirements concerning milestones, phasing, MOT, sequence of construction, means and methods, specified constraints and restrictions, etc. are in conformance with the Contract;

iii) Activity durations are realistic;

iv) The schedule reflects a logical progression of work and practicable plan;

v) The critical path make sense (CPM schedules only);

vi) Calendars and constraints are properly assigned;

vii) There are no scheduling conflicts due to resources, trade types, or work by others that may cause delays, quality, or safety issues;

viii) The schedule conforms to the requirements of the scheduling specifications.

F. Obtain Buy-in/Acceptance – The schedule should be communicated to the project team and other involved parties to obtain their buy-in. Upon concurrence by the project team, the schedule should be submitted to the Department for review and acceptance, as required. Upon acceptance by the Engineer, the schedule then becomes the project Schedule of Record (SOR) with which all parties will plan and schedule their work and against which progress will be measured.

4. UPDATING THE SCHEDULE

Once the project is underway and the Schedule of Record (SOR) is established, it is of utmost importance that the schedule is updated regularly to determine the current status of the project and to ensure that the schedule accurately reflects how the work is being performed.

A. Why Update the Schedule – An updated schedule provides the current status of the activities and the project and the current plan to complete the remaining work. Furthermore, an updated schedule provides a means to:

i) Create an accurate historical record of when activities actually started and finished.

ii) Determine whether the project is ahead or behind progress.

iii) Reasonably forecast project completion dates.

iv) Plan for resources needed to accomplish the remaining work.

v) Identify changes in the work, sequencing, or other deviations from the original plan to determine if adjustments in the work plan or schedule are necessary.

vi) Identify areas that require special attention and where to concentrate the Contractor's forces to meet project goals and objectives.

vii) To determine the effects of time-related issues on the project to allow for timely and informed decisions on how the impacts may possibly be avoided or mitigated.

B. Monitor the Project – As the project progresses, the schedule becomes a viable tool, with which to monitor the day-to-day activities and control the project. The work should be monitored on an on-going basis to record progress information for each event as it occurs. This information is then used to update the schedule to determine the current status of the activities and the project; as well as to predict the schedule outcome of the project. The following are guidelines for monitoring the project and gathering activity progress information:

i) Progress and as-built information should be gathered to reflect actual progress of the Work as of the status date (typically the Contractor's monthly progress estimate date).

ii) As-built schedule information can be collected using any of the following methods:

a) Daily field reports;

b) Weekly look-ahead schedules;

c) Turnaround reports;

d) Update meeting minutes;

e) Progress photographs or videos.

iii) Record as-built schedule information for each completed or on-going activity as follows:

a) Actual start date;

b) Percent complete of on-going activities. Percent complete should be based on amount of work-in-place as of the data date relative to the total amount of work planned (estimate at completion);

c) Remaining duration of on-going activities. Remaining duration should be based on amount of work remaining as of the data date relative to the total amount of work planned;

d) Actual finish date dates for completed tasks;

e) Milestone(s) met or missed;

f) Resources (manpower and equipment) used.

iv) Conduct periodic progress update meetings with field personnel to:

a) Review and agree on status of the activities;

b) Review and agree on as-built dates;

c) Discuss the schedule for remaining work;

d) Discuss issues relating to the current status of the schedule.

v) Document changes to the Work or work plan.

vi) Document potential issues or problems encountered.

C. Update the Schedule – Once the progress and as-built information has been gathered and status of the activities have been determined; the schedule will be updated periodically to determine the current status of the project. The schedule should be updated at a minimum monthly or as required by specifications. The following are guidelines for updating the project schedule:

i) Maintain records of the project schedules:

a) Keep hard copies of all schedules;

b) Keep electronic copies of the baseline, monthly schedule updates, revisions, and reviews.

ii) Prior to updating the schedule, create a copy of the previous schedule update and rename as the current update.

iii) Record activity as-built schedule information for completed or on-going activities as of the data date (typically the Contractor's monthly progress estimate date):

a) Record actual start date for activities that have started;

b) Record activity percent complete for on-going or completed activities to determine how much of the work has been completed. Activity percent complete will be based on work-in-place relative to the total amount of work planned;

c) Enter remaining duration for in-progress activities to determine the planned finish date of the activity. Remaining duration will be the amount of time needed to complete the remaining work as of the data date;

d) Record actual finish date for activities that have completed.

iv) Adjust the data date to the current progress payment estimate date.

v) Calculate the schedule to determine the current status of the project.

5. ANALYZING AND REVISING THE SCHEDULE

For a variety of reasons a project is rarely performed precisely as planned. Since the plan is likely to change over time, particularly when problems are encountered, it is essential that the schedule is maintained regularly to ensure that the schedule remains a viable tool to monitor and control the project. When changes in the Work or the work plan occur, the schedule should be analyzed to determine the impact of the changes. If necessary, the schedule should be revised accordingly to incorporate the changes in the Work or to reflect how the work is being performed. This section provides guidelines on analyzing and revising the schedule when necessary. *For guidelines on performing schedule impact analysis for changes or delays, refer to Section VI*.

A. Analyze the Schedule – Prior to submitting the updated schedule, the schedule should be analyzed to determine if it accurately reflects how the work is being performed and whether the plan to complete the remaining work is realistic. The schedule should also be analyzed to identify deviations from scheduled performance to determine if the project goals are still being met or if revisions are required. The following are guidelines for analyzing the schedule:

i) Check to ensure that the schedule accurately reflects the current status of the activities and the project.

ii) Check to ensure that the Work is progressing according to plan and that the interim milestone and contract completion dates are still being met.

iii) Check to ensure that the critical path or critical activities have not deviated from the SOR. If so, determine the reasons why and if revisions are necessary.

iv) Check to determine if total float of activities have deviated significantly from the SOR. If so, determine if changes to the work plan or schedule are necessary.

v) Review work in the field and out-of-sequence report to identify activities that are being performed out of sequence.

vi) Review relationships of remaining activities to determine if the relationships are still valid.

vii) Review rate of performance of completed activities or activities in-progress to identify deviations from planned performance to determine if corrective actions are necessary.

viii) Review to ensure that approved changes in the work since the last update have been incorporated.

vi) Determine if changes in the schedule are required and if the changes are minor or major.

B. Minor Revisions – Minor revisions are modifications to the schedule that do not significantly impact the schedule or cause a significant shift in the progress earnings curve, but are needed to ensure that the schedule accurately reflects the current plan to complete the remaining work. When it is determined that minor revisions to the schedule are needed, the schedule will be adjusted as necessary to ensure that the schedule accurately reflects how the work is being performed. For such revisions, the modified schedule will be submitted as an update schedule.

Revisions are considered minor if:

i) Minor adjustments are needed to correct unrealistic activity durations or outdated logic or out-of-sequence progress to reflect the current work plan.

ii) Minor adjustments are needed to incorporate minor changes in the Work (added or changed work) that do not affect the critical path, interim milestones, or project completion milestone; or cause a significant shift in the progress earnings curve.

iii) Adjustments are needed to reflect a proposed recovery plan to correct progress deficiency.

C. Major Revisions – Major revisions are modifications made to the schedule that significantly impact the schedule or cause a significant shift in the progress earnings curve. Such revisions may involve major changes in the Work or Contractor's approach. When it is determined that major adjustments to the schedule are needed, the schedule will be revised as necessary to incorporate the changes or to ensure that the schedule accurately reflects how the work is being performed. For such revisions, the schedule will be submitted as a revised baseline schedule.

Revisions are considered major if:

i) Major adjustments are needed to correct unrealistic activity durations or a significant number of activities that are being performed out-of-sequence.

ii) Major adjustments are needed to incorporate major changes in the Work (added or changed work) that alter the critical path or extend the completion date of an interim milestone or the project; or cause a significant shift in the progress earnings curve.

iii) Progress of the Work is deemed unsatisfactory, but it is determined by the Engineer that the project is not at risk of finishing late. In which case a revised schedule rather than a recovery schedule is required to complete the remaining work.

D. Revising the Schedule – When revisions are necessary to incorporate changes in the Work or work plan, the schedule will be revised as follows:

i) Prior to revising the schedule, create a copy of the current version of the project schedule and rename as the new update or revision, as applicable.

ii) Add activities as necessary to:

a) Incorporate approved changes in the Work;

b) To provide more details.

iii) Revise activity logic as necessary to:

a) Incorporate approved changes in the Work;

b) Reflect any changes in the work plan;

c) Reflect changes for known or anticipated changes or conditions.

iv) Revise activity durations as necessary to reflect any changes in:

a) Scope of work;

b) Resource allocation;

c) Means and methods;

d) Productivity;

e) Conditions;

f) Deleted work (Activities for deleted work should not be deleted; instead, activity durations should be revised to zero (0)).

v) Note in the activity log or notepad, the changes made and reasons for the changes.

vi) For schedules prepared in scheduling software such as Primavera P6, set the data date to the current date or as required by specifications.

vii) Calculate the schedule to determine the current status of the project.

viii) Review the schedule to ensure that project goals and objectives are being met.

ix) Review the schedule for completeness and compliance with the Contract and specifications.

x) Obtain endorsement of the schedule by the project team and other involved parties.

xi) Submit the schedule to the Department for review and acceptance.

Upon review and acceptance by the Engineer, a revised schedule submitted for major changes then becomes the new SOR, against which progress of the remaining work will be assessed. And a revised schedule submitted for minor changes or recovery plan will be submitted as a schedule update and will not replace the SOR.

SECTION IV

PROGRESS SCHEDULES

1. Introduction
2. General Requirements
3. Category M Schedule of Operations
4. Category I Progress Schedule
5. Category II Progress Schedule
6. Category III Progress Schedule
7. Category IV Progress Schedule
8. Category V Progress Schedule
9. Detail Requirements and Guidelines for Preparing the Progress Schedule Submittals

SECTION IV

1. INTRODUCTION

Contracts awarded by VDOT include provisions that require the Contractor to provide a Progress Schedule for use in executing, monitoring, and controlling the Work. The scheduling requirements vary by project category based primarily on size, level of complexity, and associated risk as described in Section I. This section expounds on the requirements of the Progress Schedule specifications; as well as provides guidelines to facilitate development, review, and use of the Progress Schedule.

2. GENERAL REQUIREMENTS

This section provides general requirements concerning the Progress Schedule, which shall apply to all projects, except as noted herein or elsewhere in the Contract:

A. Progress Schedule – The Contractor shall prepare and submit a Progress Schedule, as specified in the Contract, to aid the Contractor and the Department in planning, scheduling, and executing the Work. The Progress Schedule shall depict the sequence in which the Contractor proposes to perform the Work and the dates on which the Contractor contemplates starting and completing all schedule activities required to accomplish the Work, in accordance with the requirements of the Contract. The Contractor shall maintain the Progress Schedule regularly, at a minimum monthly, to ensure that the Progress Schedule continues to reflect the current status of the Project and plan to complete the Work. The Progress Schedule shall be used by all involved parties to plan, schedule, and coordinate all work required to complete the project. The Progress Schedule shall also be used to assess progress of the Work and to evaluate the effects of time-related changes or delays on the project.

B. Scheduling Conference – At least seven (7) calendar days prior to beginning the Work, the Contractor shall attend a Scheduling Conference with the Engineer on a mutually agreed date. The Contractor may be allowed to begin work on certain project start-up activities prior to the Scheduling Conference, as approved by the Engineer. Such start-up activities may include, but are not limited to submittals, mobilization, surveying, construction access and signage, erosion and sedimentation controls. The Contractor shall be prepared to discuss the following:

i) The Contractor's Overall Plan: The Contractor's intentions and proposed overall plan to accomplish the Work, including, as applicable the:

a) Proposed general sequence of construction. Where the work will begin and how it will progress, including any deviations from the phasing, staging, or sequence of construction as indicated on the Contract Documents or as approved by the Engineer.

b) Maintenance of traffic (MOT) plan.

c) Proposed means and methods for major operations.

d) Work planned or anticipated each construction season.

ii) Initial Start-up Plan: The detail work plan for accomplishing the work scheduled for the initial start-up period. For Categories I and II projects, the initial start-up period is thirty (30) calendar days. For Categories III and IV projects, the initial start-up period is ninety (90) calendar days. For Category V projects, the initial start-up period is one-hundred and twenty (120) calendar days.

iii) Key Project-specific Requirements: Key project-specific requirements and information necessary for the development of the Baseline Progress Schedule including, as applicable:

a) Scheduling and submission requirements such as software settings, WBS, activity codes, calendars, reports, etc.;

b) Phasing or sequencing;

c) Milestone(s) and other time-related requirements;

d) Work to be performed by the Department or other involved parties;

e) Time of year restrictions.

iv) Project Constraints and Key Issues: Project constraints and other key issues necessary for the development of the Baseline Progress Schedule including, as applicable:

a) Key submittals;

b) Permits;

c) Construction access;

d) Right of way;

e) Environmental;

f) Utility;

g) Traffic or local events;

h) Constructability issues relative to the Contract plans and specifications;

i) Other known or foreseeable issues that may impact the schedule.

3. CATEGORY M PROGRESS SCHEDULE SUBMISSION REQUIREMENTS

For projects designated in the Contract as Category M, the Contractor shall furnish the Progress Schedule in accordance with the following submission requirements:

A. Initial Schedule of Operations – At least seven (7) calendar days prior to beginning the Work, the Contractor shall prepare and submit an Initial Schedule of Operations to the Engineer for review and acceptance. The Initial Schedule of Operations is the Contractor's initial overall plan to accomplish the Work in accordance with the Contract. The Initial Schedule of Operations submission shall consist of the following:

1. An Initial Tabular Schedule of Operations: The Initial Tabular Schedule of Operations shall show in a tabular format the overall sequence and period of time during which activities representing work for each location, route, or segment of work, as delineated in the Contract Documents, or as approved by the Engineer, are planned to occur.

   At the discretion of the Contractor, a Bar-chart or CPM Progress Schedule may be submitted in lieu of a Tabular Schedule of Operations. In which case, the schedule shall be prepared and submitted in accordance with the requirements and guidelines for a Bar-chart or CPM Progress Schedule, as defined herein. Otherwise, the Category M Tabular Schedule of Operations shall be prepared in accordance with the requirements and guidelines described in Section IV.9.A below.

2. A Schedule of Operations Narrative: The written Schedule of Operations Narrative shall describe the Contractor's overall plan and sequence in which the Work will be accomplished. The Category M Initial Schedule of Operations Narrative shall be prepared in accordance with the requirements and guidelines described in Section IV.9.D.2 below.

B. Two-week Look-ahead (2WLA) Schedule – Once the Work has commenced the Contractor shall submit every week, on a day agreed to by the Contractor and the Engineer, a 2WLA Schedule to show the status of on-going work for the current week and work planned for the following two-week period. The Contractor shall notify the Department within two (2) work days of any proposed changes in the Contractor's planned operations or critical stage work requiring Department oversight or inspection. Unless directed otherwise by the Engineer, the Contractor shall provide three (3) paper copies of the 2WLA Schedule. The 2WLA Schedule shall show in a tabular or spreadsheet format:

i) A detailed list of activities for work currently in progress and any work starting or scheduled for completion during the next two-week period. The activities shall indicate the type of operation, location or limits of the work, planned start and finish dates, and proposed working days, shifts, and hours.

ii) Any critical stage work requiring Department oversight or inspection and work to be performed by the Department and other involved parties.

C. Revised Schedule of Operations – When the Contractor proposes a significantly different approach from the overall work plan or sequence as reflected on the SOR or when the Contractor's overall work plan or schedule has deviated significantly from the SOR, the Contractor shall submit a Revised Schedule of Operations.

When deemed necessary by the Engineer, the Revised Schedule of Operations shall be submitted within five (5) business days of receiving the Engineer's request or as directed. The Revised

Schedule of Operations will be submitted in the form of an Initial Schedule of Operations and shall reflect the current status of the Work and any changes in the Contractor's overall work plan as of the date of submittal. Upon acceptance by the Engineer, the Revised Schedule of Operations will replace any previously accepted Schedule of Operations as the SOR for the remainder of the Work. Circumstances that may prompt the Engineer's request include the following:

i) A significant change in the overall sequence of the Work has occurred or the current schedule has deviated by one or more months from the SOR.

ii) Percentage of amount of time expended has exceeded the percentage of work completed by ten (10) or more percentage points.

4. CATEGORY I PROGRESS SCHEDULE SUBMISSION REQUIREMENTS

For projects designated in the Contract as Category I, the Contractor shall furnish the Progress Schedule in accordance with the following submission requirements:

A. Baseline Progress Schedule – At least seven (7) calendar days prior to beginning the Work, the Contractor shall prepare and submit a Baseline Progress Schedule to the Engineer for review and acceptance. The Baseline Progress Schedule shall represent the Contractor's complete initial detailed plan for accomplishing the Work. The Baseline Progress Schedule shall reflect the current status of the project and the Contractor's current plan to complete the remaining work, as of the date of submittal:

1. A Tabular Baseline Progress Schedule: The Tabular Baseline Progress Schedule shall show in a tabular format the overall sequence and period of time during which activities representing the work items and all time-based tasks required to complete the project are planned to be completed.

   At the discretion of the Contractor, a Bar-chart or CPM Progress Schedule may be submitted in lieu of a Tabular Progress Schedule. In which case, the schedule shall be prepared and submitted in accordance with the requirements and guidelines for a Bar-chart or CPM Progress Schedule, as applicable, and as defined herein. Otherwise, the Category I Baseline Tabular Progress Schedule shall be prepared in accordance with the requirements and guidelines described in Section IV.9.A below.

2. A Baseline Progress Schedule Narrative: The written Baseline Progress Schedule Narrative shall describe the Contractor's overall plan and sequence in which the Work will be accomplished. The Category I Baseline Progress Schedule Narrative shall be prepared in accordance with the requirements and guidelines described in Section IV.9.D.2 below.

3. A Baseline Progress Earnings Schedule: The Baseline Progress Earnings Schedule shall indicate the Contractor's anticipated progress of the Work for each month, as reflected on the accepted Tabular Baseline Progress Schedule. The anticipated progress shall be expressed as a percentage of anticipated total earnings to date, as of the progress estimate date, relative to the Total Contract Value. Total Contract Value will be considered to mean the original amount of the Contract including any authorized adjustments for changes in the Work in accordance with, but not limited to, the provisions of Sections 109.04 and 109.05 *of the Specifications*. *Anticipated payments for Material on Hand in accordance with Section 109.09 of the Specifications or for other adjustments such as asphalt, fuel, retainage, liquidated damages, incentives, disincentives, etc., will not be considered in the Progress Earnings Schedule*.

   The Category I Baseline Progress Earnings Schedule shall be prepared and submitted using the VDOT Form C-13C and in accordance with the requirements and guidelines described in Section IV.9.E.1 below.

B. Two-week Look-ahead (2WLA) Schedule – Once the Work has commenced the Contractor shall submit every week, on a day agreed to by the Contractor and the Engineer, a 2WLA Schedule to show the status of on-going work for the current week and work planned for the following two-week period. The Contractor shall notify the Department within two (2) work days of any proposed changes in the Contractor's planned operations or critical stage work requiring Department oversight or inspection. Unless directed otherwise by the Engineer, the Contractor

shall provide three (3) paper copies of the 2WLA Schedule. The 2WLA Schedule shall show in a tabular or spreadsheet format:

i) A detailed list of activities for work currently in progress and any work starting or scheduled for completion during the next two-week period. The activities shall indicate the type of operation, location or limits of the work, planned start and finish dates, and proposed working days, shifts, and hours.

ii) Any critical stage work requiring Department oversight or inspection and work to be performed by the Department and other involved parties.

C. Revised Progress Schedule – When the Contractor proposes a different approach to the overall work plan or sequence that deviates significantly from what was planned as reflected on the SOR, the Contractor shall submit a Revised Progress Schedule. Deviate *significantly* from the SOR will be construed to mean major changes in the work plan resulting in schedule impacts that alter the project critical path or Contract milestones or cause a major shift in the Progress Earnings Schedule.

Also, when major changes in the Work are directed or authorized by the Engineer or when it is determined by the Engineer that the Contractor's current work plan or schedule has deviated significantly from the SOR, the Engineer will issue a written request for a Revised Progress Schedule. Circumstances that may prompt the Engineer's request include the following:

i)

ii) The Engineer has approved a significant change to the Contract that modifies the completion date of an interim Contract milestone or the project completion date by at least thirty (30) calendar days.

iii) A significant amount of work is being performed out of sequence.

iv) The percentage of work completed falls behind by ten (10) or more percentage points relative to the SOR and the project is not presently at risk of finishing late, as determined by the Engineer.

The Revised Progress Schedule shall be submitted in lieu of the subsequent monthly Progress Schedule Update, or as directed by the Engineer. The Revised Progress Schedule shall be submitted in the form of a Baseline Progress Schedule and shall reflect the current status of the Work and any changes in the Contractor's current work plan as of the date of submittal. Upon acceptance by the Engineer, the Revised Progress Schedule shall replace any previously accepted Baseline (re-baseline) or Revised Progress Schedule as the SOR for the remainder of the Work.

5. CATEGORY II PROGRESS SCHEDULE SUBMISSION REQUIREMENTS

For projects designated in the Contract as Category II, the Contractor shall furnish the Progress Schedule in accordance with the following submission requirements:

A. Baseline Progress Schedule – At least seven (7) calendar days prior to beginning the Work, the Contractor shall prepare and submit a Baseline Progress Schedule to the Engineer for review and acceptance. The Baseline Progress Schedule shall represent the Contractor's complete initial detailed plan for accomplishing the Work. The Baseline Progress Schedule shall reflect the current status of the project and the Contractor's current plan to complete the remaining work, as of the date of submittal:

1. A Bar-chart Baseline Progress Schedule: The Bar-chart Baseline Progress Schedule shall show in a time-scaled bar-chart (Gantt chart) format the overall sequence and period of time during which activities representing each feature and all time-based tasks required to complete the project are planned to be completed.

   At the discretion of the Contractor, a CPM Progress Schedule may be submitted in lieu of a Bar-chart Progress Schedule. In which case, the schedule shall prepare and submit in accordance with the requirements and guidelines for a CPM Progress Schedule, as defined herein. Otherwise, the Category II Baseline Bar-chart Progress Schedule shall be prepared in accordance with the requirements and guidelines described in Section IV.9.B.1 below.

2. A Baseline Progress Schedule Narrative: The written Baseline Progress Schedule Narrative shall describe the Contractor's complete overall work plan and sequence in which the Work will be accomplished. The Category II Baseline Progress Schedule Narrative shall be prepared in accordance with the requirements and guidelines described in Section IV.9.D.2 below.

3. A Baseline Progress Earnings Schedule: The Baseline Progress Earnings Schedule shall indicate the Contractor's anticipated progress of the Work for each month, as reflected on the accepted Bar-chart Baseline Progress Schedule. The anticipated progress shall be expressed as a percentage of anticipated total earnings to date, as of the progress estimate date, relative to the Total Contract Value. Total Contract Value will be considered to mean the original amount of the Contract including any authorized adjustments for changes in the Work in accordance with, but not limited to, the provisions of Sections 109.04 and 109.05 *of the Specifications*. *Anticipated payments for Material on Hand in accordance with Section 109.09 of the Specifications or for other adjustments such as asphalt, fuel, retainage, liquidated damages, incentives, disincentives, etc., will not be considered in the Progress Earnings Schedule*.

   The Category II Baseline Progress Earnings Schedule shall be prepared and submitted using the VDOT Form C-13C and in accordance with the requirements and guidelines described in Section IV.9.E.1 below.

B. Monthly Progress Schedule Update – On a monthly basis, the Contractor shall submit a Progress Schedule Update within five (5) business days of the data date (Contractor's current progress estimate date). The Progress Schedule Update shall provide the as-built status of the project and the Contractor's current plan to complete the remaining work as of the data date.

The Category II Monthly Progress Schedule Update submission shall consist of:

1. A Bar-chart Progress Schedule Update: The Bar-chart Progress Schedule Update shall show as-built schedule information for the completed and ongoing activities and the sequence and dates on which the remaining activities are scheduled to be completed, as of the data date. The Category II Bar-chart Progress Schedule Update shall be prepared in accordance with the requirements and guidelines described in Section IV.9.B.2 below.

2. A Progress Earnings Schedule Update: The Progress Earnings Schedule Update shall show the actual earnings percentage to date and the projected earnings for each month, as of the Contractor's progress estimate date. The Progress Earnings Schedule Update shall be prepared using the VDOT Form C-13C and in accordance with the requirements and guidelines described in Section IV.9.E.1 below.

C. Revised Progress Schedule – When the Contractor proposes a different approach to the overall work plan or sequence that deviates significantly from what was planned as reflected on the SOR, the Contractor shall submit a Revised Progress Schedule. Deviate *significantly* from the SOR will be construed to mean major changes in the work plan resulting in schedule impacts that alter the project critical path or Contract milestones or cause a major shift in the Progress Earnings Schedule.

Also, when major changes in the Work are directed or authorized by the Engineer or when it is determined by the Engineer that the Contractor's current work plan or schedule has deviated significantly from the SOR, the Engineer will issue a written request for a Revised Progress Schedule. Circumstances that may prompt the Engineer's request include the following:

i) Significant changes have been made to the Progress Schedule.

ii) The Engineer has approved a significant change to the Contract that modifies the completion date of an interim Contract milestone or the project completion date by at least thirty (30) calendar days.

iii) A significant amount of work is being performed out of sequence.

iv) The percentage of work completed falls behind by ten (10) or more percentage points relative to the SOR and the project is not presently at risk of finishing late, as determined by the Engineer.

The Revised Progress Schedule shall be submitted in lieu of the subsequent monthly Progress Schedule Update, or as directed by the Engineer. The Revised Progress Schedule shall be submitted in the form of a Baseline Progress Schedule and shall reflect the current status of the Work and any changes in the Contractor's current work plan as of the date of submittal. Upon acceptance by the Engineer, the Revised Progress Schedule shall replace any previously accepted Baseline (re-baseline) or Revised Progress Schedule as the SOR for the remainder of the Work.

D. Final As-built Progress Schedule – Within thirty (30) calendar days after final acceptance, the Contractor shall submit to the Engineer a Final As-built Progress Schedule. The Final As-built Progress Schedule shall show the actual start and finish dates for each activity in the schedule. The Contractor shall certify in writing that the Final As-built Progress Schedule accurately reflects the dates on which all activities contained in the Progress Schedule were actually performed. The Final As-built Progress Schedule shall be submitted in the form of a monthly Progress Schedule Update and shall represent the last Progress Schedule Update submission.

6. CATEGORY III PROGRESS SCHEDULE SUBMISSION REQUIREMENTS

For projects designated in the Contract as Category III, the Contractor shall furnish the Progress Schedule in accordance with the following submission requirements:

A. Preliminary Progress Schedule – At least two (2) business days prior to the date of the Scheduling Conference, or as approved by the Engineer, the Contractor shall prepare and submit a Preliminary Progress Schedule. The Preliminary Progress Schedule is the Contractor's short-term schedule for executing the work planned for the initial ninety (90) calendar days, pending the acceptance of the Baseline Progress Schedule. At the Contractor's discretion, a complete Baseline Progress Schedule may be submitted in lieu of a Preliminary Progress Schedule. The Preliminary Progress Schedule submission shall consist of:

1. A CPM Preliminary Progress Schedule: The CPM Preliminary Progress Schedule shall depict:

    i) At a summary level the proposed overall sequence and general timing of the Work by phase, feature, and major work category, as applicable.

    ii) At a detail level the work planned during the first ninety (90) calendar days.

    iii) The project milestones indicating the anticipated start/finish dates.

    iv) Work by all involved parties including sub-contractors, the Department, utilities, suppliers, etc.

    The Category III CPM Preliminary Progress Schedule shall be prepared in accordance with the requirements and guidelines described in Section IV.9.C below, with the exception of cost-loading.

2. A Preliminary Progress Schedule Narrative: The Preliminary Progress Schedule Narrative shall describe the Contractor's work plan for the initial ninety (90) calendar days. The Category III Preliminary Progress Schedule Narrative shall be prepared in accordance with the requirements and guidelines described in Section IV.9.D.1 below.

B. Baseline Progress Schedule – At least forty-five (45) calendar days after the Notice to Proceed (NTP) date, or as approved by the Engineer, the Contractor shall prepare and submit to the Engineer a Baseline Progress Schedule. The Baseline Progress Schedule shall represent the Contractor's complete initial detailed plan for accomplishing the Work. The Baseline Progress Schedule shall reflect the current status of the project and the Contractor's current plan to complete the remaining work, as of the date of submittal.

The Baseline Progress Schedule submission shall consist of:

1. A CPM Baseline Progress Schedule: The CPM Baseline Progress Schedule shall indicate the sequence and dates on which the activities that make up the project, project milestones, and all necessary time-based tasks required to complete the project are scheduled to be completed. The CPM Baseline Progress Schedule shall also include, as applicable, all work to be performed by the Department and other involved parties. The CPM Baseline Progress Schedule submission shall include the following submittals:

    i) A time-scaled bar-chart (Gantt chart) plot showing for each activity the Activity ID, Activity Name, Original Duration, Remaining Duration, Start Date, Finish Date, Percent Complete, Total Float, and Budgeted Cost (for cost-loaded schedules only).

ii) A critical path plot depicting the project critical path based on the "Longest Path".

iii) A network logic diagram depicting the inter-relationships between the activities and the sequence in which the Contractor proposes to perform the Work.

The Category III CPM Baseline Progress Schedule shall be prepared in accordance with the requirements and guidelines described in Section IV.9.C below, as applicable.

2. A Baseline Progress Schedule Narrative: The Baseline Progress Schedule Narrative shall describe the Contractor's complete overall work plan and sequence in which the Work will be accomplished. The Category III Baseline Progress Schedule Narrative shall be prepared in accordance with the requirements and guidelines described in Section IV.9.D.2 below.

3. A Baseline Progress Earnings Schedule: The Baseline Progress Earnings Schedule shall indicate the Contractor's anticipated progress of the Work for each month, as reflected on the accepted CPM Baseline Progress Schedule. The anticipated progress shall be expressed as a percentage of anticipated total earnings to date, as of the progress estimate date, relative to the Total Contract Value. Total Contract Value will be considered to mean the original amount of the Contract including any authorized adjustments for changes in the Work in accordance with, but not limited to, the provisions of Sections 109.04 and 109.05 *of the Specifications*. *Anticipated payments for Material on Hand in accordance with Section 109.09 of the Specifications or for other adjustments such as asphalt, fuel, retainage, liquidated damages, incentives, disincentives, etc., will not be considered in the Progress Earnings Schedule*.

   At the Contractor's discretion, the CPM Baseline Progress Schedule may be cost-loaded. In which case, the Baseline Progress Earnings Schedule shall be prepared and submitted using the VDOT Form C-13CPM, as defined herein. Otherwise, the Category III Baseline Progress Earnings Schedule shall be prepared and submitted using the VDOT Form C-13C and in accordance with the requirements and guidelines described in Section IV.9.E.1 below.

C. Monthly Progress Schedule Update – On a monthly basis, the Contractor shall submit a Progress Schedule Update within five (5) business days of the data date (Contractor's current progress estimate date). The Progress Schedule Update shall provide the as-built status of the project and the Contractor's current plan to complete the remaining work as of the data date.

The Category III Progress Schedule Update submission shall consist of:

1. A CPM Progress Schedule Update: The CPM Progress Schedule Update shall show as-built schedule information for the completed and ongoing activities and the sequence and dates during which the remaining activities are scheduled to be completed, as of the data date. The CPM Progress Schedule Update shall be prepared and submitted in accordance with the requirements and guidelines described in Section IV.9.C.15 below, as applicable.

2. A Progress Schedule Update Narrative: The Progress Schedule Update Narrative shall describe the current status of the project, any deviations from scheduled performance, and any changes in the Contractor's work plan as of the data date. The Progress Schedule Update shall be prepared in accordance with the requirements and guidelines described in Section IV.9.D.3 below.

3. A Progress Earnings Schedule Update: The Progress Earnings Schedule Update shall show the actual earnings percentage to date and the projected earnings for each month, as of the

Contractor's progress estimate date. If the CPM Baseline Progress Schedule is cost-loaded, then the Progress Earnings Schedule Update shall be prepared and submitted using the VDOT Form C-13CPM. Otherwise, the Progress Earnings Schedule Update shall be prepared and submitted using the VDOT Form C-13C and in accordance with the requirements and guidelines described in Section IV.9.E.1 below.

D. Revised Progress Schedule – When the Contractor proposes a different approach to the overall work plan or sequence that deviates significantly from what was planned as reflected on the SOR, the Contractor shall submit a Revised Progress Schedule. Deviate *significantly* from the SOR will be construed to mean major changes in the work plan resulting in schedule impacts that alter the project critical path or Contract milestones or cause a major shift in the Progress Earnings Schedule.

Also, when major changes in the Work are directed or authorized by the Engineer or when it is determined by the Engineer that the Contractor's current work plan or schedule has deviated significantly from the SOR, the Engineer will issue a written request for a Revised Progress Schedule. Circumstances that may prompt the Engineer's request include the following:

i) Significant changes have been made to the Progress Schedule.

ii) The Engineer has approved a significant change to the Contract that modifies the completion date of an interim Contract milestone or the project completion date by at least thirty (30) calendar days.

iii) A significant amount of work is being performed out of sequence.

iv) The percentage of work completed falls behind by ten (10) or more percentage points relative to the SOR and the project is not presently at risk of finishing late, as determined by the Engineer.

The Revised Progress Schedule shall be submitted in lieu of the subsequent monthly Progress Schedule Update, or as directed by the Engineer. The Revised Progress Schedule shall be submitted in the form of a Baseline Progress Schedule and shall reflect the current status of the Work and any changes in the Contractor's current work plan as of the date of submittal. Upon acceptance by the Engineer, the Revised Progress Schedule shall replace any previously accepted Baseline (re-baseline) or Revised Progress Schedule as the SOR for the remainder of the Work.

E. Final As-built Progress Schedule – Within thirty (30) calendar days after final acceptance, the Contractor shall submit to the Engineer a Final As-built Progress Schedule. The Final As-built Progress Schedule shall show the actual start and finish dates for each activity in the schedule. The Contractor shall certify in writing that the Final As-built Progress Schedule accurately reflects the dates on which all activities contained in the Progress Schedule were actually performed. The Final As-built Progress Schedule shall be submitted in the form of a monthly Progress Schedule Update and shall represent the last Progress Schedule Update submission.

7. CATEGORY IV PROGRESS SCHEDULE SUBMISSION REQUIREMENTS

For projects designated in the Contract as Category IV, the Contractor shall furnish the Progress Schedule in accordance with the following submission requirements:

A. Preliminary Progress Schedule – At least two (2) business days prior to the date of the Scheduling Conference, or as approved by the Engineer, the Contractor shall prepare and submit a Preliminary Progress Schedule. The Preliminary Progress Schedule is the Contractor's short-term schedule for executing the work planned for the initial ninety (90) calendar days, pending the acceptance of the Baseline Progress Schedule. At the Contractor's discretion, a complete Baseline Progress Schedule may be submitted in lieu of a Preliminary Progress Schedule. The Preliminary Progress Schedule submission shall consist of:

1. A CPM Preliminary Progress Schedule: The CPM Preliminary Progress Schedule shall depict:

    i) At a summary level the proposed overall sequence and general timing of the Work by phase, feature, and major work category, as applicable.

    ii) At a detail level the work planned during the first ninety (90) calendar days.

    iii) The project milestones indicating the anticipated start/finish dates.

    iv) Work by all involved parties including sub-contractors, the Department, utilities, suppliers, etc.

    The Category IV Preliminary CPM Progress Schedule shall be prepared in accordance with the requirements and guidelines described in Section IV.9.C below, with the exception of cost-loading.

2. A Preliminary Progress Schedule Narrative: The Preliminary Progress Schedule Narrative shall describe the Contractor's work plan for the initial ninety (90) calendar days. The Category IV Preliminary Progress Schedule Narrative shall be prepared in accordance with the requirements and guidelines described in Section IV.9.D.1 below.

B. Baseline Progress Schedule – At least forty-five (45) calendar days after the Notice to Proceed (NTP) date, or as approved by the Engineer, the Contractor shall prepare and submit to the Engineer a Baseline Progress Schedule. The Baseline Progress Schedule shall represent the Contractor's complete initial detailed plan for accomplishing the Work, as of the date of submittal. The Baseline Progress Schedule shall reflect the current status of the project and the Contractor's current plan to complete the remaining work, as of the date of submittal. The Baseline Progress Schedule submission shall consist of:

1. A CPM Baseline Progress Schedule: The CPM Baseline Progress Schedule shall indicate the sequence and dates on which the activities that make up the project, project milestones, and all necessary time-based tasks required to complete the project are scheduled to be completed. The CPM Baseline Progress Schedule shall also include, as applicable, all work to be performed by the Department and other involved parties.

    The CPM Baseline Progress Schedule submission shall include the following submittals:

    i) A time-scaled bar-chart (Gantt chart) plot showing for each activity the Activity ID, Activity Name, Original Duration, Remaining Duration, Start Date, Finish Date, Percent Complete, Total Float, and Budgeted Cost (for cost-loaded schedules only).

ii) A critical path plot depicting the project critical path based on the "Longest Path".

iii) A network logic diagram depicting the inter-relationships between the activities and the sequence in which the Contractor proposes to perform the Work.

The CPM Baseline Progress Schedule shall be cost-loaded to indicate the bid item quantity and cost associated with each activity that represents work for which payment will be made. The Category IV CPM Baseline Progress Schedule shall be prepared in accordance with the requirements and guidelines described in Section IV.9.C below, as applicable.

2. A Written Baseline Progress Schedule Narrative: The written Baseline Progress Schedule Narrative shall describe the Contractor's complete overall work plan and sequence in which the Work will be accomplished. The Category IV Progress Schedule Narrative shall be prepared in accordance with the requirements and guidelines described in Section IV.9.D.2 below.

3. A Baseline Progress Earnings Schedule: The Baseline Progress Earnings Schedule shall show the Contractor's anticipated early dates and late dates progress earnings for each month, as of the progress estimate date, based on the accepted cost-loaded CPM Baseline Progress Schedule. The anticipated progress shall be expressed as a percentage of total earnings to date relative to the Total Contract Value. Total Contract Value will be considered to mean the original amount of the Contract including any authorized adjustments for changes in the Work in accordance with, but not limited to, the provisions of Sections 109.04 and 109.05 of the Specifications. *Anticipated payments for Material on Hand in accordance with Section 109.09 of the Specifications or for other adjustments such as asphalt, fuel, retainage, liquidated damages, incentives, disincentives, etc., will not be considered in the Progress Earnings Schedule*.

The Baseline Progress Earnings Schedule submission shall include the following:

i) An Activity Cost-loading Report (ACR) generated from the cost-loaded CPM Progress Schedule to provide a breakdown of the bid item resource and cost associated with each cost-loaded activity. The ACR shall:

a) Show for each activity the Activity ID, Activity Name, Price/Unit, Budgeted Unit (quantity), Budgeted Cost, Actual Cost, Remaining Cost, and At Completion Cost.

b) Be grouped by Resource ID and sorted by Activity ID.

c) Show the proportional budgeted units and cost allocated to each cost-loaded activity.

d) Show an aggregate sum of the total budgeted units and cost for each bid item resource and the overall total budgeted cost for the project.

ii) A Commodity Tracking Report (CTR) generated from the cost-loaded CPM Progress Schedule to provide production information on activities associated with selected commodities. A commodity is a measurable output of work associated with a bid item. Eligible bid items shall include items of work that involve activities that collectively are expected to be completed over considerable span of time, whose rate of progress are expected to drive the schedule. Prior to preparing the Baseline Progress Schedule, the Contractor and Engineer shall mutually agree on a proposed list of commodities and associated eligible bid items that will be tracked. The list of

approved commodities shall not exceed five (5). Such commodities may include, but are not limited to earthwork, drainage, piling, precast, concrete, and paving.

The CTR shall be grouped by commodity activity codes and sorted by Activity ID and to show:

a) For each activity, Activity ID, Activity Name, Original Duration, Budgeted Units, Unit of Measure, Budgeted Units/Time, Actual Duration, Actual Units, Units % Complete, Remaining Duration, Remaining Units, Remaining Units/Time, At Completion Units, and Max Units/Time.

b) For each commodity, an aggregate sum of the budgeted units, actual units, remaining units, and at completion units.

iii) A Progress Earnings Schedule using the VDOT Form C-13CPM. The Category IV Progress Earnings Schedule shall be prepared and submitted in accordance with the requirements and guidelines described in Section IV.9.E.2 below, as applicable.

C. Three Week Look-Ahead Schedule (3WLA) – Once the Work has commenced the Contractor shall submit every week, on a day agreed to by the Contractor and the Engineer, a 3WLA Schedule to show the status of on-going work for the current week and work planned for the following three-week period. The Contractor shall notify the Department within two (2) work days of any proposed changes in the Contractor's planned operations or critical stage work requiring Department oversight or inspection. Unless directed otherwise by the Engineer, the Contractor shall provide three (3) paper copies of the 3WLA Schedule. The 3WLA Schedule shall show in a tabular or spreadsheet format:

i) A detailed list of activities for work currently in progress and any work starting or scheduled for completion during the next three-week period. The activities shall indicate the type of operation, location or limits of the work, planned start and finish dates, and proposed working days, shifts, and hours.

ii) Any critical stage work requiring Department oversight or inspection and work to be performed by the Department and other involved parties.

D. Monthly Progress Schedule Update – On a monthly basis, the Contractor shall provide a Progress Schedule Update within five (5) business days of the data date (Contractor's current progress estimate date). The Progress Schedule Update shall provide the as-built status of the project and the Contractor's current plan to complete the remaining work as of the data date.

The Category IV Progress Schedule Update submission consists of:

1. A CPM Progress Schedule Update: The CPM Progress Schedule Update shall show the as-built schedule information of the completed and ongoing activities; as well as the sequence and dates during which the remaining activities are scheduled to be completed, as of the data date. The CPM Progress Schedule Update shall be prepared and submitted in accordance with the requirements and guidelines described in Section IV.9.C.15 below, as applicable.

2. A Progress Schedule Update Narrative: The Progress Schedule Update Narrative shall describe the current status of the project, any deviations from scheduled performance, and any changes in the Contractor's work plan as of the data date. The Progress Schedule Update shall be prepared in accordance with the requirements and guidelines described in Section IV.9.D.3 below.

3. A Progress Earnings Schedule Update: The Progress Earnings Schedule Update shall show the actual earnings percentage to date and the projected earnings for each month, as of the Contractor's progress estimate date. The Progress Earnings Schedule Update shall be prepared and submitted using the VDOT Form C-13CPM and in accordance with the requirements and guidelines described in Section IV.9.E.2 below.

   The Progress Earnings Schedule Update submission shall include the following:

   i) An updated Activity Cost-loading Report (ACR).

   ii) An updated Commodity Tracking Report (CTR).

   iii) An updated Form C-13CPM.

E. Revised Progress Schedule – When the Contractor proposes a different approach to the overall work plan or sequence that deviates significantly from what was planned as reflected on the SOR, the Contractor shall submit a Revised Progress Schedule. Deviate *significantly* from the SOR will be construed to mean major changes in the work plan resulting in schedule impacts that alter the project critical path or Contract milestones or cause a major shift in the Progress Earnings Schedule.

Also, when major changes in the Work are directed or authorized by the Engineer or when it is determined by the Engineer that the Contractor's current work plan or schedule has deviated significantly from the SOR, the Engineer will issue a written request for a Revised Progress Schedule. Circumstances that may prompt the Engineer's request include the following:

i) Significant changes have been made to the Progress Schedule.

ii) The Engineer has approved a significant change to the Contract that modifies the completion date of an interim Contract milestone or the project completion date by at least thirty (30) calendar days.

iii) A significant amount of work is being performed out of sequence.

iv) The percentage of work completed falls behind by ten (10) or more percentage points relative to the SOR and the project is not presently at risk of finishing late, as determined by the Engineer.

The Revised Progress Schedule shall be submitted in lieu of the subsequent monthly Progress Schedule Update, or as directed by the Engineer. The Revised Progress Schedule shall be submitted in the form of a Baseline Progress Schedule and shall reflect the current status of the Work and any changes in the Contractor's current work plan as of the date of submittal. Upon acceptance by the Engineer, the Revised Progress Schedule shall replace any previously accepted Baseline (re-baseline) or Revised Progress Schedule as the SOR for the remainder of the Work.

F. Final As-built Progress Schedule – Within thirty (30) calendar days after final acceptance, the Contractor shall submit to the Engineer a Final As-built Progress Schedule. The Final As-built Progress Schedule shall show the actual start and finish dates for each activity in the schedule. The Contractor shall certify in writing that the Final As-built Progress Schedule accurately reflects the dates on which all activities contained in the Progress Schedule were actually performed. The Final As-built Progress Schedule shall be submitted in the form of a monthly Progress Schedule Update and shall represent the last Progress Schedule Update submission.

8. CATEGORY V PROGRESS SCHEDULE SUBMISSION REQUIREMENTS

For projects designated in the Contract as Category V, the Contractor shall furnish the Progress Schedule in accordance with the following submission requirements:

A. Designated Project Scheduler – Prior to submission of any Progress Schedule, the Contractor shall designate a Project Scheduler for the project and shall submit his/her qualifications for the Engineer's written approval. The Project Scheduler shall have at least three (3) years of verifiable experience in successfully preparing and maintaining resource-loaded CPM schedules on large scale projects of similar type and complexity. The Contractor shall provide current contacts for verification of the Project Scheduler's qualifications and experience. The Project Scheduler shall be primarily responsible for the development and maintenance of the Contractor's Progress Schedule and shall represent the Contractor in all scheduling meetings on discussions or major issues concerning the Progress Schedule. The Contractor shall submit, for the Engineer's approval, a written notification and qualifications of a replacement Project Scheduler prior to replacing the Project Scheduler.

B. Preliminary Progress Schedule – At least two (2) business days prior to the date of the Scheduling Conference, or as approved by the Engineer, the Contractor shall prepare and submit a Preliminary Progress Schedule. The Preliminary Progress Schedule is the Contractor's short-term schedule for executing the work planned for the initial one-hundred and twenty (120) calendar days, pending the acceptance of the Baseline Progress Schedule. At the Contractor's discretion, a complete Baseline Progress Schedule may be submitted in lieu of a Preliminary Progress Schedule. The Preliminary Progress Schedule submission consists of:

1. A CPM Preliminary Progress Schedule: The CPM Preliminary Progress Schedule shall depict:

    i) At a summary level the proposed overall sequence and general timing of the Work by phase, feature, and major work category, as applicable.

    ii) At a detail level the work planned during the first one-hundred and twenty (120) calendar days.

    iii) The project milestones indicating the anticipated start/finish dates.

    iv) Work by all involved parties including sub-contractors, the Department, utilities, suppliers, etc.

    The Category V Preliminary CPM Progress Schedule shall be prepared in accordance with the requirements and guidelines described in Section IV.9.C below, with the exception of cost-loading.

2. A Preliminary Progress Schedule Narrative: The Preliminary Progress Schedule Narrative shall describe the Contractor's work plan for the initial one-hundred and twenty (120) calendar days. The Category V Preliminary Progress Schedule Narrative shall be prepared in accordance with the requirements and guidelines described in Section IV.9.D.1 below.

C. Baseline Progress Schedule – At least sixty (60) calendar days after the Notice to Proceed (NTP) date, or as approved by the Engineer, the Contractor shall prepare and submit to the Engineer a Baseline Progress Schedule. The Baseline Progress Schedule shall represent the Contractor's complete initial detailed plan for accomplishing the Work, as of the date of submittal. The Baseline Progress Schedule shall reflect the current status of the project and the Contractor's

current plan to complete the remaining work, as of the date of submittal. The Baseline Progress Schedule submission shall consist of:

1. A CPM Baseline Progress Schedule: The CPM Baseline Progress Schedule shall indicate the sequence and dates on which the activities that make up the project, milestones, and all necessary time-based tasks required to complete the project are scheduled to be completed. The CPM Baseline Progress Schedule shall also include, as applicable, all work to be performed by the Department and other involved parties.

   The CPM Baseline Progress Schedule submission shall include the following submittals:

   i) A time-scaled bar-chart (Gantt chart) plot showing for each activity the Activity ID, Activity Name, Original Duration, Remaining Duration, Start Date, Finish Date, Percent Complete, Total Float, and Budgeted Cost (for cost-loaded schedules only).

   ii) A critical path plot depicting the project critical path based on the "Longest Path".

   iii) A network logic diagram depicting the inter-relationships between the activities and the sequence in which the Contractor proposes to perform the Work.

   The CPM Baseline Progress Schedule shall be resource-loaded to indicate the resources needed to complete activities representing major operations that are expected to drive the schedule. The CPM Baseline Progress Schedule shall also be cost-loaded to indicate the bid item quantity and cost associated with each activity that represents work for which payment will be made. The Category V CPM Baseline Progress Schedule shall be prepared in accordance with the requirements and guidelines described in Section IV.9.C below, as applicable.

2. A Written Baseline Progress Schedule Narrative: The written Baseline Progress Schedule Narrative shall describe the Contractor's complete overall work plan and sequence in which the Work will be accomplished. The Category V Progress Schedule Narrative shall be prepared in accordance with the requirements and guidelines described in Section IV.9.D.2 below.

3. A Baseline Progress Earnings Schedule: The Baseline Progress Earnings Schedule shall show the Contractor's anticipated early dates and late dates progress earnings for each month, as of the progress estimate date, based on the accepted cost-loaded CPM Baseline Progress Schedule. The anticipated progress shall be expressed as a percentage of total earnings to date relative to the Total Contract Value. Total Contract Value will be considered to mean the original amount of the Contract including any authorized adjustments for changes in the Work in accordance with, but not limited to, the provisions of Sections 109.04 and 109.05 of the Specifications. *Anticipated payments for Material on Hand in accordance with Section 109.09 of the Specifications or for other adjustments such as asphalt, fuel, retainage, liquidated damages, incentives, disincentives, etc., will not be considered in the Progress Earnings Schedule*.

   The Baseline Progress Earnings Schedule submission shall include the following:

   i) An Activity Cost-loading Report (ACR) generated from the cost-loaded CPM Progress Schedule to provide a breakdown of the bid item resource and cost associated with each cost-loaded activity. The ACR shall:

a) Show for each activity the Activity ID, Activity Name, Price/Unit, Budgeted Unit (quantity), Budgeted Cost, Actual Cost, Remaining Cost, and At Completion Cost.

b) Be grouped by Resource ID and sorted by Activity ID.

c) Show the proportional budgeted units and cost allocated to each cost-loaded activity.

d) Show an aggregate sum of the total budgeted units and cost for each bid item resource and the overall total budgeted cost for the project.

ii) A Commodity Tracking Report (CTR) generated from the cost-loaded CPM Progress Schedule to provide production information on activities associated with selected commodities. A commodity is a measurable output of work associated with a bid item. Eligible bid items shall include items of work that involve activities that collectively are expected to be completed over considerable span of time, whose rate of progress are expected to drive the schedule. Prior to preparing the Baseline Progress Schedule, the Contractor and Engineer shall mutually agree on a proposed list of commodities and associated eligible bid items that will be tracked. The list of approved commodities shall not exceed five (5). Such commodities may include, but are not limited to earthwork, drainage, piling, precast, concrete, and paving.

The CTR shall be grouped by commodity activity codes and sorted by Activity ID and to show:

c) For each activity, Activity ID, Activity Name, Original Duration, Budgeted Units, Unit of Measure, Budgeted Units/Time, Actual Duration, Actual Units, Units % Complete, Remaining Duration, Remaining Units, Remaining Units/Time, At Completion Units, and Max Units/Time.

d) For each commodity, an aggregate sum of the budgeted units, actual units, remaining units, and at completion units.

iii) A Progress Earnings Schedule using the VDOT Form C-13CPM. The Category V Progress Earnings Schedule shall be prepared and submitted in accordance with the requirements and guidelines described in Section IV.9.E.2 below, as applicable.

D. Three Week Look-Ahead Schedule (3WLA) – Once the Work has commenced the Contractor shall submit every week, on a day agreed to by the Contractor and the Engineer, a 3WLA Schedule to show the status of on-going work for the current week and work planned for the following three-week period. The Contractor shall notify the Department within two (2) work days of any proposed changes in the Contractor's planned operations or critical stage work requiring Department oversight or inspection. Unless directed otherwise by the Engineer, the Contractor shall provide three (3) paper copies of the 3WLA Schedule. The 3WLA Schedule shall show in a tabular or spreadsheet format:

i) A detailed list of activities for work currently in progress and any work starting or scheduled for completion during the next three-week period. The activities shall indicate the type of operation, location or limits of the work, planned start and finish dates, and proposed working days, shifts, and hours.

ii) Any critical stage work requiring Department oversight or inspection and work to be performed by the Department and other involved parties.

E. Monthly Progress Schedule Update – On a monthly basis, the Contractor shall submit a Progress Schedule Update within five (5) business days of the data date (Contractor's current progress estimate date). The Progress Schedule Update shall provide the as-built status of the project and the Contractor's current plan to complete the remaining work as of the data date.

The Category V Progress Schedule Update submission shall consist of:

1. A CPM Progress Schedule Update: The CPM Progress Schedule Update shall show the as-built schedule information for the completed and ongoing activities and the sequence and dates during which the remaining activities are scheduled to be completed, as of the data date. The CPM Progress Schedule Update shall be prepared and submitted in accordance with the requirements and guidelines described in Section IV.9.C.15 below, as applicable.

2. A Progress Schedule Update Narrative: The Progress Schedule Update Narrative shall describe the current status of the project, any deviations from scheduled performance, and any changes in the Contractor's work plan as of the data date. The Progress Schedule Update shall be prepared in accordance with the requirements and guidelines described in Section IV.9.D.3 below.

3. A Progress Earnings Schedule Update: The Progress Earnings Schedule Update shall show the actual earnings percentage to date and the projected earnings for each month, as of the Contractor's progress estimate date. The Progress Earnings Schedule Update shall be prepared and submitted using the VDOT Form C-13CPM, in accordance with the requirements and guidelines described in Section IV.9.E.2 below.

   The Progress Earnings Schedule Update submission shall include the following:

   i) An updated Activity Cost-loading Report (ACR).

   ii) An updated Commodity Tracking Report (CTR).

   iii) An updated Form C-13CPM.

F. Revised Progress Schedule – When the Contractor proposes a different approach to the overall work plan or sequence that deviates significantly from what was planned as reflected on the SOR, the Contractor shall submit a Revised Progress Schedule. Deviate *significantly* from the SOR will be construed to mean major changes in the work plan resulting in schedule impacts that alter the project critical path or Contract milestones or cause a major shift in the Progress Earnings Schedule.

Also, when major changes in the Work are directed or authorized by the Engineer or when it is determined by the Engineer that the Contractor's current work plan or schedule has deviated significantly from the SOR, the Engineer will issue a written request for a Revised Progress Schedule. Circumstances that may prompt the Engineer's request include the following:

i) Significant changes have been made to the Progress Schedule.

ii) The Engineer has approved a significant change to the Contract that modifies the completion date of an interim Contract milestone or the project completion date by at least thirty (30) calendar days.

iii) A significant amount of work is being performed out of sequence.

iv) The percentage of work completed falls behind by ten (10) or more percentage points relative to the SOR and the project is not presently at risk of finishing late, as determined by the Engineer.

The Revised Progress Schedule shall be submitted in lieu of the subsequent monthly Progress Schedule Update, or as directed by the Engineer. The Revised Progress Schedule shall be submitted in the form of a Baseline Progress Schedule and shall reflect the current status of the Work and any changes in the Contractor's current work plan as of the date of submittal. Upon acceptance by the Engineer, the Revised Progress Schedule shall replace any previously accepted Baseline (re-baseline) or Revised Progress Schedule as the SOR for the remainder of the Work.

G. Final As-built Progress Schedule – Within thirty (30) calendar days after final acceptance, the Contractor shall submit to the Engineer a Final As-built Progress Schedule. The Final As-built Progress Schedule shall show the actual start and finish dates for each activity in the schedule. The Contractor shall certify in writing that the Final As-built Progress Schedule accurately reflects the dates on which all activities contained in the Progress Schedule were actually performed. The Final As-built Progress Schedule shall be submitted in the form of a monthly Progress Schedule Update and shall represent the last Progress Schedule Update submission.

9. PROGRESS SCHEDULE DETAIL REQUIREMENTS AND GUIDELINES

This section provides the detail requirements and guidelines necessary for preparing the various types of submittals required for an acceptable Progress Schedule submission. For each Progress Schedule submission, as applicable, the required submittals shall be prepared in accordance with the following:

A. Tabular Progress Schedule – When a Tabular Progress Schedule is specified, the Tabular Progress Schedule shall show the dates on which all work, including work to be performed by sub-contractors, suppliers, the Department and other involved parties will be completed. The Tabular Progress Schedule shall show for each activity the Activity ID, Activity Name (indicating the feature, phase, type of operation, and location or limits of the work), Activity Duration, Start Date, Finish Date, and Critical Dates (the dates on which the activity must be started or finished to avoid delaying a related interim milestone or the project, as applicable).

At the Contractor's option, the Tabular Progress Schedule may be prepared and submitted in a tabular, spreadsheet, or bar-chart format using Microsoft (MS) Word or MS Excel. The schedule may also be prepared using a scheduling software application that is capable of exporting project schedules in either Primavera "XER" or Microsoft Project "MPX" or "XML" file formats.

The following are guidelines for preparing the Categories M and I Tabular Progress Schedule:

i) Breakdown the Work by phase, feature, type of work, trade, and specific location or limits, as applicable.

ii) Create a tabular listing of the activities that make up the project, including as applicable, all necessary time-based tasks required to complete the project, milestones, and critical stage work requiring Department oversight or inspection; as well as work to be performed by the Department and other involved parties.

iii) Name the activities so that they are easily understood. Refer to phase, feature, and specific location or limits, as applicable (i.e. roadway segments, NB/SB lane, station numbers, or other identifiable locations).

iv) Group the activities by phase, segment, feature, or location, as applicable.

v) List the activities in order of intended sequence of progress.

vi) Assign unique activity identification (Activity ID). Assign numbers in ascending order and in increments of 10 to allow for future additional activities.

vii) Estimate the amount time needed to complete each activity based on quantity of work and anticipated rate of progress, with considerations for all known and foreseeable constraints.

viii) Determine the start and finish dates of the activities using available monthly/yearly calendars or other preferred method, with considerations for working calendar and resource constraints.

ix) Identify the controlling items of work and the critical dates. Controlling items of work are the series of items that are expected to drive the project completion date. The critical dates are the dates on which the controlling items of work must be completed to avoid delaying the project or interim milestone activity, as applicable.

x) Review/analyze the schedule to ensure that it conforms to the requirements of the Contract and that the project objectives are met.

xi) Save and name the file to indicate the Contract ID, type and number of submission; as well as the date of submission (e.g. C00012345C01_B01_4-2-12).

B. Bar-chart Progress Schedule – When a Bar-chart Progress Schedule is specified, the Bar-chart Progress Schedule shall show in a graphical time-scaled bar-chart format the dates on which the activities representing work items and time-based tasks required to complete the project are planned to occur. The Bar-chart Progress Schedule shall also include work to be performed by sub-contractors, suppliers, the Department and other involved parties. The Bar-chart Progress Schedule shall show for each activity, the Activity ID, Activity Name (indicating the feature, phase, type of operation, and location or limits of the work), Activity Duration, Start Date, Finish Date, and Critical Dates (the dates on which the activity must be started or finished to avoid delaying a related interim milestone or the project, as applicable).

At the Contractor's option, the Bar-chart Progress Schedule may be prepared and submitted using MS Excel or a scheduling software application that is capable of exporting project schedules in either Primavera "XER" or Microsoft Project "MPX" or "XML" file formats.

The following are guidelines for preparing and updating a Bar-chart Progress Schedule:

1. Baseline Bar-chart Progress Schedule: The following are guidelines for preparing a Baseline Bar-chart Progress Schedule:

i) Breakdown the Work by phase, feature, type of work, trade, and specific location or limits, as applicable.

ii) Create a tabular listing of the activities that make up the project, including as applicable, all necessary time-based tasks required to complete the project, milestones, and critical stage work requiring Department oversight or inspection; as well as work to be performed by the Department and other involved parties.

iii) Name the activities so that they are easily understood. Refer to phase, feature, and specific location or limits, as applicable (i.e. roadway segments, NB/SB lane, station numbers, or other identifiable locations).

iv) Group the activities by phase, segment, feature, or location, as applicable.

v) List the activities in order of intended sequence of progress.

vi) Assign unique activity identification (Activity ID). Assign numbers in ascending order and in increments of 10 to allow for future additional activities.

vii) Estimate the amount time needed to complete each activity based on quantity of work and anticipated rate of progress, with considerations for all known and foreseeable constraints.

viii) Determine the start and finish dates of the activities using available monthly/yearly calendars or other preferred method, with considerations for working calendar and resource constraints. If the schedule is prepared using scheduling software such as Primavera P6, the constraints feature may be used in lieu of logic relationships to establish the start and finish dates.

ix) Identify the controlling items of work and the critical dates. Controlling items of work are the series of items that are expected to drive the project completion date. The critical dates are the dates on which the controlling items of work must be completed to avoid delaying the project or interim milestone activity, as applicable.

x) Prepare a time-scaled bar-chart plot for each activity. Provide an extra row per activity to allow for a plot of the as-built schedule.

xi) Review/analyze the schedule to ensure that it conforms to the requirements of the Contract and that the project objectives are met.

xii) Save and name the file to indicate the Contract ID, type and number of submission, and the date of submission (e.g. C00012345C01_B01_4-2-12).

2. Bar-chart Progress Schedule Update: The following are guidelines for preparing a Bar-chart Progress Schedule Update:

i) Make a copy of the previously accepted Bar-chart Progress Schedule and rename it to indicate the Contract ID, type and number of submission, and the current data date of the submission (e.g. C00012345C01_U01_5-4-12).

ii) Specify the actual start dates and finish dates for all completed activities as of the data date. Also, specify actual start dates for all for all on-going activities.

iii) Specify the actual percent complete for completed and on-going activities as of the data date. Percent complete shall reflect the amount of work completed to date relative to total amount of work estimated at completion.

iv) Specify remaining duration and projected finish dates for all on-going activities as of the data date. Remaining duration shall be based on amount of time needed to complete the remaining work as of the data date.

v) Review the sequence of work for the on-going and remaining activities to determine if the activities are being performed out-of-sequence and if the activities need to be re-sequenced based on the current plan.

vi) Determine the currently projected start and finish dates of the remaining activities, as necessary.

vii) Prepare a time-scaled bar-chart plot of the current schedule update versus the SOR (most recently accepted Baseline or Revised Progress Schedule).

viii) Review/analyze the schedule to ensure that it conforms to the requirements of the Contract and that the project objectives are met.

ix) Save the file and send a working copy and a “PDF” copy of the schedule along with other required submittal items to the Engineer, as required.

C. CPM Progress Schedule – When a CPM Progress Schedule is specified, the CPM Progress Schedule shall be prepared and updated in accordance with the following:

1. Software Compatibility: The CPM Progress Schedule shall be submitted in the Primavera proprietary exchange format (XER) to ensure compatibility with the Department's scheduling software system. The Department's scheduling software system is the current version of Primavera's Project Management software application (P6 version 7.0). For projects that are included in a multi-contract mega-project, the Contractor may be required to prepare and maintain the Progress Schedule in the Department's scheduling software database.

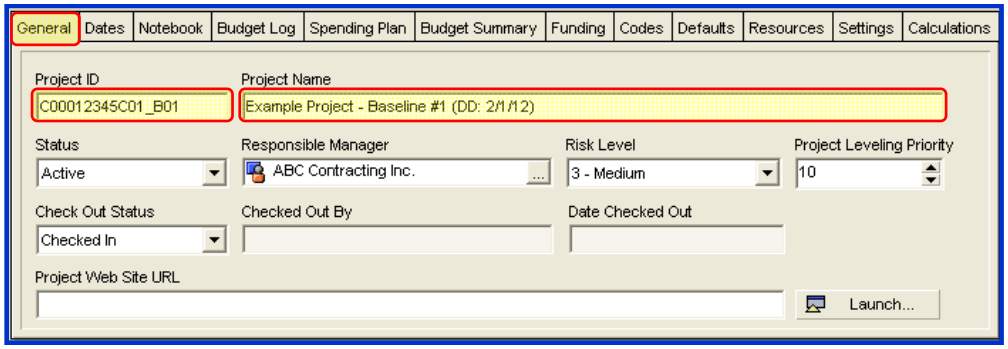
   At the Contractor's discretion, the Progress Schedule may be prepared using any preferred scheduling software; however, the Contractor shall be responsible for converting the Progress Schedule into the Primavera file exchange format (XER). At the Contractor's request, secured access via the internet may be granted for up to two (2) users to allow the Contractor to develop/maintain the Progress Schedule in a secured environment within the Department's scheduling software system. The Contractor must submit a written request for access to the Engineer, including the name(s) and contact information of the users as well information on the VDOT projects for which the application will be used. The Contractor will be required to adhere to certain rules to protect global data from possible contamination.

   For guidelines on accessing and using the VDOT scheduling software (Primavera P6), click on the following link to download the "PDF" document:

   http://www.virginiadot.org/business/resources/const/GuidelinesforAccessingandUsingtheVDOTSchedulingApplication.pdf

2. Project Properties and Default Settings: For each CPM Progress Schedule submission, the Contractor shall define the project properties and default settings in accordance with the following to ensure consistency with the Department's default settings and standards of practice:

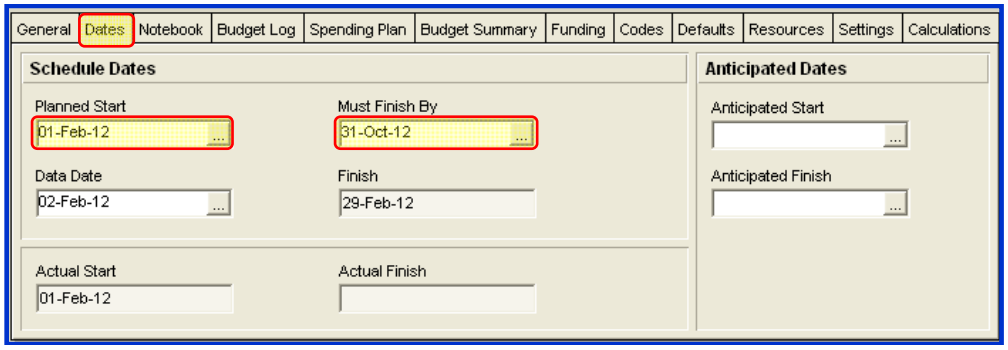
   i) Project Identification: The Project ID and Project Name shall be defined as follows:



   a) The Project ID must be unique for each submission and shall comprise of the Contract ID number, a letter (Baseline (B), Update (U), Recovery (R), Schedule Impact Analysis (SIA)), and a number to indicate the type and number of the submission (i.e. C00012345C01_B01, C00012345C01_U01, C00012345C01_R01, C00012345C01_SIA01, etc.).

b) The Project Name must clearly describe the project, version, and data date (DD) of the schedule (e.g. I-95 Bridge Restoration Project – Baseline No. 1 (DD: 5-1-12)).

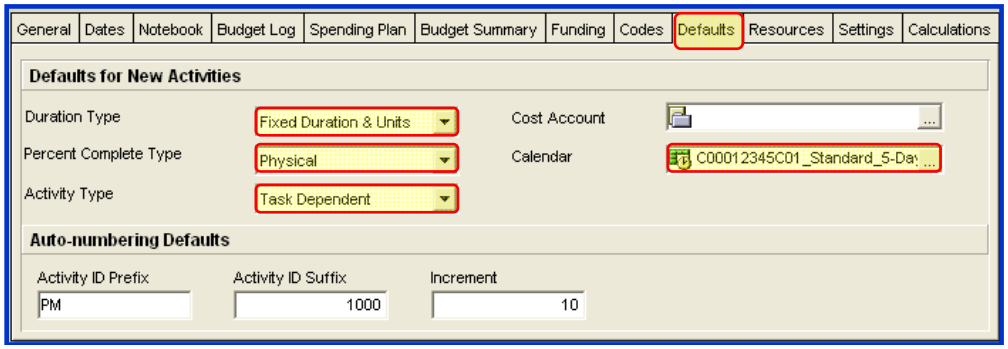
ii) Project Dates: The project Planned Start and Must Finish By dates shall be defined as follows:



a) The Planned Start date shall be equal to the start date of the earliest activity; typically, the Bid Letting date or NTP date, as applicable.

b) The Must Finish By date shall be equal to the Contract fixed completion date.

iii) Activity Default Settings: The following activity default settings shall be defined and assigned to activities as follows:



a) Duration Type: Specify Fixed Duration & Units as the default duration type:

b) Percent Complete Type: For cost-loaded schedules, the default percent complete type shall be specified as "Physical". In other cases, the Contractor may define the percent complete type as follows:

1. Specify "Duration" percent complete type when the percent complete and remaining duration of an activity will be calculated automatically based on time expended as of the data date rather than amount of work performed. *(Note: When Duration percent complete type is used, the percent complete of an activity and the remaining duration will be linked; therefore, a change to the percent complete or remaining duration will affect the other).*

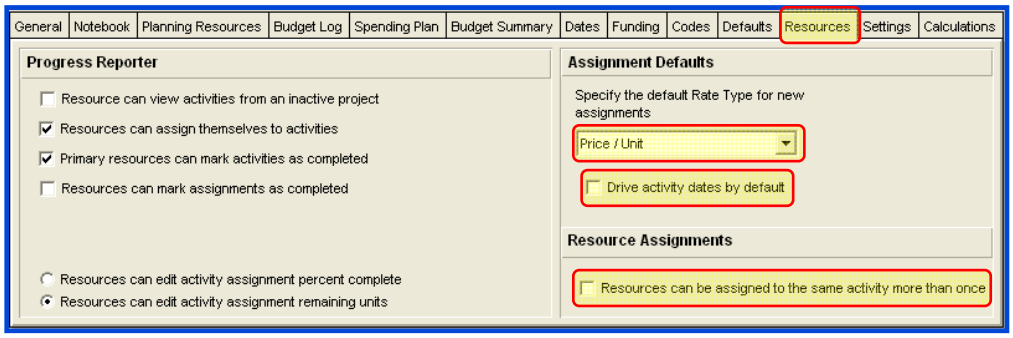
2. Specify "Physical" percent complete type when the percent complete will be defined by the user based on amount of work performed rather than time expended or time remaining. *(Note: When Physical percent complete is used, a percent complete must be manually entered when statusing the activity. Also, remaining duration must also be defined to reflect the amount of time needed to complete the remaining work)*.

3. Specify "Units" percent complete type when the percent complete is based on the actual labor or non-labor units expended.

c) Activity Type: Specify "Task Dependent" as the default activity type. The Activity Type may be modified for each individual activity, as necessary.

d) Calendar: Specify a default Project-level calendar that will be assigned to new activities. Specific Project-level calendars may be assigned at the activity level to individual activities, as necessary.

iv) Resource Assignment Settings: The project default settings for resource assignments shall be defined as follows:

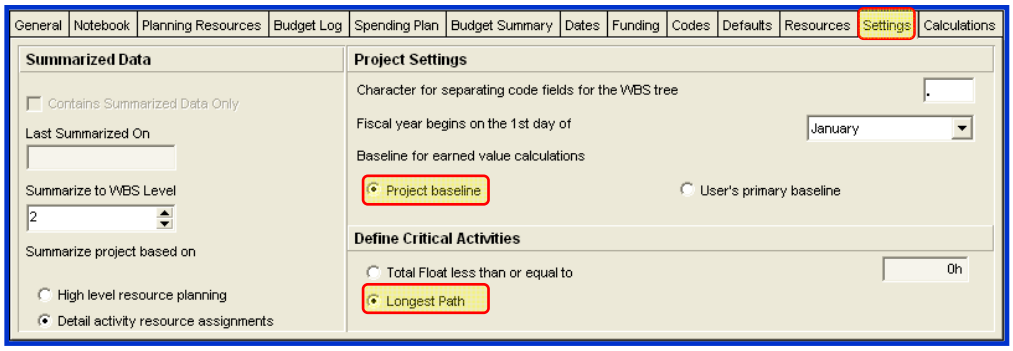


a) Specify the default rate type for new assignments as "Price / Unit".

b) Uncheck the "Drive activity dates by default" checkbox to allow the activity dates to be independent of the resources for resource dependent activities.

c) Uncheck the "Resource Assignments" checkbox to prevent the same resource from being assigned to an activity more than once.

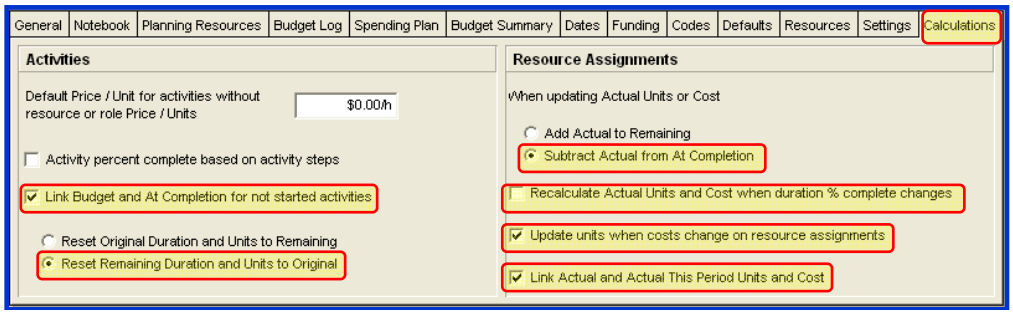
v) Project Settings: The project default settings for calculating earned value and defining critical activities shall be defined as follows:



a) Specify "Project Baseline" as the baseline for performing earned value calculations.

b) Specify "Longest Path" as the method of defining the project critical activities.

vi) Calculations Default Settings: The project default settings for calculating cost and resource usage when updating a cost-loaded or resource-loaded schedule shall be defined as follows:



a) Activities: In the Activities section of the "Calculations" tab:

1. Mark the "Link Budget and At Completion Cost for not started activities" checkbox to make the Budgeted Cost and At Completion Cost are the same for activities that have not started.

2. Specify "Reset Remaining Cost and Units to Original" to ensure that the remaining cost and units of an activity is reset to the original budgeted units and cost when the activity is un-progressed.

b) Resource Assignments: In the Resource Assignment section of the "Calculations" tab:

1. Specify "Subtract Actual from At Completion", when updating Actual Units or Cost.

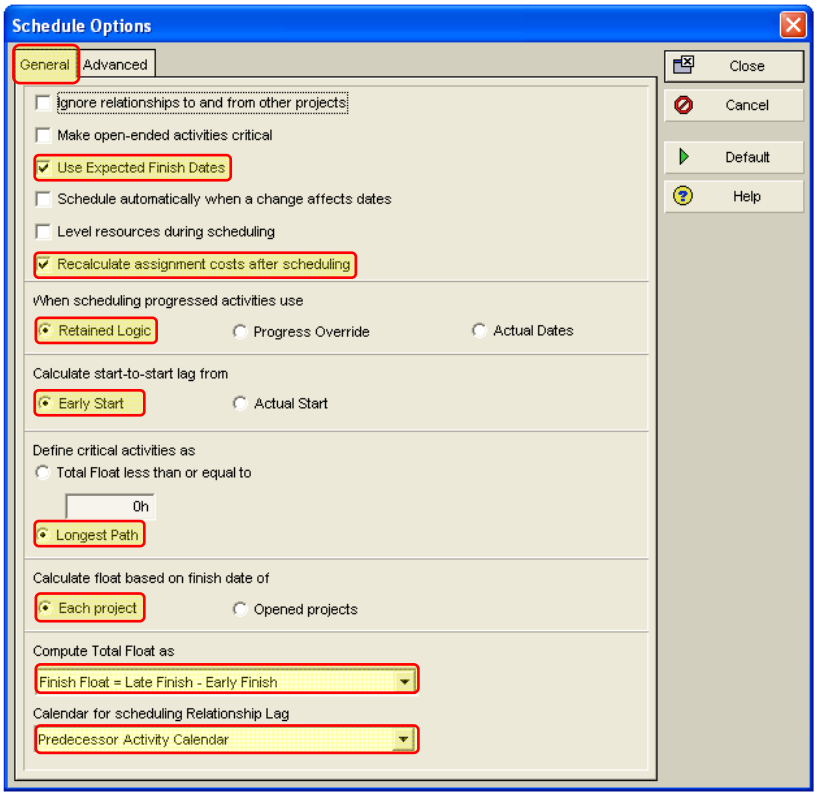
2. Uncheck the "Recalculate Actual Units and Cost when duration % complete changes" checkbox to prevent the application from automatically calculating the actual units and cost when the duration % changes. This will allow the user to manage the actual cost and units by manually entering the information when updating the schedule.

3. Mark the "Update units when costs changes on resource assignments" checkbox to allow the application to re-calculate the units based on the Price/Unit when the cost is changed.

4. Mark the "Link Actual and Actual This Period Units and Cost" checkbox to allow the application to automatically change the Period Actual Units and Costs when the Actual Units and Costs are changed and vice versa.

vii) Date Format: Schedule dates shall be shown in the "Month-Day-Year" date format, with 2-digit numbers for the month, day, and year (e.g. 08-31-12).

viii) Schedule Calculation Settings: When calculating the CPM Progress Schedule, the schedule calculation settings in the "Schedule Options" dialogue box shall be defined as follows to ensure consistency with the Department's default settings:



a) Ensure that the "Ignore relationships to and from other projects" checkbox is unchecked to maintain activity relationships between projects, as applicable.

b) Ensure that the "Make open-ended activities critical" checkbox is unchecked to avoid treating open-ended activities as critical.

c) Mark the “Use Expected Finish Dates” checkbox to allow the application to schedule activity end dates as expected end dates.

d) Ensure that the “Schedule automatically when a change affects dates” checkbox is unchecked to disallow the application from scheduling the project automatically every time a change is made.

e) Ensure that the “Level resources during scheduling” checkbox is unchecked to prevent the application from resource-leveling when scheduling open projects.

f) Mark the “Recalculate assignment costs after scheduling” checkbox to allow the application to recalculate resource and role costs after scheduling projects.

g) Specify “Retained Logic” when scheduling progressed activities to maintain original network logic.

h) Specify “Early Start” to calculate the lag for start-to-start.

i) Specify the “Longest path’ as the method for defining critical activities.

j) Specify “Each project” to ensure that float is calculated based on each individual project as opposed to all open projects.

k) Select from the drop down list “Finish Float = Late Finish - Early Finish” as the method for computing total float.

l) Select from the drop down list “Predecessor Activity Calendar” as the calendar to use for scheduling relationship lag.

3. Work Breakdown Structure (WBS): The CPM Progress Schedule shall be organized using a multi-level hierarchical WBS to allow for a hierarchical organization and breakdown of the Work. Depending on the Scope of Work and Contractor’s approach, the Work shall be broken down into meaningful and manageable parts based on the Contractor’s approach and in the sequence in which the work will be performed. The project WBS shall reflect the sequence of construction/maintenance of traffic (MOT) as specified in the Contract or as approved by the Engineer.

   The following are examples of a breakdown of the Work into manageable parts using a WBS:

   i) Project Management: The Project Management WBS node shall be decomposed into its sub-ordinate WBS nodes, including as applicable:

      a) Milestones;

      b) Notifications;

      c) Permits;

      d) Submittals.

ii) Environmental Impact Study (EIS): The EIS WBS node shall be decomposed into its sub-ordinate WBS nodes, as applicable.

iii) Design: The Design WBS node shall be decomposed into its sub-ordinate WBS nodes by design phase, including as applicable:

a) Preliminary Design (Site Survey, ROW Design, Geotechnical Investigation, Preliminary Design, etc.);

b) Final Design;

c) Design Packages/Construction Plans.

iv) Right-of-Way (ROW): The ROW WBS node shall be decomposed into its sub-ordinate WBS nodes by property or parcel, as applicable:

v) Procurement: The Procurement WBS node shall be decomposed into its sub-ordinate WBS nodes by long lead item, as applicable.

vi) Utilities: The Project Management WBS node shall be decomposed into its sub-ordinate WBS nodes by type of utility, including as applicable:

a) Sewer Line Relocation/Adjustment;

b) Water Line Relocation;

c) Gas Main Relocation;

d) Telephone Line Relocation;

e) Fiber-optics Line Relocation;

f) Cable Television Line Relocation;

g) Electric Power Line Relocation.

vii) Construction: The Construction WBS node shall be decomposed into its sub-ordinate WBS nodes, with each subordinate WBS node further decomposed into their respective sub-ordinate nodes, as applicable:

a) General Construction (Mobilization, MOT, Surveying, Clearing and Grubbing, Erosion and Sedimentation Control, etc.);

b) Features (Major Drainage Structures, Roadways, Bridges, Ramps, SWMB, Traffic Signals, Overhead Sign Structures, etc.);

c) Segments or Major Areas;

d) Phases (Phase 1, Phase 2, etc.);

e) Stages (Stage 1, Stage 2, etc.);

f) Punch-list/Clean-out/Demobilization.

4. Activity Codes: The Contractor shall define and assign as appropriate, project-specific activity codes to allow for filtering, grouping, and sorting of activities by category to facilitate review and use of the Progress Schedule. The Contractor shall define the activity codes using the project-level option. *Use of global activity codes shall not be allowed and shall be justification for rejecting the Progress Schedule submission*.

   The following activity codes shall be defined and assigned to the activities, as applicable:

   i) Responsibility: The party responsible for performing the work (i.e. Contractor, Department, Sub-contractor ABC, Utility Company, etc.).

   ii) Phase: The phase in which the work is being performed (i.e. Phase 1, Phase, 2, etc.).

   iii) Stage: The stage in which the work is being performed (i.e. Stage 1, Stage, 2, etc.).

   iv) Feature: A major component of the Work being constructed (i.e. Haul Rd, Roadway XYZ, Bridge B601, Ramp A, SWMB #1, Overhead Sign Structure, Sewer Line, etc.).

   v) Area: General area or roadway segment in which the work is being performed (i.e. Non-Area-Specific, Rte. 123/600 Intersection, Rte. 29/250 Interchange, Mainline (ML) Roadway: NB Sta. 100+25 – Sta. 500+50, etc.).

   vi) Location: Specific location in which the work is being performed (i.e. Non-Location-Specific, Abutment A, Pier 1, Pier 2, Span A, Span B, Rte. 29 ML Sta. 200+00, etc.).

   vii) Work Type: Type of work or major operation (i.e. Design, ROW, Permits, Utility, Drainage, Earthwork, Bridge Work, Paving, Signing, Landscaping, etc.).

   viii) Crew: Contract-specific "Crew" activity codes shall be assigned to define the type and number of the crew performing the work (i.e. Drainage Crew #1, Grading Crew #1, Bridge Crew #1, Paving Crew #1, etc.). *(Note: Crew activity codes are not needed for resource loaded schedules)*.

   ix) Contract Modification: Contract changes activity code (i.e. WO #1, WO #2, etc.).

   x) Commodity: For cost-loaded CPM schedules (required for Categories IV and V projects only), contract-specific commodity activity codes, as approved by the Engineer, shall be defined and assigned to the applicable activities to allow for filtering, sorting, grouping, and reporting of production data by commodity activity codes. Such commodity activity codes may include, but are not limited to Earthwork (including regular or borrow excavation items), Drainage (drainage pipe items), Piling (steel or concrete piles), Concrete (bridge substructure or superstructure), Precast Units (pre-cast structures), Girders (steel or concrete), Subbase (aggregate base items), Asphalt Paving (asphalt paving items), and Concrete Paving (concrete paving items).

5. Calendars: The Contractor shall define and assign as appropriate, project-specific calendar to each activity to indicate when the activity can be performed. The Contractor shall define the project calendars using the project-level option. The project calendars shall indicate, as applicable, the standard working hours per day, standard working days per week, and non-work days such as week-ends, holidays, weather days, local events, environmental, time-of-year restrictions, etc. *Use of global calendars shall not be allowed and shall be justification for rejecting the Progress Schedule submission*.

The project calendars shall be defined and assigned as follows:

i) Standard Working Calendar: Define and assign a standard 4-day, 5-day, or 6-day calendar, as applicable to activities and milestones that will be completed during the Contractor's normal working schedule. The Contractor's standard working calendar must indicate the standard work hours, work days, and any planned or anticipated non-work days such as week-ends, holidays, special events, weather days, etc.

ii) Standard 7-Day Calendar: Define and assign a standard 7-day calendar (without holidays or other non-work days) to activities that are not constrained by week-ends, holidays, weather, or other non-work day restrictions. The 7-Day Calendar may also be used for activities whose durations are specified in calendar days rather than work days. Such activities may include Department review, administrative, procurement, fabrication, MOT, curing period, load test period, settlement or surcharge period, etc.

iii) Special Calendars: Define and assign standard 4-day, 5-day, or 6-day special calendars such as Seasonal, Environmental, Weather, or Winter Shutdown, as applicable, for weather sensitive activities that are typically affected by adverse weather or other activities that are constrained by temperature, seasonal, or environmental restrictions that do not permit work during such conditions or time of year. Such calendars may be based on the Contractor's standard working calendar, with exclusions for the additional non-work periods.

iv) Other Special Calendars: Define and assign other standard 4-day, 5-day, or 6-day special calendars, as applicable, for activities to be performed by sub-Contractors, utilities, or other involved parties, whose working calendars are different from the Contractor's normal working calendar.

6. Level of Details: The Contractor shall develop the Progress Schedule to an appropriate level of detail that allows for effective use of the Progress Schedule to monitor progress of the Work and to quantify the impacts of time-related changes on the project. The CPM Progress Schedule shall include sufficient details to allow for the formation of a reasonable critical path. The Progress Schedule shall include all work items and necessary time-based tasks required for completion of the project, including as applicable, work to be performed by the Department, sub-Contractors, suppliers, and other involved parties. The Progress Schedule shall also include, as applicable, Contract milestones and other key milestones needed to monitor the status of significant project events.

   The Work shall be broken down into discrete and measurable work tasks by trade based on the Contractor's proposed means and methods. The Work shall be broken down in sufficient details necessary to distinctly identify the feature, type of work, and specific location or limits of the work that the activity represents. To the extent feasible, the Work shall be broken down to a level of detail such that the activity durations for on-site work excluding activities whose durations are specified in the Contract, are twenty (20) work days or less. Longer durations may be allowed, as approved by the Engineer, for activities that typically span long periods of time such as fabrication and delivery of long lead materials, administrative, MOT, or other such level of effort activities.

   The following are guidelines for defining the detail activities required to complete a project:

   i) Administrative: Define the administrative activities associated with the Work, including as applicable:

a) Contract milestones;

b) Key submittals such as permits, schedules, etc;

c) Notifications such as traffic switches, utility, shutdowns, outages, etc.;

d) Department review.

ii) Procurement: Define the individual activities associated with the procurement of long lead materials or specialty items, including as applicable:

a) Procurement;

b) Preparation of shop drawings, installation drawings, etc.;

c) Fabrication;

d) Delivery.

iii) Start-up: Define the individual activities necessary for construction start-up, including as applicable:

a) Mobilization;

b) Construction access, staging area, etc.;

c) Survey, etc.

iv) Maintenance of Traffic (MOT): Define the individual MOT activities necessary for maintaining traffic, including as applicable:

a) Installation of temporary signs;

b) Installation of traffic control devices;

c) Traffic switches, etc.

v) Utilities: Define the utility relocation or adjustments activities, including as applicable:

a) Design, shop drawings, etc.;

b) Materials procurement;

c) Mobilization;

d) Shutdowns, outages, etc.;

e) Temporary relocation or adjustments;

f) Permanent relocation or adjustments;

g) Testing.

vi) Bridges and Structures: Define the individual activities necessary for constructing the bridges or structures, including as applicable:

a) Installation and removal of temporary systems or structures such as causeways, shoring, sheet piling, cofferdams, etc.;

b) Structural excavation;

c) Steel piling, concrete piling, drilled shafts, etc.;

d) Load test;

e) Form/Rebar/Place (FRP) pier footing, abutment footing, etc.;

f) Install MSE walls;

g) FRP pier column, pier caps, abutment walls, etc.;

h) Curing periods;

i) Install bearings;

j) Erect structural steel girders, precast girders, precast box girders, etc.;

k) Install overhang forms;

l) Install expansion joints;

m) FRP deck concrete;

n) FRP parapets;

o) Install bridge rails;

p) FRP Approach slabs;

q) Concrete deck overlays;

r) Bridge lighting or navigation lights;

s) Riprap or concrete slope protection;

t) Bridge fender system or dolphin construction;

u) Demolition and removal of existing structures, etc.

vii) Roadway: Define the roadway construction activities, including as applicable:

a) Clearing and grubbing;

b) Siltation and sediment control;

c) Install drainage;

d) Install drainage structures (culverts, inlets, manholes, etc.);

e) Regular excavation;

f) Borrow excavation;

g) Settlement or surcharge periods;

h) Place select material;

i) Subgrade preparation;

j) Place aggregate base (subbase);

k) Install under-drains;

l) Cement or lime stabilization;

m) Asphalt-stabilized open-graded material;

n) Asphalt or concrete curb and gutter;

o) Asphalt or concrete median;

p) Place asphalt concrete base course;

q) Place asphalt concrete inter-mediate course;

r) Place asphalt concrete surface course;

s) Place Portland cement concrete pavement.

viii) Incidental Roadway Items: Define the incidental roadway construction activities, including as applicable:

a) Installation of guardrail or steel median barriers;

b) Sidewalk;

c) Retaining walls;

d) Sound barrier walls;

e) Demolition of existing pavements;

f) Fences, etc.

ix) Traffic Control: Define the traffic control activities, including as applicable:

a) Sign structures;

b) Lighting structures;

c) Signal structures;

d) Traffic signals;

e) Traffic signs and delineators;

f) Pavement markings and markers;

g) Roadway lighting, etc;

h) Traffic switches, etc.

x) Roadside Development: Define the individual roadside development activities, including as applicable:

a) Seeding;

b) Sodding;

c) Planting, landscaping, etc.

xi) Miscellaneous: Define other miscellaneous activities that consume time and are required for completion of the project, including as applicable:

a) Installation and removal of temporary systems or structures such as causeways, shoring, etc.;

b) Sampling and testing periods;

c) Acceptance testing;

d) Demolition of existing pavements;

e) Punch list and clean-up;

f) Traffic control tear-down;

g) Demobilization and move-out.

7. Activity Properties: The Contractor shall define for each activity the following attributes:

i) Activity ID: Activity ID assignments should include a prefix that identifies the responsible party and should reflect the WBS within which the activity exists. The Activity ID should also be defined in increments of at least 10 and in the order in which the work will be performed. *Once the Baseline Progress Schedule is accepted, the Activity ID must never be changed*.

ii) Activity Name: Activity Name shall be unique and recognizable. It shall identify the feature, phase, type of operation, and location of the work.

iii) Duration Type: Duration Type shall be defined as Fixed Duration & Units.

iv) Percent Complete Type: For cost-loaded Progress Schedules, the Percent Complete Type shall be defined as "Physical". When the Percent Complete Type is defined as "Physical", the Contractor shall ensure that the percent complete and remaining duration are manually updated for each progressed activity to reflect the amount of work completed and amount of time required to complete the remaining work as of the data date.

v) Activity Type: Activity Type shall be defined as Task Dependent, unless the activity is a WBS Summary activity, Start Milestone activity, Finish Milestone activity, or Level of Effort activity. *Use of Resource Dependent activity type shall be on a case by case basis as approved by the Engineer*.

8. Activity Duration: Activity duration shall be reasonable to allow for an accurate determination of progress of ongoing activities between update periods. Activity durations shall be defined and assigned as follows:

   i) Durations shall be defined in number of workdays except for activities that are assigned a 7-day calendar. For such activities, activity durations shall be defined in calendar days.

   ii) Durations for on-site work activities shall not exceed twenty (20) workdays or thirty (30) calendar days, unless specified in the Contract or approved by the Engineer. Activity durations in excess of twenty (20) workdays or thirty 30 calendar days will be allowed for the summary level activities in the Preliminary Progress Schedule. Longer durations may also be allowed for certain activities that typically span long periods of time and cannot be feasibly broken down into discrete activities. Such activities may include procurement activities such as fabrication and delivery of long lead materials; administrative, surveying, MOT, or other such level of effort activities; activities for settlement, surcharge, curing, or testing periods; or activities included for work by third parties.

   iii) Longer durations may also be allowed for certain on-site work activities that cannot be feasibly broken down into discrete activities such as regular excavation. However, the durations for such activities shall not include intermittent periods of inactivity of more than ten (10) workdays. In such cases the activity shall be split to show discrete period(s) of work, unless approved by the Engineer.

   iv) Department activities for submittal review and/or approval shall have durations of thirty (30) calendar days, except as otherwise defined herein or elsewhere by specific Contract language.

9. Critical Path: The Progress Schedule shall be based on the Critical Path Method (CPM). The Contractor shall apply the Precedence Diagram Method (PDM) to establish the network logic, with which to calculate the Progress Schedule and to generate the project critical path. The network logic shall depict the inter-dependence between the activities and the sequence in which the Contractor proposes to accomplish the Work. The critical path shall be defined as the "Longest Path".

10. Schedule Constraints: The Contractor's use of schedule constraints with the exception of the specific requirements defined below is not allowed, unless approved by the Engineer. The use of schedule constraints such as "Start On" or "Finish On" for the purpose of manipulating float or the use of schedule constraints that violate network logic such "Mandatory Start" or "Mandatory Finish" shall not be allowed. When a schedule constraint is used, other than the

schedule constraints defined below, the Contractor shall provide explanation for the use of such constraint. The explanation may be provided within the Progress Schedule using the activity log or in the Progress Schedule Narrative. Milestone activities for Contract mandated milestones shall be constrained as follows:

i) All milestone activities for Contract mandated milestones shall be constrained with a date equal to the associated dates, as specified in the Contract and as follows:

a) Start-no-earlier-than Contract milestone activities shall be constrained with a "Start On or After" milestone date;

b) Start-no-later-than Contract milestone activities shall be constrained with a "Start On or Before" milestone date;

c) Finish-no-earlier-than Contract milestone activities shall be constrained with a "Finish On or After" milestone date;

d) Finish-no-later-than Contract milestone activities shall be constrained with a "Finish On or Before" milestone date.

ii) For Contracts that include a Contract provision with requirements to complete the Work or a portion of the Work by a specified interim completion milestone date, the interim completion milestone activity shall be constrained with a "Finish On or Before" date equal to the Contract specified "Must Finish By" date.

iii) For Contracts that include a Contract provision with "Early Completion" incentive requirements to complete the Work or a portion of the Work earlier than a Contract specified completion milestone date, the "Early Completion" milestone activity shall be constrained with a "Finish On or Before" date equal to the later of the Contractor's proposed early completion milestone date, as shown on the Baseline Progress Schedule, and the early date corresponding with the maximum number of days of early completion incentive allowed in the Contract.

11. Data Date: The data date for calculating the schedule shall be defined as follows:

i) For the Preliminary, Baseline, or subsequent Revised Progress Schedule submission, the data date shall be no more than five (5) business days prior to the submittal date.

ii) For the monthly Progress Schedule Update submissions the data date shall be the Contractor's monthly progress estimate date, in accordance with Section 109.08.(a) of the Specifications.

12. Float: The definition, ownership of float, and use of float, as described in this section are intended solely for the purpose of evaluating time extension requests resulting from changes or delays on the project. For considerations for other requests for adjustments to the Contract, refer to the applicable sections in the Specifications. Any float available in the Progress Schedule, at any time, including *"Total Float"* and *"Free Float"* shall be considered project float and is not for the exclusive use or benefit of either the Department or the Contractor. It shall be understood by the Contractor and the Department that float is a shared commodity and either party has the right to full use of any available float. Until such time that all available float is depleted, project float shall be used responsibly to mitigate delays on the project. *Total float* is defined as a CPM network calculated property that

represents the amount of time (workdays) that an activity can be delayed without extending the completion date of a related Contract milestone activity or the project completion milestone activity, as applicable, beyond the dates specified in the Contract or subsequently approved by the Engineer. *Free float* is defined as a CPM network calculated property that represents the amount of time (workdays) that an activity can be delayed without delaying its immediate successor activity.

Project float shall be calculated relative to a constrained Contract milestone activity or the project "Must Finish By" date (approved Contract fixed completion date), as applicable, and as follows:

i) For Contracts that do not include a Contract provision with requirements to complete the Work or a portion of the Work by a specified completion milestone date other than the Contract fixed completion date, project float for all activities shall be calculated relative to the Contract fixed completion date.

ii) For Contracts that include a Contract provision with requirements to complete the Work or a portion of the Work by a specified completion milestone date, project float for all activities leading to the completion milestone activity shall be calculated relative to the completion milestone date specified in the Contract.

iii) For Contracts that include a Contract provision with "Early Completion" Incentive/Disincentive requirements to complete the Work or a portion of the Work earlier than a specified milestone date, project float for all activities leading to the "Early Completion" milestone activity shall be calculated relative to the early completion date corresponding with the maximum number of days of early completion Incentive allowed in the Contract or the Contractor's initial proposed early completion milestone date, as calculated in the Baseline Progress Schedule, if later.

iv) For Contracts that include a Contract provision with Incentive/Disincentive requirements to complete the Work or a portion of the Work no later than a specified milestone date, project float for all activities leading to the Incentive/Disincentive milestone activity shall be calculated relative to the Incentive/Disincentive completion milestone date specified in the Contract.

If the Contractor submits a Baseline Progress Schedule showing a calculated completion date that is earlier than a specified completion milestone date or the Contract fixed completion date, as applicable, the Contractor must declare in writing, at the time of submitting the Baseline Progress Schedule or as specified in the Contract, its intension to finish early. The Contractor may request a modification of the Contract specified completion dates to the proposed early completion dates. Otherwise, any float available as a result of the early completion schedule, shall be considered project float. Any requests for Contract time extension will be evaluated in accordance with Section 108.04 of the Specifications and based on available project float. No time extensions will be considered until all available project float has been depleted.

Any modifications of the Progress Schedule, at any time, for the purpose of manipulating float shall be justification for rejecting the Progress Schedule. *Negative float conditions will not be allowed in the Preliminary, Baseline, or Revised Progress Schedules.*

13. Resource-Loading: When resource-loading is specified (required only for Category V), the Contractor shall resource-load each activity in the CPM Progress Schedule that represents a major operation for which manpower, materials, and/or equipment will be utilized, as

approved by the Engineer. The CPM Progress Schedule shall be reasonably resource-loaded to allow for an accurate determination of the manpower, materials, and/or equipment required for completion of the work associated with activity. The CPM Progress Schedule shall also be reasonably resource loaded to ensure that there are no resource conflicts between activities requiring the same resource and that sufficient resources are assigned.

The CPM Progress Schedule shall be resource-loaded as follows:

i) Contract-specific "Labor" (Manpower) resources shall be defined and assigned to the applicable activities to define the manpower (people) needed to complete the activity. A labor resource may be defined in terms of a person, trade, or crew. If a labor resource is defined by crew, then the Contractor shall define by trade using the resource notes, the number of people that make up the crew. If multiple shifts are needed to perform certain activities, the Contractor shall assign separate labor resources for each shift.

   When defining labor resources, the type of crew or labor classification and number (if multiple) shall be defined for each specific labor resource. The labor Resource ID shall be unique and shall consist of a prefix of the Contract ID number followed by a unique code (e.g. C00012345C01.Pipe-1). Also, the *Max Units/Time* shall be defined for each labor resource to establish the daily availability limits for determining over-allocation. When assigning a labor resource to an activity the *Budgeted Units/Time* or *Budgeted Units* shall be defined to establish the daily usage and total units of time required to perform the activity.

   The following are examples of labor resources defined by crew:

   a) C00012345C01.DC1 – Drainage Crew #1

   b) C00012345C01.GC1 – Grading Crew #1

   c) C00012345C01.FC1 – Forming Crew #1

   d) C00012345C01.RC1 – Rebar Installation Crew #1

   e) C00012345C01.CC1 – Concrete Placement Crew #1

   f) C00012345C01.APC1 – Asphalt Paving Crew #1

   g) C00012345C01.CPC1 – Concrete Paving Crew #1

ii) Contract-specific "Non-labor" (Equipment) resources shall be defined and assigned to the applicable activities to define the machinery or equipment needed to perform the work associated with the activity. When defining non-labor resources, the type of equipment, size (small, med-size, large), and number (if multiple) shall be defined for each specific non-labor resource. The labor Resource ID shall be unique and shall consist of a prefix of the Contract ID number followed by a unique code (e.g. C00012345C01.Crane-1). Also, the *Max Units/Time* shall be defined for each non-labor resource to establish the daily availability limits for determining over-allocation. When assigning a non-labor resource to an activity the *Budgeted Units/Time* or *Budgeted Units* shall be defined to establish the daily usage and total units of time required to perform the activity.

The following are examples of typical equipment resource definitions:

a) C00012345C01.GRDR – Grader

b) C00012345C01.EXC – Excavator

c) C00012345C01.DZR – Dozer

d) C00012345C01.CRN – Crane

e) C00012345C01.PDR – Pile Driving Rig

f) C00012345C01.DTRK – Dump Truck

g) C00012345C01.SCRP – Scraper

h) C00012345C01.PAVR – Asphalt Paver

i) C00012345C01.CSCRD – Concrete Deck Screed

iii) Contract-specific "Material" (Supplies) resources shall be defined and assigned to the applicable activities to define the consumable or re-usable items needed to accomplish the work associated with the activity. When defining material resources, the type of material and number (if multiple) and the *Units of Measure* shall be defined for each specific material resource. Also, the *Max Units/Time* shall be defined for each material resource to establish the daily availability limits for determining over-allocation. The material Resource ID shall be unique and shall consist of a prefix of the Contract ID number followed by a unique code (e.g. C00012345B01.Form-1). When assigning a material resource to an activity the *Budgeted Units/Time* or *Budgeted Units* shall be defined to establish the daily usage and total units of time required to perform the activity.

The following are examples of typical material resource definitions:

a) C00012345C01.FF1 – Foundation Forms #1

b) C00012345C01.CF1 – Column Forms Set #1

c) C00012345C01.FLSW – Falsework

d) C00012345C01.OHF1 – Overhang Forms Set #1

e) C00012345C01.DCF1 – Deck Concrete Forms Set #1

iv) Use of "Resource Dependent" Activity Type shall be on a case by case basis as approved by the Engineer. For resource dependent activities that are scheduled to be performed based on the calendar of their assigned resources, the Contractor shall define and assign a contract-specific resource calendar for each applicable resource.

v) Contract-specific manpower, equipment, and material resource codes, as approved by the Engineer, shall be defined and assigned to the applicable resources to allow for filtering, sorting, grouping, and reporting of project data by resource codes.

14. Cost Loading: When cost-loading is specified (required only for Categories IV and V), the Contractor shall cost load each activity in the Progress Schedule that represents work that will be measured for payment. The Progress Schedule shall be reasonably cost loaded to allow for accurate determination of progress of the individual activities based on quantity and costs. "Cost" shall mean the proportional Contract bid item amount associated with the activity for which the Contractor expects to receive payment upon completion of the work. A bid item may be assigned to multiple activities or multiple bid items may be assigned to an activity as deemed appropriate. Supporting items of work such as MOT, flagging, E&S, etc., that are typically performed intermittently over long periods of time may be assigned to a summary "Level of Effort" activity, as appropriate.

    The Progress Schedule shall be cost loaded using the "Material" resource type and in accordance with the following:

    i) Contract-specific "Material" resources shall be defined for each Contract line item as shown on the Contract Schedule of Items. The material Resource ID shall be unique and shall consist of a prefix of the Contract ID number followed by the associated Contract bid item number (e.g. C00012345B01.00100). The *Units of Measure* and *Price / Unit* for each specific bid item resource shall be defined as shown on the Contract Schedule of Items. The resource calendars shall be based on the project default contract-specific calendar used as the Contractor's standard working calendar.

        The following are examples of bid item material resources defined for use in cost-loading:

        a) C00012345C01.00100 – Mobilization

        b) C00012345C01.00110 – Clearing and Grubbing

        c) C00012345C01.00120 – Regular Excavation

        d) C00012345C01.01602 – 60" Concrete Pipe

        e) C00012345C01.07508 – Drop Inlet DI-7

        f) C00012345C01.09055 – Manhole MH-2

        g) C00012345C01.10128 – Aggr. Base Matl. TY. I No. 21B

        h) C00012345C01.10608 – Asphalt Concrete SM-12.5D

        i) C00012345C01.10610 – Asphalt Concrete IM-19.0A

        j) C00012345C01.10642 – Asphalt Concrete BM-25.0A.

    ii) When assigning the material resources to the activities, the budgeted unit (quantity) and budgeted cost shall be defined for each assigned resource based on the quantity of work that the activity represents.

    iii) The aggregate sum of the budgeted units and budgeted costs for all activities to which a bid item resource is assigned shall equal the total Contract amount for the associated Contract bid item as shown in the Contract Schedule of Items.

iv) The aggregate sum of the budgeted costs for all cost loaded activities shall equal the Total Contract Value. Total Contract Value will be considered to mean the current approved Contract amount including the original Contract amount and any authorized adjustments for changes in the Work in accordance with, but are not limited to, the provisions of Sections 109.04 and 109.05 of the Specifications. Payments for Material on Hand in accordance with Section 109.09 of the Specifications or for other adjustments such as asphalt, fuel, retainage, incentives, disincentives, etc., will not be included in the Progress Schedule, unless specifically directed otherwise by the Engineer.

v) For each eligible bid item material resource associated with a commodity as approved by the Engineer, the Contractor shall specify a *Maximum Units/Time* value to indicate the anticipated maximum number of units of work that can be performed during each workday. The material resources maximum units/time shall be defined as units/day (e.g., 100LF/Day, 300 Tons/Day, 5000 CY/Day, etc.).

15. CPM Progress Schedule Update: The CPM Progress Schedule Update shall reflect the actual status of the Work and the current plan to complete the remaining work as of the current data date. The CPM Progress Schedule Update shall be based on the most recent accepted Progress Schedule and prepared as follows:

    i) Create a copy of the previously accepted CPM Progress Schedule Update and rename it to indicate the Contract ID, type and number of submission, and the data date of the current submission (e.g. C00012345C01_U02_5-4-12).

    ii) Update the standard working calendars to reflect actual days lost due to weather or other causes beyond the contractor's control for which work on all activities to which the calendars were assigned were suspended.

    iii) For non-cost-loaded CPM Progress Schedules, the CPM schedule shall be updated as follows:

        a) Update status of the completed and on-going activities as necessary. Mark "Started' for activities that began this period. Mark "Finished" for activities that were completed this period.

        b) Specify the actual start dates for activities that began this period and finish dates for activities that were completed this period. (Note: all actual dates must occur prior to the current update data date).

        c) Update the remaining duration for on-going activities. Remaining duration shall be based on amount of time needed to complete the remaining work as of the data date.

        d) Update the percent complete for on-going activities. Percent complete shall be based on the amount of work completed to date relative to total amount of work estimated at completion, as of the data date.

    iv) For cost-loaded CPM Progress Schedules, the CPM schedules shall be updated in the following order and as follows:

a) Update status of the completed and on-going activities as necessary. Mark "Started' for activities that began this period. Mark "Finished" for activities that were completed this period.

b) Specify the actual start dates for activities that began this period and finish dates for activities that were completed this period. (Note: All actual dates must occur prior to the current update data date).

c) Update the remaining duration for on-going activities. Remaining duration shall be based on amount of time needed to complete the remaining work as of the data date.

d) Update the actual quantity and cost of work performed to date for each bid item resource assigned to the activity. (Note: *Any changes to the remaining duration will affect the actual quantity and cost*. The aggregate sum of actual cost to date for all activities associated with a bid item shall equal the total actual quantity and cost to date for the bid item as reflected on the current period progress estimate).

e) Update the at completion quantity and cost values for each applicable bid item resource assigned to the activity, as necessary to reflect any anticipated overruns or underruns. (Note: The aggregate sum of at completion values for all activities associated with a bid item shall equal the total anticipated at completion values for the bid item).

f) Update the activity percent complete for on-going activities. Activity percent complete shall be based on the activity summary cost percent complete (total actual cost to date / total at completion cost), which shall reflect the amount of work completed to date relative to the total amount of work estimated at completion, as of the data date.

v) Calculate the schedule using the current data date (progress estimate date).

vi) Review/analyze the schedule to determine if the activities are being performed out-of-sequence and if logic changes are required based on the current plan.

vii) Review the schedule to ensure that it conforms to the requirements of the Contract and that the project objectives are met.

viii) Create and save an export "XER" back-up file and "PDF" copies of the required reports. Send a copy of the "XER" and "PDF" copies of the required reports along with other required submittal items to the Engineer, as required.

For guidelines on updating the CPM Progress Schedule using the VDOT scheduling software (Primavera P6), click on the following link to download the "PDF" document:

http://www.virginiadot.org/business/resources/const/GuidelinesforAccessingandUsingtheVDOTSchedulingApplication.pdf

D. Progress Schedule Narrative – The following are specific requirements and guidelines for preparing a Progress Schedule Narrative:

1. Preliminary Progress Schedule Narrative: The Preliminary Progress Schedule shall describe:

i) The work planned for the initial start-up period.

ii) The proposed general sequence of Work. Describe where the work will begin and how it will progress.

iii) The resource plan. Describe the number of crews, crew make-up, and major equipment needed to complete the Work. Also, describe how the Contractor plans to provide resources to complete each feature of Work or major operation, as required.

iv) The proposed working calendar to indicate the normal working days per week and working hours per day; as well as any anticipated non-working days per month for any known or anticipated constraints such as holidays, weather, traffic, local events, time of year, environmental, utility, ROW, etc.

v) Any known or anticipated issues that may impact the schedule including, how the issues will impact the schedule and any actions taken or needed to avoid or mitigate the impact.

2. Baseline Progress Schedule Narrative: The Baseline Progress Schedule Narrative shall describe the following, with exceptions as noted:

i) The proposed general sequence of Work indicating where the work will begin and how it will progress.

ii) Milestone dates for Contract milestones and other key events, including as applicable, major traffic switches, start/finish dates for each major phase or stage of work, etc.

iii) A description of the project critical path. The project critical path (also known as the longest path) is defined as the series of work items or time-based tasks that collectively will take the longest time to complete. (Note: Not required for Category M projects, unless a CPM Progress Schedule is submitted in lieu of a Tabular Progress Schedule, as required).

iv) Work to be performed by the Department and other involved parties, including when the work must be performed.

v) The proposed means and methods for completing each feature. The proposed means and methods shall include a description of how the work will be performed, scheduling assumptions, and general procedures for accomplishing major operations that are expected to drive the schedule.

vi) The Contractor's resource plan indicating the number of crews, crew make-up, and major equipment needed to accomplish the Work as planned. The resource plan shall also describe how the Contractor plans on meeting the resource requirements. (Note: Not required for Category M projects).

vii) Anticipated daily production rates for each major operation. (Note: Not required for Category M projects).

viii) A log identifying the schedule constraints used in the Progress Schedule and reasons for using the constraints. (Note: Only required for Categories III, IV, and V projects for which a CPM Progress Schedule is required).

ix) For projects not using a CPM Progress Schedule (Categories M, I, and II), describe the Contractor' standard working calendar indicating the normal working days per week and working hours per day. It should also describe the anticipated non-working days per month for any known or anticipated restrictions such as holidays, weather, traffic, local events, time of year, environmental, utility, ROW, etc.

x) For projects requiring a CPM Progress Schedule (Categories III, IV, and V), or other projects for which a scheduling software such as Primavera P6 is used to prepare the schedule, the Contractor shall describe the calendar(s) used in the Progress Schedule. For each calendar, the Contractor shall describe the Calendar ID, standard number of work days per week, number of shifts per day, and number of hours per day as well as the anticipated number of non-working days per month for each calendar with considerations, as applicable, for holidays, normal weather conditions; as well as for seasonal or other known or specified restrictions (i.e. traffic, local events, environmental, permits, utility, etc.).

xi) Any known or foreseeable issues that may impact the schedule. Also, describe how the issues will impact the schedule and any actions taken or needed to avoid or mitigate the impact.

3. Progress Schedule Update Narrative: When a Progress Schedule Update Narrative is required (not required for Categories M, I, and II), the Progress Schedule Update Narrative shall describe:

i) The current period and data date for which the Progress Schedule Update Narrative is written.

ii) The current status of the project milestones including the Contract fixed completion date. It shall also describe any deviations from the date(s) specified in the Contract. If a milestone activity is scheduled to occur later than the date specified in the Contract, then provide an explanation stating why the milestone date is forecasted to occur late. Also, describe any actions taken or proposed to correct the delay.

iii) The current status of the project in terms of percent complete based on the actual total earnings to date relative to the current approved Contract Value. It shall also describe any deviation from the planned progress as indicated on the SOR. If progress is falling behind, describe reasons for the deficiency and any actions taken or proposed to correct the progress deficiency.

iv) The project critical path and any deviations from the SOR.

v) The work performed since the previous Progress Schedule Update submission and any deviations from the work scheduled.

vi) Any major changes in the Contractor's work plan in terms of sequence of construction, shifts, means and methods, manpower, equipment, or materials.

vii) Any changes made to the CPM Progress Schedule since the previous submission. A Claim Digger report (or equivalent) may be used to identify the changes.

viii) Weather days (number of days lost due to adverse weather or conditions resulting from adverse weather) during the current update period. Provide a list of the weather days, including a description and start/finish times of the weather event or condition; activities affected and how the activities were affected, and any impacts on the critical path or project milestones. Also, describe any actions taken or proposed to mitigate the weather delays.

ix) The status of pending issues such as access, permits, conflicts with other related or adjacent work, Work Orders, time extension requests, etc.

x) Any problems encountered or anticipated since the previous submission, including an explanation of any corrective actions taken or required to mitigate or avoid the effects.

xi) Work planned for the next update period and any actions needed to be taken by the Department or other involved parties to facilitate progress of the Work.

E. Progress Earnings Schedule – The following are specific requirements and guidelines for preparing a Progress Earnings Schedule:

1. Progress Earnings Schedule (For Non-cost-loaded Schedules): For projects with non-cost-loaded schedules (Categories I, II, and III), the Progress Earnings Schedule shall be prepared and submitted using the VDOT Form C-13C and as follows:

   i) Use the following links to download and save a copies of the VDOT Form C-13C "XLS" spreadsheet and "*Guidelines for Completing the VDOT Form C-13C*" "PDF" files:

   http:/www.virginiadot.org/business/resources/const/C13C.xls

   http://www.virginiadot.org/business/resources/const/GuidelinesforCompletingVDOTFormC13C.pdf

   ii) Open the saved copy of the Form C-13C spreadsheet file. Save and re-name the file for the new submission. Name the file to indicate the Contract ID, type and number of submission, and the date of submission (e.g. C00012345C01_FormC-13C_B01_4-2-12, C00012345C01_FormC-13C_U01_5-4-12, etc.).

   iii) Complete the "Breakdown of Contract Items" worksheet to provide a breakdown of the items and costs associated with each Major Work Category.

   iv) Complete the "C-13C (Baseline)" worksheet to provide a breakdown of the anticipated costs (earnings) per month for each Major Work Category.

   v) Complete the "C-13C (Update-Recovery)" worksheet to provide a breakdown of the actual costs (earnings) and projected earnings per month for each Major Work Category, when a monthly Progress Schedule Update or a Recovery Progress Schedule is required.

   vi) Complete the "Controls Chart Data" worksheet to show the total actual earnings per month as shown in the Contractor's progress estimate.

vii) Prepare a "PDF" copy of the Progress Earnings Schedule and S-Curve.

viii) Save the current copy Form C-13C and "PDF" files.

ix) Send a working copy of the Form C-13C and "PDF" files along with other required submittal items to the Engineer, as required.

2. Progress Earnings Schedule (For Cost-loaded Schedules): For projects with cost-loaded schedules (Categories IV and V), the Progress Earnings Schedule shall be prepared and submitted using the VDOT Form C-13CPM and as follows:

i) Use the following links to download and save a copies of the VDOT Form C-13CPM "XLS" spreadsheet and "*Guidelines for Completing the VDOT Form C-13CPM*" "PDF" files:

http://www.virginiadot.org/business/resources/const/C13CPM.xls

http://www.virginiadot.org/business/resources/const/GuidelinesforCompletingtheVDOTFormC13CPM.pdf

ii) Open the saved copy of the Form C-13CPM spreadsheet file. Save and re-name the file for the new submission. Name the file to indicate the Contract ID, type and number of submission, and the date of submission (e.g. C00012345C01_FormC-13CPM_B01_4-2-12, C00012345C01_FormC-13CPM_U01_5-4-12, etc.).

iii) Complete the "Control Charts Data" worksheet to provide the required project and Contract information.

iv) Copy and paste the monthly distributed earnings data generated from the cost-loaded CPM Progress Schedule into the "Earnings Data Input" worksheet to provide the required period costs data as follows:

a) For the Baseline and Revised Progress Earnings Schedule submissions, copy/paste the earnings data into both the "Baseline Monthly Cost (Earnings) Data" and the "Current Update Monthly Cost (Earnings) Data" sections.

b) For the Monthly Progress Earnings Schedule submissions, copy/paste the earnings data into the "Current Update Monthly Cost (Earnings) Data" section.

v) For the Monthly Progress Earnings Schedule submissions, complete the "Controls Chart Data" worksheet to provide the total actual earnings per month as shown in the Contractor's progress estimate.

vi) Prepare a "PDF" copy of the Progress Earnings Schedule and S-Curve.

vii) Save the current copy Form C-13CPM and "PDF" files.

viii) Send a working copy of the Form C-13C and "PDF" files along with other required submittal items to the Engineer, as required.

SECTION V

SCHEDULE MANAGEMENT AND CONTROL

1. Introduction
2. Conducting a Scheduling Conference
3. Establishing Schedule Control
4. Maintaining Schedule Control
5. Assessing Progress of the Work

SECTION V

1. INTRODUCTION

It is of utmost importance that prior to beginning Work the Contractor develops a reasonable plan to complete the Work and an effective schedule to establish who is doing what, where, and when. This is necessary to establish and maintain schedule control on the project. It is also essential that the schedule is communicated to all involved parties to show when their work must be accomplished to ensure that the project is finished on time and that project objectives are met. This section is intended to establish the VDOT Recommended Practice for Schedule Management and Control, which establishes the process as well as provides guidelines on how the Department will manage and utilize contractor provided schedules to establish and maintain schedule control on the project. Figure 5-1 is an illustration of the Schedule Management and Control process that outlines the primary steps involved in establishing and maintaining schedule control on a project. The primary steps are described in the following subsections.

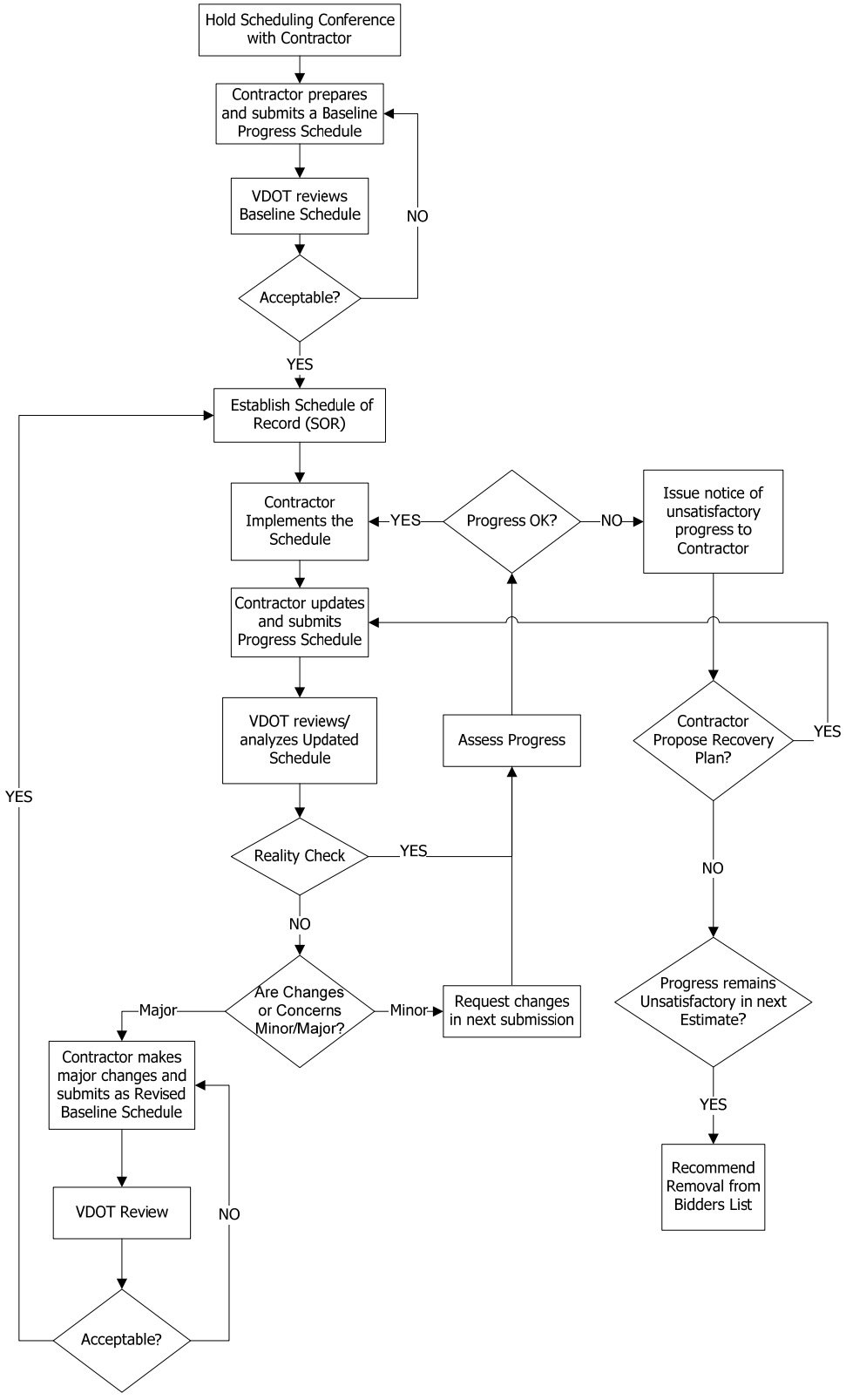


Figure 5-1: VDOT Schedule Management and Control Process

2. CONDUCTING A SCHEDULING CONFERENCE

At least seven (7) calendar days prior to beginning the Work, a Scheduling Conference will be held with the Contractor on a mutually agreed date. The Contractor may be allowed, as determined by the Engineer, to begin work on certain project start-up activities prior to the Scheduling Conference. Such start-up activities may include, but are not limited to submittals, mobilization, surveying, construction access and signage, erosion and sedimentation controls. The Scheduling Conference will be held to discuss the Contractor's detail work plan for the initial start-up period and the overall plan to accomplish the Work. Also, scheduling and project specific issues necessary for preparation and submittal of the Progress Schedule will be discussed. Such scheduling requirements and project specific issues and information include, but are not limited to the following:

i) Scheduling Issues: Discuss scheduling requirements and key schedule information necessary for the development of the Baseline Progress Schedule including, as applicable:

   a) Submission requirements including, timing of submissions, required submittals (number and type of submittals), format of submittals, file naming convention, and submittal procedures;

   b) Scheduling requirements concerning scheduling software, software settings, Project ID, WBS, activity codes, calendars, level of detail, constraints, cost-loading, resource-loading, etc.;

   c) Contract milestones and other time-related requirements including, as applicable interim milestones, incentive/disincentive, substantial completion, etc.;

   d) Phasing, sequencing, maintenance of traffic (MOT) requirements, and major traffic switches;

   e) Key submittals such as permits, shop drawings, etc.;

   f) Procurement and/or delivery of long lead materials;

   g) Work to be performed by the Department or other involved parties;

   h) Contractor's normal working schedule and exclusions;

   i) Constructability issues relative to the contract plans and specifications;

   j) Scheduling assumptions for any known or foreseeable issues including weather.

ii) Project-specific Issues: Discuss project-specific constraints or restrictions that may impact the schedule including, as applicable:

   a) Construction access or right-of-way issues;

   b) Utility;

   c) Railroad restrictions;

   d) Seasonal, traffic, local events, or time of year restrictions;

   e) Environmental, permits, or other limitations to the work;

   f) Any other known or foreseeable issues that may impact the schedule.

3. ESTABLISHING SCHEDULE CONTROL

Timely submission and review of the Baseline Progress Schedule is vital to successfully establishing schedule control on the project. The following are guidelines for reviewing the Baseline Progress Schedule submission, responding to the Contractor, and using the Baseline Progress Schedule to establish schedule control on the project:

A. Reviewing a Baseline Progress Schedule Submission – Upon receipt of the Contractor's Baseline Progress Schedule submission, it will be reviewed for acceptance within the time limit specified in the specification. The Baseline Progress Schedule submission will be reviewed as follows:

i) Review the Contract Plans and Specifications: Prior to reviewing the Baseline Progress Schedule submission, the reviewer will review the Contract Documents to be familiar with the contract requirements and scope of work.

ii) Review for Completeness: The Baseline Progress Schedule submission will be reviewed for *completeness* to determine if the Contractor has met the submittal requirements in accordance with the specifications. Review the submission for completeness to ensure that all required submittal items and reports are provided, as applicable:

a) Check to ensure that all required number of copies and submittal items and reports are provided, as required.

b) Check to ensure that a Tabular, Bar-chart, or CPM Progress Schedule is provided, as required.

c) Check to ensure that a Progress Schedule Narrative is provided, as required.

d) Check to ensure that a Progress Earnings Schedule is provided, if required.

e) Check to ensure that electronic working file copies of the Progress Schedule and Progress Earnings Schedule submittals are provided, as required.

f) Check to ensure that the electronic working file copy of the Progress Schedule is provided in the correct formats and can be loaded (imported) successfully.

g) Calculate the schedule to verify the data date and schedule calculation settings.

h) Verify that schedule information concerning the project critical path, milestones, and project completion date, as applicable, as indicated in the Progress Schedule and Progress Schedule Narrative are congruent.

Respond to the Contractor in writing within two (2) business days of receipt of the submission to acknowledge receipt and to inform the Contractor whether or not the submission is complete. If the submission is deemed incomplete, then the response will indicate any major deficiencies in the submission concerning completeness and a request for the missing information. The notice will also indicate that further review and analysis of the submission will be performed to determine acceptance.

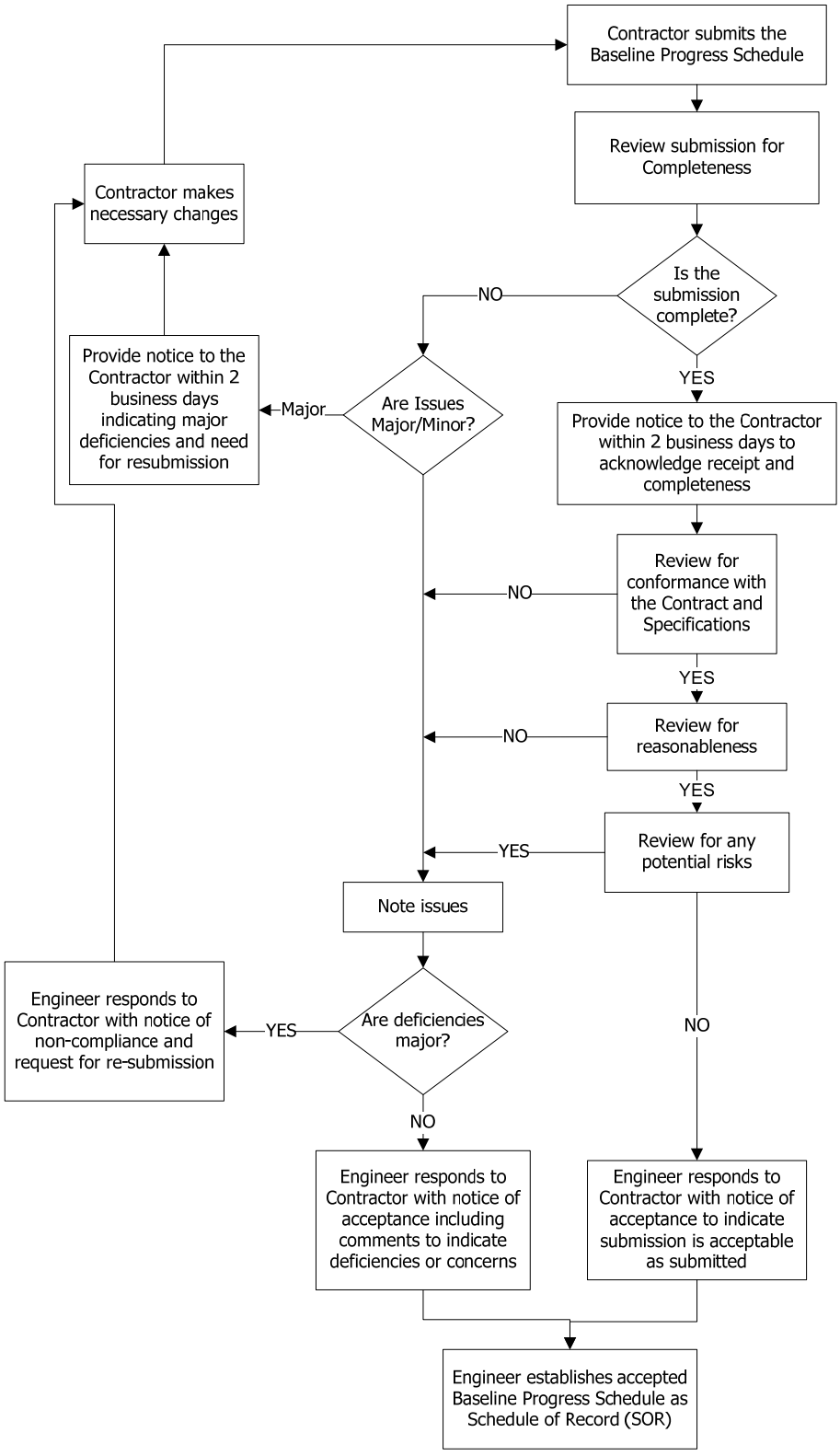


Figure 5-2: Process for Reviewing a Baseline Progress Schedule

iii) Review for Conformance: The Baseline Progress Schedule will also be reviewed for *conformance* to ensure that the Progress Schedule submission has met all scheduling requirements and that the schedule reflects a realistic plan to accomplish the Work in accordance with the Contract, as applicable. Check to ensure that:

a) All required project and activity properties are defined appropriately, as applicable;

b) Appropriate WBS was defined and level of detail is reasonable.

c) Activities are provided for all items of work required to complete the project.

d) All activities for administrative tasks required to complete the project are shown, including as applicable, permits, preparation and review of shop/working drawing submittals, procurement and fabrication/delivery of major materials, etc.

e) Provisions are made and reasonable time is allowed for work by the Department, as applicable.

f) Provisions are made and reasonable time is allowed for coordination with utilities and work by other involved parties, as applicable.

g) All required milestone activities are included and that Contract milestones and project completion requirements are met.

h) Phasing or sequencing requirements are met.

i) Maintenance of Traffic (MOT) requirements are met.

j) Appropriate logic relationships have been added and that there are no open ended activities, other than the first and the last activities (CPM schedules only).

k) Appropriate project-specific calendars are defined and assigned. And that the schedule accurately reflects the Contractor's proposed standard working calendar(s) as described in the Progress Schedule Narrative.

l) Appropriate project-specific activity codes are defined and assigned.

m) Appropriate logic relationships have been made.

n) Unnecessary or inappropriate constraints have not been used.

o) Provisions are made for specified schedule-related restrictions such as holidays, seasonal, weather, traffic, environmental, utility, railroad, permits, etc.

p) Provisions are made for applicable schedule related contract requirements involving safety, quality, DBE, etc.

q) Inflated durations, unnecessary lags, and schedule constraints are not used for the purpose of consuming available float.

r) Progress Schedule Narrative provides required content.

s) Progress Earnings Schedule was completed properly.

t) Cost-loading requirements are met for schedules requiring cost-loading.

iv) Review for Reasonableness: The Progress Schedule will also be reviewed for *reasonableness* to determine if the schedule reflects a feasible work plan. Check to ensure that:

a) Activity durations and associated production rates are reasonable;

b) The schedule reflects a logical sequence of progress relative to constructability.

c) There are no schedule conflicts due to manpower requirements.

d) There are no schedule conflicts due to equipment requirements.

e) Procurement and fabrication/delivery times are reasonable;

f) Key dates for work by other involved parties are reasonable;

g) The planned work flow makes sense;

h) The critical path and near critical path make sense (CPM schedules only);

i) The schedule reflects reality.

v) Review for Potential Risks: The Progress Schedule will also be reviewed to identify any potential scheduling issues that may result in quality or safety issues; or cause schedule delays or possible cost overruns on the project. Check to identify:

a) Scheduling interferences between concurrent activities or work by other trades that may result in quality or safety issues or schedule delays.

b) Weather sensitive work that are scheduled to be performed out of season that may result in quality issues or schedule delays.

c) Lack of testing activities or insufficient time allowed to inspect the work before work on a follow-on activity can begin, which may result in quality issues or schedule delays.

d) Lack of curing activities or insufficient time or logic allowed for related work that must be completed before work on a follow-on activity can begin, which may result in quality issues or schedule delays.

e) Lack of necessary time consuming activities that are needed to complete the project such as traffic control tear down, punch-list, testing and commissioning, clean-up and demobilization, etc.

f) Lack of considerations for normal weather that may result in schedule delays.

g) Lack of considerations for traffic constraints or other known or foreseeable issues or limitations that may impact the schedule.

h) Conflicts or deviations from other involved parties' schedules that may be due to lack of coordination.

B. Determining Acceptability – Upon review of the Baseline Progress Schedule submission, the Engineer will determine if the submission is acceptable in accordance with the following:

i) Acceptance will be based only on ***completeness*** and ***conformance*** in accordance with the requirements of the Contract and Specifications.

ii) Acceptance will not be based on *reasonableness*. However, any concerns about the reasonableness of the schedule will be noted in the response to the Contractor with a request for clarification or justification.

iii) Major deficiencies concerning completeness and conformance with the requirements of the Contract and Specifications will result in a refusal of the submission and a request for re-submission. Minor issues will be noted in the response to the Contractor with a request to clarify or correct the deficiencies in the subsequent submission.

vi) If the Contractor submits a Baseline Progress Schedule that shows the project finishing earlier than the date specified in the Contract (Early Completion Schedule), the Baseline Progress Schedule will be accepted provided the schedule meets the criteria for acceptance. However, emphasis will be placed on activity durations, logic, resource usage, and work by the Department or others when reviewing the schedule. The Engineer may request additional information to substantiate the Contractor's commitment and ability to complete the project as planned. The Engineer may also request a meeting with the Contractor to facilitate review and acceptance of the schedule.

C. Responding to the Contractor – Upon determination of acceptance, the Engineer will respond in writing within the time limit specified in the Contract to notify the Contractor whether the Progress Schedule submission is accepted as submitted, returned for re-submission, or accepted with a request to correct some minor issues as follows:

i) If the submission is not acceptable due to major deficiencies or concerns about the submission, the Engineer's response will include a notice of non-compliance indicating the deficiencies or concerns prompting the Engineer's decision. The response will also include a request for re-submission.

ii) If the submission is reasonably acceptable, but contain minor deficiencies that are necessary for effective use of the Progress Schedule, the Engineer's response will include a notice of acceptance with comments indicating the deficiencies. The response will also include a request to the Contractor to address the concerns in the subsequent submission.

iii) If the submission is acceptable and exhibits no obvious concerns, the Engineer's response will include a notice of acceptance to indicate that the submission is acceptable as submitted.

iv) The notice of acceptance will also include a statement informing the Contractor that the accepted Baseline Progress Schedule will become the Schedule of Record (SOR), with which all involved parties and stake-holders will plan and coordinate the Work. The SOR will also be used to establish the baseline with which progress for future work will be compared and schedule references will be made.

D. Establishing Schedule Control – Upon acceptance, the Contractor's Baseline Progress Schedule will become the Schedule of Record (SOR). And until a Revised Progress is submitted and accepted, the Baseline Progress Schedule will remain the SOR with which all parties will plan and schedule their work and against which progress will be compared. The SOR will be used to establish schedule control on the project as follows:

i) Pertinent schedule information and key dates will be shared with all involved parties and stake-holders for coordination.

ii) The schedule will be shared with all project field personnel involved in managing and controlling the project.

iii) The schedule will be posted in the field office for all to see and be aware of who is doing what, where, and when.

iv) The SOR will be used to create an As-built Schedule template with which to capture daily as-built schedule information as the project progresses. The As-built Schedule will be used to validate the Contractor's Progress Schedule Update as well as deal with time related issues on the project. The As-built Schedule will show for each activity the:

a) Activity ID;

b) Activity Name;

c) Whether or not the activity is on the critical path;

d) Planned Original Duration;

e) Planned Early Start date;

f) Planned Late Finish date;

g) Actual Start date;

h) Actual Finish date;

i) Actual Duration;

j) Daily log indicating work started, in progress, completed, and suspended; and weather condition (am/pm);

k) Comments noting any issues encountered, if any.

v) The SOR Progress Earnings Schedule will be used to establish the anticipated monthly earnings in SiteManager.

vi) The SOR will be used as a frame-work for planning and managing the Department's work, resources, and expenditures; as well as for coordinating, inspecting, communicating with the public, and reporting progress of the Work.

4. MAINTAINING SCHEDULE CONTROL

Once the project is underway, the SOR will be updated regularly and the Contractor will prepare and submit a Progress Schedule Update monthly to provide as-built information to show how the work is being performed, if required. The Progress Schedule Update submission will be reviewed to determine if the work is progressing according to plan or if changes to the schedule or work plan are necessary. The following are guidelines for reviewing the Progress Schedule Update submission, responding to the Contractor, and using the Progress Schedule Update to maintain schedule control on the project:

A. Reviewing the Contractor's Progress Schedule Update – Upon receipt of the Contractor's Progress Schedule Update submission, it will be reviewed for acceptance within the time limit specified in the specification. The Progress Schedule Update submission will be reviewed as follows:

i) Review for Completeness: The Progress Schedule Update submission will be reviewed for *completeness* to determine if the Contractor has met the submittal requirements in accordance with the specifications. Respond to the Contractor in writing within two (2) business days of receipt of the submission to acknowledge receipt and to inform the Contractor whether or not the submission is complete. If the submission is deemed incomplete, then the response will indicate any major deficiencies in the submission concerning completeness and a request for the missing information. The notice will also indicate that further review and analysis of the submission will be performed to determine acceptance. Review the submission for completeness to ensure that all required submittal items and reports are provided, as applicable.

a) Check to ensure that all required number of copies and submittal items and reports are provided, as required.

b) Check to ensure that a Tabular, Bar-chart, or CPM Progress Schedule is provided, as required.

c) Check to ensure that a Progress Schedule Narrative is provided, as required.

d) Check to ensure that a Progress Earnings Schedule is provided, if required.

e) Check to ensure that electronic working file copies of the Progress Schedule and Progress Earnings Schedule submittals are provided, as required.

f) Check to ensure that the electronic working file copy of the Progress Schedule is provided in the correct formats and can be loaded (imported) successfully.

g) Calculate the schedule to verify the data date and schedule calculation settings.

h) Verify that schedule information concerning the project critical path, milestones, and project completion date, as applicable, as indicated in the Progress Schedule and Progress Schedule Narrative are congruent.

ii) Review for Conformance: The Progress Schedule Update will also be reviewed for *conformance* to ensure that the Progress Schedule Update submission has met all scheduling requirements and that the schedule accurately reflects the current as-built status of the project and plan to complete the remaining work. Check to ensure that:

a) The projected completion and milestone dates are in accordance with the Contract.

b) The current sequence of work and logical relationships of the activities are in accordance with the plans and specifications.

c) All appropriate changes in the scope of work have been incorporated.

d) Unnecessary or inappropriate constraints have not been used.

e) Inflated durations, unnecessary lags, and schedule constraints are not used for the purpose of consuming available float.

f) Reported progress is accurate.

g) Actual dates are accurate. Check to ensure that the as-built dates are consistent with field reports, look-ahead schedules, and available project records, as applicable.

h) All activities reported complete are actually complete.

i) The percent complete for on-going activities are consistent with the amount of work completed relative to the total amount of work planned.

j) The schedule calculation options and other required schedule settings are set correctly, if specified.

k) Forecast dates are accurate after re-calculating the schedules.

l) Narrative report is complete and accurately reflects the current status of the project and current plan to complete the remaining work.

m) Actual earnings data reported in the Progress Earnings Schedule are accurate. For cost-loaded schedules check to ensure that the actual quantity and cost data in the schedule are accurate.

iii) Review for Reasonableness: The Progress Schedule Update will also be reviewed for *reasonableness* to determine if the schedule reflects a feasible work plan to complete the remaining work. Check to ensure that:

a) Durations and associated production rates for remaining activities are reasonable.

b) The remaining duration for on-going activities are consistent with the amount of work remaining relative to the total amount of work planned.

c) The schedule reflects a logical sequence of progress for the remaining work. Check the sequence of progress for the on-going and remaining work to ensure that there is no out-of-sequence progress.

d) There are no schedule conflicts due to manpower requirements.

e) There are no schedule conflicts due to equipment requirements.

f) Key dates for work by other involved parties are reasonable.

g) The planned work flow makes sense.

h) The critical path and near critical path make sense (CPM schedules only).

i) The schedule reflects reality.

B. Analyzing for Changes or Concerns – Upon reviewing the Contractor's Progress Schedule Update submission, the schedule will be analyzed to determine if minor or major changes were made or if there are any concerns about the submission:

i) Analyze for Changes: The Progress Schedule Update will also be analyzed to determine if changes were made since the previous update relative to the SOR. Check to determine if:

a) Changes were made to activity durations.

b) Changes were made to network logic.

c) Activities were or added or deleted.

d) The critical path has changed. If it has changed, note the changes.

e) Changes were made to project calendars.

f) Changes were made in calculation options (progress override vs. retained logic).

g) Changes have any effects on the critical path, Contract milestones, or overall schedule.

h) Determine if the changes are minor or major.

ii) Analyze for Concerns: The Progress Schedule Update will also be analyzed to determine if there are any concerns and if changes are necessary. Review to determine if adjustments are necessary to correct:

a) Unreasonable durations.

b) Inaccurate as-built dates.

c) Inaccurate progress.

d) Out-of-sequence or out-dated logic.

e) Inaccurate representation of changed work.

f) Improper use of constraints and lags.

v) Determine if Changes or Concerns are Minor: Determine if the changes made or concerns are minor. Minor changes or concerns include:

a) Minor disagreements about as-built dates that will not impact the schedule;

b) Minor disagreements over percent complete of activities that do not affect the critical path;

c) Minor disagreements over remaining duration of activities with large amount of float that do not affect the critical path;

d) Minor disagreements over activities with large amount of float that will not impact the schedule;

e) Minor logic adjustments that do not affect the critical path;

iii) Determine if Changes or Concerns are Major: Determine if the changes made or concerns are major. Major changes or concerns include:

a) Significant adjustments to the schedule for changes in the scope of work;

b) Unreasonable logic changes to the critical path;

c) Major deviations from the overall sequence that will affect the critical path or milestones;

d) Significant number of activities being performed out-of-sequence

e) Significant number of inaccurate as-built dates or percent complete

f) Inaccurate representation of changed work;

g) Unsatisfactory progress;

C. Determining Acceptability – Upon review and analysis of the Contractor's Progress Schedule Update submission, the Engineer will determine acceptance as follows:

i) Acceptance will be based only on *completeness, conformance,* and *accuracy* in accordance with the requirements of the Contract and Specifications.

ii) Acceptance will not be based on *reasonableness*. However, any concerns about the reasonableness of the schedule will be noted in the response to the Contractor with a request for clarification or justification.

iii) Major deficiencies concerning completeness, conformance, and accuracy will result in a refusal of the submission and a request for re-submission. Minor issues will be noted in the response to the Contractor with a request to clarify or correct the deficiencies in the subsequent submission.

D. Responding to the Contractor – Upon determination of acceptance, the Engineer will respond in writing within the time limit specified in the Contract to notify the Contractor whether the Progress Schedule submission is accepted as submitted, returned for re-submission, or accepted with a request to correct some minor issues as follows:

i) If the submission is not acceptable due to major deficiencies or concerns about the submission, the Engineer's response will include a notice of non-compliance indicating the deficiencies or concerns prompting the Engineer's decision. The response will also include a request for re-submission.

ii) If the submission is reasonably acceptable, but contain minor deficiencies that are necessary for effective use of the Progress Schedule, the Engineer's response will include a notice of acceptance with comments indicating the deficiencies. The response will also include a request to address the concerns in the subsequent submission.

iii) If the submission is acceptable and exhibits no obvious concerns, the Engineer's response will include a notice of acceptance to indicate that the submission is acceptable as submitted.

iv) If it was determined by the Engineer that significant changes were made, the notice of acceptance may also include a statement informing the Contractor that the Progress Schedule submission will be accepted as a Revised Progress; therefore, will become the current SOR. The SOR will then be used as the new baseline with which progress for future work will be compared and schedule references will be made.

E. Maintaining Schedule Control – Upon acceptance, the Contractor's Progress Schedule Update will be used maintain control on the project as described above in Section V.4.A. If a Revised Progress Schedule is submitted and accepted, then it will become the current SOR. The SOR will be used to re-establish schedule control for the remainder of the project as described above in Section V.3.D.

5. ASSESING PROGRESS OF THE WORK

Status of the work will be assessed monthly to ensure that the work is progressing accordingly and that the project goals and objectives are being met.

A. Monthly Progress Meeting – A monthly progress meeting will be held with the Contractor on a mutually agreed day in accordance with the provisions of Section 108.01. The meeting will be held to discuss the current status of the project and the plan for the next period. The Contractor must furnish its detailed 30-day look-ahead schedule at the progress meeting and must be prepared to discuss the current status of the Work and planned operations for the following thirty (30) calendar days. The 30-day look-ahead schedule will be based on the Contractor's current Progress Schedule Update:

B. Progress Evaluation – Progress of the work will be evaluated based on amount of work completed to determine if the Contractor is accomplishing the work at a rate of progress necessary to ensure timely completion of the project. Progress will also be evaluated based on the schedule to ensure that the critical activities or controlling items of work are progressing as planned. Progress will be assessed relative to the SOR and as of the Contractor's progress payment estimate date based on Progress will be evaluated by the Engineer at the time of the monthly progress estimate relative to the SOR. The Contractor's actual progress will be considered unsatisfactory in accordance with the following:

i) Category I: For Category I projects, progress will be deemed unsatisfactory if any one of the following conditions occur;

   a) The current actual total earnings to date percentage for work completed, based on the Contractor's progress payment estimate, falls behind the SOR anticipated cumulative earnings percentage by more than ten (10) percentage points;

   b) The current projected completion date of a Contract interim milestone is later than the specified completion date by more than seven (7) calendar days;

   c) The current projected completion date of the project is later than the Contract fixed completion date by more than fourteen (14) calendar days;

ii) Category II: For Category II projects, progress will be deemed unsatisfactory if any one of the following conditions occur:

   a) The current actual total earnings to date percentage for work completed, based on the Contractor's progress payment estimate, falls behind the SOR anticipated cumulative earnings percentage by more than ten (10) percentage points;

   b) The current projected completion date of a Contract interim milestone is later than the specified completion date by more than fourteen (14) calendar days;

   c) The current projected completion date of the project is later than the Contract fixed completion date by more than twenty-one (21) calendar days;

iii) Category III: For Category III projects, progress will be deemed unsatisfactory if any one of the following conditions occur;

a) The current actual total earnings to date percentage for work completed, based on the Contractor's progress payment estimate, falls behind the SOR planned cumulative earnings percentage by more than ten (10) percentage points. If the Progress Earnings Schedule is based on a cost-loaded Progress Schedule, then the unsatisfactory progress threshold will be based on falling behind the SOR planned cumulative late dates earnings percentage.

b) The current calculated completion date of a Contract interim milestone is later than the specified completion date by more than twenty-one (21) calendar days.

c) The current calculated project completion date is later than the Contract fixed completion date by more than thirty (30) calendar days.

iv) Category IV: For Category IV projects, progress will be deemed unsatisfactory if any one of the following conditions occur:

a) The current actual total earnings to date percentage for work completed, based on the Contractor's progress payment estimate, falls behind the SOR planned cumulative late dates earnings percentage.

b) The current calculated completion date of a Contract interim milestone is later than the specified completion date by more than thirty (30) calendar days.

c) The current calculated project completion date is later than the Contract fixed completion date by more than forty-five (45) calendar days.

v) Category V: For Category V projects, progress will be deemed unsatisfactory if any one of the following conditions occur:

a) The current actual total earnings to date percentage for work completed, based on the Contractor's progress payment estimate, falls behind the SOR planned cumulative late dates earnings percentage.

b) The current calculated completion date of a Contract interim milestone is later than the specified completion date by more than thirty (30) calendar days.

c) The current calculated project completion date is later than the Contract fixed completion date by more than sixty (60) calendar days.

C. Progress Deficiency and Schedule Slippage – When the Contractor's actual progress is trending toward unsatisfactory status, the Engineer will request a meeting with the Contractor to discuss any actions taken or needed to correct the progress deficiency or schedule slippage.

When progress of the Work is deemed unsatisfactory, the Engineer will issue a written notice of unsatisfactory performance to advise the Contractor that five (5) percent retainage of the monthly progress estimate is being withheld and will continue to be withheld as described in Section 109.08 (c), for each month the Contractor's actual progress remains unsatisfactory.

The Engineer's notice of unsatisfactory performance will also indicate that the Contractor's prequalification status may be adjusted as described in Section 102.01, and that the Contractor may be temporarily disqualified from bidding on Contracts with the Department as described in Section 102.08, if progress remains unsatisfactory at the time of preparation of the ensuing monthly progress estimate.

The Engineer may delay withholding retainage, if there is a pending decision by the Engineer on a request for modification of the Contract, for which the Contractor had previously requested an extension of the Contract time limit and has provided proper documentation as required.

Prior to recommendation for adjustment of the prequalification status or disqualification, the Engineer will allow the Contractor fourteen (14) calendar days from the date of the unsatisfactory performance notice to respond.

If the Contractor responds in good faith by submitting a written statement describing the Contractor's proposed recovery plan, actions taken or planned. The Contractor must also submit a modified Progress Schedule Update to reflect the Contractor's proposed recovery plan to correct the progress deficiency or schedule slippage. The Contractor may also submit to the Engineer a written explanation and supporting documentation to establish that such delinquency was attributable to conditions beyond its control. In which case, a Schedule Impact Analysis (SIA) will be required to substantiate the Contractor's position. Any Progress Schedule submission that is based on a recovery plan will be considered a Progress Schedule Update and will not replace the SOR.

When the Engineer determines the Contractor's progress is again satisfactory the five (5) percent retainage previously withheld will be released to the Contractor in accordance with the provisions of Section 109.08 (c) of the Specifications.

If the Contractor is temporarily disqualified from bidding on Contracts with the Department, the Contractor will not be reinstated until either the progress of the Work has improved to the extent that in the opinion of the Engineer the Work can be completed on time or the project has received final acceptance in accordance with the provisions of Section 108.09.

SECTION VI

CHANGES, DELAYS, TIME EXTENSION, AND COMPENSATION FOR DELAY DAMAGES

1. Introduction
2. Changes and Delays
3. Types of Delays
4. Schedule Impact Analysis
5. Determination and Extension of Contract Time Limit
6. Determination and Compensation for Delay Damages

SECTION
VI

1. INTRODUCTION

This section is being developed.

For guidelines for performing a Schedule Impact Analysis (SIA) see the following:

1. "Schedule Impact Analysis Using CPM Schedules" manual written by Brian A. Henschel, P.E, PMP (VDOT/VT Partnership for Project Scheduling):

   http://www.virginiadot.org/business/resources/const/0701_SIAModule-VPPSTechnicalReport.pdf

2. AACE Recommended Practice – Forensic Schedule Impact Analysis No. 29R-03:

   http://www.virginiadot.org/business/resources/const/AACE_Recommended_Practice_Forensic_Schedule_Impact_Analysis-29R-03.pdf

3. AACE International Recommended Practice – Time Impact Analysis (TIA) No. 52R-06:

   http://www.virginiadot.org/business/resources/const/AACE_Recommended_Practice_Time_Impact_Analysis-52R-06.pdf

SECTION VII

APPENDICES

A. Example of a Category M Schedule of Operations

B. Example of a Category I Progress Schedule

C. Example of a Tabular Progress Schedule

D. Example of a Category II Bar-chart Progress Schedule

E. Example of a Category I, II, or III Progress Earnings Schedule (C-13C)

F. Example of a Category I, II, or III Progress Earnings Schedule (S-Curve)

G. References/Resources/Training

APPENDIX A: EXAMPLE OF A CATEGORY M SCHEDULE OF OPERATIONS

Acme Construction
Schedule of Operations
Project No. ST-8E-08
Any County, Virginia
Submittal Date: 3/25/2009

1. Description of the Contractor's Proposed Sequence of Work *(A written description of the proposed overall sequence of construction)*

The contract work consists of Surface Treatment and Pavement Markings in three Counties namely County X, Y, and Z. The work has been planned to progress from north to south, starting at County Y and proceeding to County Z and finishing at County X, as indicated in the Tabular Schedule of Operations below.

Work will commence with the mobilization of materials and equipment to a central staging site for each Area (*Residency, Subdivision, or Route*) within the County. All operations required to complete the work for each Area will be completed prior to mobilizing to the next Area. One week has been scheduled for mobilization of materials and equipment to each Area.

Mobilization will begin the week of April 1, 2009 for work in County Y. Once Mobilization is complete, work will commence with installation of traffic control devices, temp signs/striping, and traffic will be detoured as shown in the contract documents. Once the traffic control devices have been installed work will commence on the application of Modified Double Seal, Pavement Dotting, and placement of Pavement Line Markings for all locations in County Y starting with Route 678 and working east to west. All work including mobilization and punch list is scheduled for four weeks.

Mobilization will begin the week of May 4, 2009 for work in County Y. Once Mobilization is complete and the traffic control devices and temp signs/striping have been installed, work will commence on the application of Modified Double Seal, Pavement Dotting, and placement of Pavement Line Markings for all locations in County Z starting with Route 789 and working east to west. All work including mobilization and punch list is scheduled for four weeks.

Mobilization will begin the week of June 8, 2009 for work in County Y. Once Mobilization is complete and the traffic control devices and temp signs/striping have been installed, work will commence on the application of Modified Double Seal, Pavement Dotting, and placement of Pavement Line Markings for all locations in County X starting with Route 889 and working north to south. All work including mobilization and punch list is scheduled for three weeks.

All work on this Contract Schedule is scheduled to be finished by June 30, 2009.

2. Tabular Schedule of Operations: *(A tabular schedule to indicate the general sequence and schedule of work).*

Task Description	Start	Finish
Receive Notice to Proceed (NTP)	**3-2-09**	
Pre-construction/Scheduling Conference	3-15-09	3-15-09
County Y	**4-1-09**	**4-30-09**
Mobilization	4-1-09	4-7-09
– Rte 678	4-8-09	4-8-09
– Rte 679	4-9-09	4-9-09
– Rte 680	4-10-09	4-10-09
Subdivision ABC – Rte 1400	4-13-09	4-15-09
Subdivision ABC – Rte 1401	4-16-09	4-17-09
– Rte 681	4-22-09	4-22-09
– Rte 682	4-23-09	4-24-09
Punch list/Cleanup/Demob	4-27-09	4-30-09
County Z	**5-4-09**	**5/29/09**
Mobilization	5-4-09	5-8-09
– Rte 789	5-11-09	5-13-09
– Rte 790	5-14-09	5-15-09
– Rte 791	5-18-09	5-18-09
– Rte 793	5-19-09	5-19-09
– Rte 794	5-20-09	5-20-09
– Rte 795	5-21-09	5-22-09
– Rte 796	5-25-09	5-25-09
– Rte 797	5-26-09	5-27-09
Punch list/Cleanup/Demob	5-27-09	5-29-09
County X	**6-8-09**	**6-30-09**
Mobilization	6-8-09	6-12-09
– Rte 889	6-15-09	6/16/09
– Rte 891	6-17-09	6-19-09
– Rte 892	6-22-09	6-22-09
– Rte 893	6-23-09	6-23-09
– Rte 894	6-24-09	6-24-09
– Rte 895	6-25-09	6-26-09
Punch list/Cleanup/Demob	6-29-09	6-30-09
Complete Contract Schedule ST-8E-08		**6-30-09**

APPENDIX B: EXAMPLE OF A CATEGORY I BASELINE PROGRESS SCHEDULE

Acme Construction
Baseline Progress Schedule
Project No. 0123-456-789
Any County, Virginia
Submittal Date

1. **Description of the Contractor's Plan of Operations** *(A written description of the overall plan of operations and proposed means and methods to complete each feature or major operation in terms of the proposed overall sequence of construction, general procedures, crew(s),and anticipated daily production rates for each major operation)*

   a) Sequence of Construction:

   The Work will commence with Mobilization April 4, 2011. The Work has been planned to progress east to west, starting at Station 0+00 to Station 28+65 according to the suggested phasing included in the project documents.

   Once Mobilization is complete, work will commence with installation of traffic control devices, temp signs/striping, and traffic will be detoured as shown in the MOT plans.

   Once the traffic control devices have been installed work will commence on the erosion and sediment control devices and clearing and grubbing in preparation for grading operations.

   Phase 1 earthwork will commence about one week after clearing and grubbing has commenced. The first cut from Station 2+99 to Station 4+75 will be opened as soon as E&S devices are installed up to Station 10+00. We figure the first cut and the two grade areas will take about 3 weeks to complete. Once the first cut is complete, work will immediate commence on the second cut. The second cut area (sta. 10+50 to 20+00) and final grade areas are scheduled for 5 weeks.

   Drainage work will follow the earthwork and we estimate drainage work will require about 3 weeks to complete. Once drainage is complete, fine grading will commence for about 2 weeks.

   Once fine grading is complete, we will lay base stone; construct curb and gutter, and place base course, intermediate, and final asphalt to complete Phase 1 of the project. One week is scheduled for each operation.

   Two weeks have been scheduled for punch list and cleanup work. The punch list needs to be prepared to allow for enough time to complete the work before the October 31st milestone completion date for Phase 1.

   b) Procedures:

   Mobilization will involve organizing materials, mobilizing materials and equipment to the site, getting utility locates started, and coordinating our requirements with the superintendent (i.e. surveying, traffic control, sequence of the project, scheduling, etc.).

   The first cut from Station 2+99 to Station 4+75 will be made with excavators loading into tandem axel dump trucks, which will haul the material to either the grade areas or the disposal area. Rock is anticipated in both the cut areas and will be broken up using hydraulic rams.

Material for each cut will be used to build the adjacent grade areas, and then all excess material will be disposed.

Drainage work will follow the earthwork and excavators and/or backhoes will be used. We estimate drainage work will require about 3 weeks to complete. Once drainage is complete, 2 weeks is needed for fine grading the entire project using a motor grader.

Base stone will be tailgated in place and spread with a small dozer, graded with a motor grader, and compacted with a vibratory roller.

Paving will be performed using an asphalt paving machine and vibratory rollers.

c) Planned Resources:

i) Planned Crew: Our typical crew will be one (1) Superintendent and one (1) 6-8 man crew including two (2) Certified Flaggers, two (2) Operators, and 2-4 Laborers.

ii) Planned Equipment: Planned equipment will include but not limited to one (1) Excavator, one (1) Backhoe, one (1) Small Dozer, one (1) Motor Grader, one (1) Dump Truck, one (1) Vibratory Roller, and one (1) Paving Machine.

d) Anticipated Daily Production Rates: *(Required only for Category II and higher)*

i) Earthwork: 500 cy/day;

ii) Drainage: 100 ft/day;

iii) Aggregate Base: 400 ton/day;

iv) Asphalt Paving: 200 ton/day.

2. Calendar Considerations: *(A discussion on the working calendar with considerations for applicable constraints and restrictions (i.e. normal weather, holidays, traffic, time of year, utility, etc.)*

a) Work Calendar:
A normal work week is five (5) days (M-F) with one shift per day. The normal start time is 7:00 AM with eight (8) hours per shift. The schedule accounts for normally recognized holidays. The schedule assumes that work will be suspended at 12:00 noon on the day before major holidays.

b) Weather:
Based on historical weather data for this area, we anticipate rain to impact the work about four (4) days per month between April and September. The schedule assumes one (1) lost day per work week for the effects of rain for the entire duration of the project.

c) Schedule Constraints and Restrictions:
The schedule does not consider any constraints or restrictions. Work times will be adjusted as necessary to accommodate traffic control restrictions.

3. Tabular Schedule: *(A tabular schedule to show milestones for completing each phase, feature, or stage of work; and sequence, start and finish dates of all relevant time-based tasks required for timely completion of the work. Show major milestones only for Cat II and higher; other time-related tasks will be shown in the Bar-chart or CPM schedules).*

Activity ID	Activity Name	Activity Dur	Start Date	Finish Date
100	**Contract Award/NTP**	**0**	**3-21-11**	
110	Pre-construction/Scheduling Conference	1	3-31-11	3-31-11
120	Mobilization/Survey	10	4-4-11	4-15-11
130	**Start Phase I Construction**	**0**	**4-18-11**	
140	Install Erosion Control System – Ph-I	1	4-18-11	4-18-11
150	Clear & Grub – Ph-I	2	4-19-11	4-20-11
160	Install Temp Signs/Striping/Traffic Control Device	2	4-21-11	4-22-11
170	Left Shoulder Strengthening/Shift Traffic – Ph-I	5	4-25-11	4-29-11
180	Saw-cut/Demo Existing Shoulder Rt. Side	5	5-2-11	5-6-11
190	Excavation/Grading – Ph-I	10	5-9-11	5-20-11
200	Extend Drainage Structure/Install Riprap	15	5-16-11	6-6-11
210	Fine Grading/Sub-grade Prep	2	6-7-11	6-8-11
220	Install Aggregate/UD/Aggregate Base	3	6-9-11	6-13-11
230	Construct Curb & Gutter	5	6-14-11	6-20-11
240	Place Asphalt Concrete Base for Rt. Turn Lane.	2	7-5-11	7-6-11
250	Intermediate Course for Rt. Turn Lane.	1	7-7-11	7-7-11
260	Place Final Course Asphalt Concrete	1	7-11-11	7-11-11
270	Install Striping/Signs/Seeding	5	7-12-11	7-18-11
280	Punch list/Cleanup	5	7-19-11	7-26-11
290	Open Right Turn Lane/Shift Traffic	1	7-27-11	7-27-11
300	**Complete Phase I Construction**	**0**		**7-27-11**

4. Potential Impacts: *(A discussion of any potential issues that may impact the schedule)*

There is a potential for soft soils in the area of the fill around Stations 5+00 and 27+00. If encountered, a quick decision from your field personnel will help maintain the schedule.

APPENDIX C: EXAMPLE OF A TABULAR PROGRESS SCHEDULE

CONTRACTOR'S TABULAR PROGRESS SCHEDULE

Monthly Progress Schedule Update - April 2008

CONTRACT ID. NO.: C00012345C01
PROJECT NO.: 0123-456-789, N123
FHWA PROJECT NO.: N/A
PROJECT NAME: Sample Project
ROUTE: VA-100
CITY/COUNTY: Chester/Chesterfield

CONTRACT NTP DATE: March 3, 2008
CONTRACT FIXED COMPLETION DATE: November 30, 2008
PROJECTED COMPLETION DATE: November 17, 2008
BASELINE DATA DATE: March 3, 2008
CURRENT DATA DATE: April 21, 2008

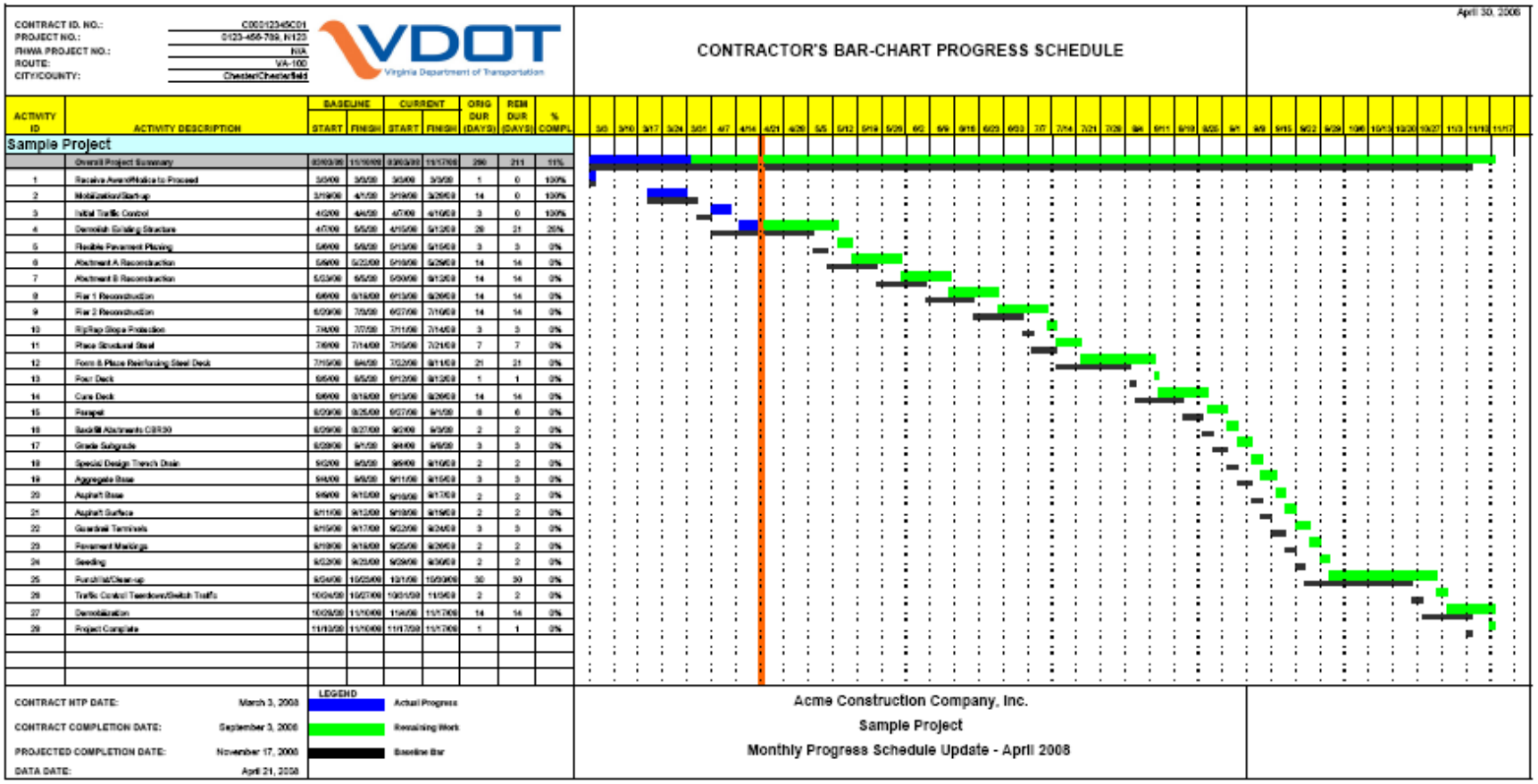
ACTIVITY ID	ACTIVITY DESCRIPTION	BASELINE							CURRENT UPDATE						
		START DATE	FINISH DATE	ORIG DUR	REM DUR	% COMPL	CRITICAL DATES START	CRITICAL DATES FINISH	PLANNED START	PLANNED FINISH	ACTUAL START	ACTUAL FINISH	ORIG DUR	REM DUR	% COMPL
	Overall Project Summary	3/3/08	11/10/08	253	253	0%	3/3/08	11/10/08	3/3/08	11/17/08	3/3/08		260	211	11%
1	Receive Award/Notice to Proceed	3/3/08	3/3/08	1	1	0%	3/3/08	3/3/08	3/3/08	3/5/08	3/3/08	3/3/08	1	0	100%
2	Mobilization/Start-up	3/19/08	4/1/08	14	14	0%	3/19/08	4/1/08	3/19/08	3/28/08	3/19/08	3/28/08	14	0	100%
3	Initial Traffic Control	4/2/08	4/4/08	3	3	0%	4/2/08	4/4/08	4/7/08	4/10/08	4/7/08	4/10/08	3	0	100%
4	Demolish Existing Structure	4/7/08	5/5/08	28	28	0%	4/8/08	5/5/08	4/15/08	5/12/08	4/15/08		28	21	25%
5	Flexible Pavement Planing	5/6/08	5/8/08	3	3	0%	5/6/08	5/8/08	5/13/08	5/15/08			3	3	0%
6	Abutment A Reconstruction	5/9/08	5/22/08	14	14	0%	5/9/08	5/22/08	5/16/08	5/29/08			14	14	0%
7	Abutment B Reconstruction	5/23/08	6/5/08	14	14	0%	5/23/08	6/5/08	5/30/08	6/12/08			14	14	0%
8	Pier 1 Reconstruction	6/6/08	6/19/08	14	14	0%	6/6/08	6/19/08	6/13/08	6/26/08			14	14	0%
9	Pier 2 Reconstruction	6/20/08	7/3/08	14	14	0%	6/20/08	7/3/08	6/27/08	7/10/08			14	14	0%
10	Rip/Rap Slope Protection	7/4/08	7/7/08	3	3	0%	7/5/08	7/7/08	7/11/08	7/14/08			3	3	0%
11	Place Structural Steel	7/8/08	7/14/08	7	7	0%	7/8/08	7/14/08	7/15/08	7/21/08			7	7	0%
12	Form & Place Reinforcing Steel Deck	7/15/08	8/4/08	21	21	0%	7/15/08	8/4/08	7/22/08	8/11/08			21	21	0%
13	Pour Deck	8/5/08	8/5/08	1	1	0%	8/5/08	8/5/08	8/12/08	8/12/08			1	1	0%
14	Cure Deck	8/6/08	8/19/08	14	14	0%	8/6/08	8/19/08	8/13/08	8/26/08			14	14	0%
15	Parapet	8/20/08	8/25/08	6	6	0%	8/20/08	8/25/08	8/27/08	9/1/08			6	6	0%
16	Backfill Abutments CBR30	8/26/08	8/27/08	2	2	0%	8/26/08	8/27/08	9/2/08	9/5/08			2	2	0%
17	Grade Subgrade	8/28/08	9/1/08	3	3	0%	8/30/08	9/1/08	9/4/08	9/5/08			3	3	0%
18	Special Design Trench Drain	9/2/08	9/3/08	2	2	0%	9/2/08	9/3/08	9/8/08	9/10/08			2	2	0%
19	Aggregate Base	9/4/08	9/8/08	3	3	0%	9/6/08	9/8/08	9/11/08	9/15/08			3	3	0%
20	Asphalt Base	9/9/08	9/10/08	2	2	0%	9/9/08	9/10/08	9/16/08	9/17/08			2	2	0%
21	Asphalt Surface	9/11/08	9/12/08	2	2	0%	9/11/08	9/12/08	9/18/08	9/19/08			2	2	0%
22	Guardrail Terminals	9/15/08	9/17/08	3	3	0%	9/15/08	9/17/08	9/22/08	9/24/08			3	3	0%
23	Pavement Markings	9/18/08	9/19/08	2	2	0%	9/18/08	9/19/08	9/25/08	9/26/08			2	2	0%
24	Seeding	9/22/08	9/23/08	2	2	0%	9/22/08	9/23/08	9/29/08	9/30/08			2	2	0%
25	Punchlist/Clean-up	9/24/08	10/23/08	30	30	0%	9/24/08	10/23/08	10/1/08	10/30/08			30	30	0%
26	Traffic Control Teardown/Switch Traffic	10/24/08	10/27/08	2	2	0%	10/26/08	10/27/08	10/31/08	11/3/08			2	2	0%
27	Demobilization	10/28/08	11/10/08	14	14	0%	10/28/08	11/10/08	11/4/08	11/17/08			14	14	0%
28	Project Complete	11/10/08	11/10/08	1	1	0%	11/10/08	11/10/08	11/17/08	11/17/08			1	1	0%

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

ACCEPTED BY: Joe D. Engineer, P.E.
TITLE: Area Construction Engineer
DATE: May 4, 2007

CONTRACTOR: Acme Construction Company, Inc.
BY: John Doe
SUBMITTAL DATE: April 30, 2008

APPENDIX D: EXAMPLE OF A CATEGORY II BAR-CHART PROGRESS SCHEDULE



CONTRACT ID. NO.: C00012345C01
PROJECT NO.: 0123-456-789, N123
FHWA PROJECT NO.: N/A
ROUTE: VA-100
CITY/COUNTY: Chester/Chesterfield

VDOT Virginia Department of Transportation

CONTRACTOR'S BAR-CHART PROGRESS SCHEDULE

April 30, 2008

ACTIVITY ID	ACTIVITY DESCRIPTION	BASELINE START	BASELINE FINISH	CURRENT START	CURRENT FINISH	ORIG DUR (DAYS)	REM DUR (DAYS)	% COMPL
Sample Project								
	Overall Project Summary	03/03/08	11/10/08	03/03/08	11/17/08	256	211	11%
1	Receive Award/Notice to Proceed	3/3/08	3/3/08	3/3/08	3/3/08	1	0	100%
2	Mobilization/Start-up	3/10/08	4/1/08	3/10/08	3/28/08	14	0	100%
3	Initial Traffic Control	4/2/08	4/4/08	4/7/08	4/10/08	3	0	100%
4	Demolish Existing Structure	4/7/08	5/5/08	4/15/08	5/12/08	26	21	25%
5	Flexible Pavement Paving	5/6/08	5/8/08	5/13/08	5/15/08	3	3	0%
6	Abutment A Reconstruction	5/6/08	5/22/08	5/16/08	5/29/08	14	14	0%
7	Abutment B Reconstruction	5/23/08	6/5/08	5/30/08	6/12/08	14	14	0%
8	Pier 1 Reconstruction	6/6/08	6/19/08	6/13/08	6/26/08	14	14	0%
9	Pier 2 Reconstruction	6/20/08	7/3/08	6/27/08	7/10/08	14	14	0%
10	Rip-Rap Slope Protection	7/4/08	7/7/08	7/11/08	7/14/08	3	3	0%
11	Place Structural Steel	7/8/08	7/14/08	7/15/08	7/21/08	7	7	0%
12	Form & Place Reinforcing Steel Deck	7/15/08	8/4/08	7/22/08	8/11/08	21	21	0%
13	Pour Deck	8/5/08	8/5/08	8/12/08	8/12/08	1	1	0%
14	Cure Deck	8/6/08	8/19/08	8/13/08	8/26/08	14	14	0%
15	Parapet	8/20/08	8/25/08	8/27/08	9/1/08	6	6	0%
16	Backfill Abutments CBR30	8/20/08	8/27/08	9/2/08	9/3/08	2	2	0%
17	Grade Subgrade	8/28/08	9/1/08	9/4/08	9/8/08	3	3	0%
18	Special Design Trench Drain	9/2/08	9/3/08	9/9/08	9/10/08	2	2	0%
19	Aggregate Base	9/4/08	9/8/08	9/11/08	9/15/08	3	3	0%
20	Asphalt Base	9/9/08	9/10/08	9/16/08	9/17/08	2	2	0%
21	Asphalt Surface	9/11/08	9/12/08	9/18/08	9/19/08	2	2	0%
22	Guardrail Terminals	9/15/08	9/17/08	9/22/08	9/24/08	3	3	0%
23	Pavement Markings	9/18/08	9/19/08	9/25/08	9/26/08	2	2	0%
24	Seeding	9/22/08	9/23/08	9/29/08	9/30/08	2	2	0%
25	Punchlist/Clean-up	9/24/08	10/23/08	10/1/08	10/30/08	30	30	0%
26	Traffic Control Teardown/Switch Traffic	10/24/08	10/27/08	10/31/08	11/3/08	2	2	0%
27	Demobilization	10/28/08	11/10/08	11/4/08	11/17/08	14	14	0%
28	Project Complete	11/10/08	11/10/08	11/17/08	11/17/08	1	1	0%

CONTRACT NTP DATE: March 3, 2008
CONTRACT COMPLETION DATE: September 3, 2008
PROJECTED COMPLETION DATE: November 17, 2008
DATA DATE: April 21, 2008

LEGEND
Actual Progress
Remaining Work
Baseline Bar

Acme Construction Company, Inc.
Sample Project
Monthly Progress Schedule Update - April 2008

APPENDIX E: EXAMPLE OF A CATEGORY I, II, & III PROGRESS EARNINGS SCHEDULE (FORM C-13C)

Form C-13C (Baseline)

CONTRACTOR'S PROGRESS EARNINGS SCHEDULE (BASELINE)

CONTRACT ID. NO.:	C00012345C01	CONTRACT NTP DATE:	March 20, 2007
PROJECT NO.:	0123-456-789, N123	CONTRACT FIXED COMPLETION DATE:	June 30, 2008
FHWA PROJECT NO.:	N/A	PROJECTED COMPLETION DATE:	June 30, 2008
PROJECT NAME:	Grade, Drain, & Asphalt Pave	ORIGINAL TOTAL CONTRACT VALUE:	$1,052,400.00
ROUTE:	VA-100	ADJUSTED TOTAL CONTRACT VALUE:	$1,052,400.00
CITY/COUNTY:	Chester, Chesterfield	FIRST PROGRESS ESTIMATE DATE:	April 4, 2007

MONTHLY PROGRESS ESTIMATE DATES	MAJOR CATEGORY OF WORK													MONTHLY TOTAL	CUMULATIVE TOTAL	CUMULATIVE PERCENT COMPLETE
	CLEARING & GRUBBING	EROSION & SILTATION CONTROL	GRADING & DRAINAGE	SELECT MATERIAL & SUBBASE	CULVERTS & BRIDGES	RETAINING WALL STRUCTURES	BASE	SURFACE	GUARDRAIL	SIGNS & SIGN STRUCTURES	SIGNAL & LIGHTING	SEEDING & LANDSCAPING	MISC.			
03/20/07	Contract Notice to Proceed Date													$ -	$ -	0.0%
04/04/07	$ 5,000	$ 5,000											$ 25,500	$ 35,500	$ 35,500	3.4%
05/04/07	$ 9,500	$ 5,000	$ 18,570									$ 1,000	$ 5,750	$ 37,820	$ 73,320	7.0%
06/04/07			$ 27,125									$ 1,500	$ 7,250	$ 35,875	$ 109,195	10.4%
07/04/07			$ 75,000	$ 15,000									$ 10,250	$ 100,250	$ 209,445	19.9%
08/04/07			$ 95,180	$ 15,010								$ 1,967	$ 5,250	$ 117,407	$ 326,852	31.1%
09/04/07			$ 55,123	$ 18,542			$ 25,000						$ 12,000	$ 110,665	$ 437,517	41.6%
10/04/07			$ 12,000	$ 26,000			$ 32,000		$ 12,000			$ 6,500	$ 10,000	$ 98,500	$ 536,017	50.9%
11/04/07							$ 35,000		$ 15,000				$ 5,200	$ 55,200	$ 591,217	56.2%
12/04/07							$ 28,680		$ 25,000				$ 7,500	$ 59,180	$ 650,397	61.8%
01/04/08													$ 12,000	$ 12,000	$ 662,397	62.9%
02/04/08										$ 15,000			$ 15,200	$ 30,200	$ 692,597	65.8%
03/04/08										$ 5,000			$ 5,200	$ 10,200	$ 702,797	66.8%
04/04/08								$ 25,000		$ 25,000			$ 5,200	$ 55,200	$ 757,997	72.0%
05/04/08								$ 45,000		$ 20,000		$ 15,000	$ 5,200	$ 85,200	$ 843,197	80.1%
06/04/08								$ 85,000	$ 12,003	$ 12,000		$ 25,000	$ 5,200	$ 139,203	$ 982,400	93.3%
06/30/08								$ 20,000		$ 10,000		$ 25,000	$ 15,000	$ 70,000	$ 1,052,400	100.0%
TOTALS	$ 14,500	$ 10,000	$ 280,998	$ 74,552			$ 118,680	$ 175,000	$ 64,003	$ 87,000		$ 75,967	$ 151,700	$ 1,052,400		

Note:
Form C-13C (Baseline) shall be used by the Contractor to submit his baseline (or revised baseline) progress earnings schedule as specified in the Category I and II Progress Schedule Special Provisions.

COMMONWEALTH OF VIRGINIA
DEPARTMENT OF TRANSPORTATION

ACCEPTED BY: Joe Engineer, P.E.
TITLE: Area Construction Engineer
DATE: April 4, 2007

CONTRACTOR: Acme Construction Company, Inc.
BY: John Doe
SUBMITTAL DATE: March 31, 2007

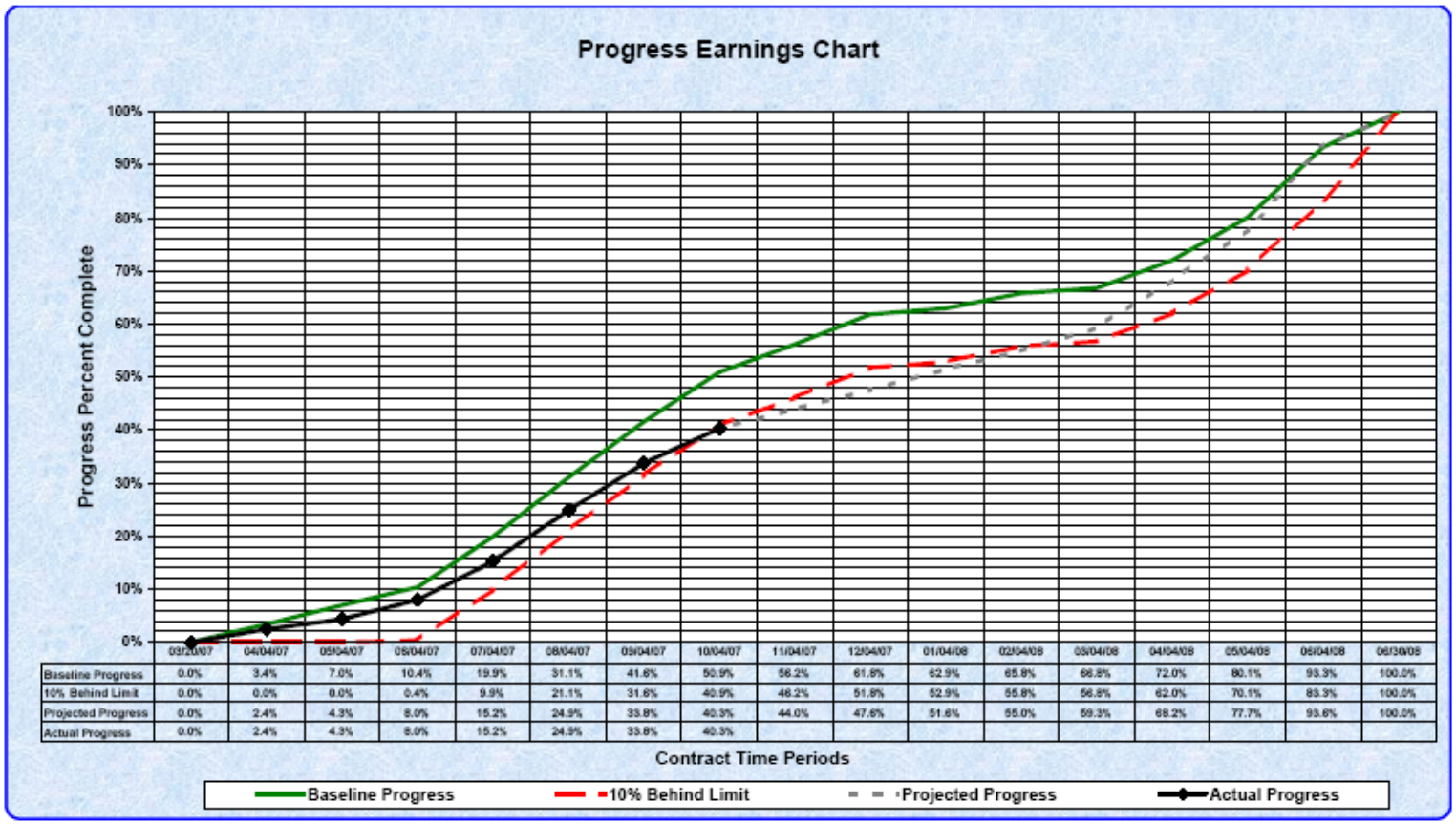
APPENDIX F: EXAMPLE PROGRESS EARNINGS SCHEDULE (FORM C-13C S-CURVE) FOR CATEGORY I & II

Acme Construction Company, Inc.

CONTRACTOR'S PROGRESS EARNINGS CURVE

CONTRACT ID. NO.:	C00012345C01
PROJECT NO.:	0123-456-789, N123
FHWA PROJECT NO.:	N/A
PROJECT NAME:	Grade, Drain, & Asphalt Pave
ROUTE:	VA-100
CITY/COUNTY:	Chester, Chesterfield

CONTRACT NTP DATE:	March 20, 2007
CONTRACT FIXED COMPLETION DATE:	June 30, 2008
PROJECTED COMPLETION DATE:	June 30, 2008
ORIGINAL TOTAL CONTRACT VALUE:	$1,052,400.00
ADJUSTED TOTAL CONTRACT VALUE:	$1,052,400.00
CURRENT PROGRESS ESTIMATE DATE	October 4, 2007



	03/20/07	04/04/07	05/04/07	06/04/07	07/04/07	08/04/07	09/04/07	10/04/07	11/04/07	12/04/07	01/04/08	02/04/08	03/04/08	04/04/08	05/04/08	06/04/08	06/30/08
Baseline Progress	0.0%	3.4%	7.0%	10.4%	19.9%	31.1%	41.6%	50.9%	56.2%	61.8%	62.9%	65.8%	66.8%	72.0%	80.1%	93.3%	100.0%
10% Behind Limit	0.0%	0.0%	0.0%	0.4%	9.9%	21.1%	31.6%	40.9%	46.2%	51.8%	52.9%	55.8%	56.8%	62.0%	70.1%	83.3%	100.0%
Projected Progress	0.0%	2.4%	4.3%	8.0%	15.2%	24.9%	33.8%	40.3%	44.0%	47.6%	51.6%	55.0%	59.3%	68.2%	77.7%	93.6%	100.0%
Actual Progress	0.0%	2.4%	4.3%	8.0%	15.2%	24.9%	33.8%	40.3%									

APPENDIX G: REFERENCES/RESOURCES/TRAINING

1. VDOT Form C-13C (Contractor's Progress Earnings Schedule) (*website link*)
2. VDOT Microsoft Excel Bar-chart Template (Version 1.0) (*website link*)
3. Category I Progress Schedule Review Checklist (*website link*)
4. Category II Progress Schedule Review Checklist (*website link*)
5. Construction Planning and Scheduling (The Associated General Contractors of America)
6. The ABC's of CPM (Workshop Manual of the U.S. Department of Transportation, Federal Highway Administration and the Department of Transportation of the Commonwealth of Virginia)
7. Use of CPM for Estimating, Scheduling, and Timely Completion Training Manual (Publication No. FHWA NHI-03-019, November 2002)
8. Schedule Impact Analysis Using CPM Schedules (Brian A. Henschel, P.E., PMP)
9. Managing Highway Contract Claims: Analysis and Avoidance Training Manual (Publication No. FHWA NHI-04-187, September 2005)
10. FHWA National Highway Institute, Course No. 134049 - "Critical Path Method for Estimating, Scheduling, and Timely Completion"
11. VDOT MBTP On-line Construction Scheduling Training Course – VDOT's Experience Based Knowledge (EBK) (VDOT University - Trainer: Pruitt, Charles M., NOVA District)
12. VDOT MBTP Construction Scheduling Training Course – Developing a Construction Plan (VDOT University - Trainer: Wayne Nolde, PE, Staunton District)
13. VDOT MBTP Construction Scheduling Training Course – Using Sequence Templates for Schedule Development (VDOT University - Trainer: Dianna C. Sheesley, P.E., Culpeper District)
14. VDOT MBTP Construction Scheduling Training Course – Establishing Contract Time Simple Projects (VDOT University - Trainer: Bobby R. Phlegar, P.E., Salem District)
15. VDOT MBTP Construction Scheduling Training Course – Developing Pre-advertisement CPM Schedules (VDOT University - Trainer: Sam Giallombardo, Richmond District)
16. VDOT MBTP Construction Scheduling Training Course – Establishing Schedule Control on Category I & II Projects (VDOT University - Trainer: Zachary P. Weddle, P.E., Lynchburg District)
17. VDOT MBTP Construction Scheduling Training Course – Reviewing Baseline CPM Schedule Submittals (VDOT University - Trainer: Robert Griffith, P.E., Bristol District)
18. VDOT MBTP Construction Scheduling Training Course – Maintaining the Schedule During Construction (VDOT University - Trainer: Waheed Uz Zaman, Fredericksburg District)
19. VDOT MBTP Construction Scheduling Training Course – Reviewing CPM Schedule Updates and Assessing Progress (VDOT University - Trainer: Shimelis A. Meskellie, NOVA District)
20. VDOT MBTP Construction Scheduling Training Course – Schedule Impact Analysis (VDOT University - Trainer: Brian Henschel, P.E., Lynchburg District)