Development of a Tool for Estimating Bridge Construction Contract Time

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WSB and Associates

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Research Project
Final Report 2020-01

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16. Abstract (Limit: 250 words)

The purpose of this project was to develop a tool, available at mndot.gov/research/reports/2020/20201S.xlsm, that estimates bridge construction contract time based on various controlling activities of bridge construction. As part of this project, various transportation departments throughout the United States were interviewed on how contract time is established in their states. Many states had some sort of estimating tool that aided in establishing contract time, while others followed the process and protocols established by the Federal Highway Administration (FHWA).

Chapter 5 of this report contains a user manual for the spreadsheet tool. The MnDOT Bridge Office also developed four instructional videos.

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DEVELOPMENT OF A TOOL FOR ESTIMATING BRIDGE CONSTRUCTION CONTRACT TIME

FINAL REPORT

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We thank Paul Johns, MnDOT project manager, and Paul Pilarski, MnDOT Bridge Office technical advisor, for their overall support throughout the development of the bridge contract time estimating tool. The comments throughout the development process greatly improved the overall functionality of the bridge tool.

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EXECUTIVE SUMMARY

This research paper was commissioned to review bridge contract time determination methods used by various transportation departments throughout the United States. The first portion of the research was to draw attention to the pros and cons of the estimating tools used by various transportation agencies. The second portion of the research was to develop a bridge contract time estimating tool specifically for MnDOT using the data generated during the first portion of the research. Our team of researchers reviewed 60 bridges that were constructed within the last 10 years to populate the database used to estimate bridge contract time. The bridges, found throughout Minnesota, varied in location, size and complexity. The research found that to obtain a 95% confidence interval with the output, there needs to be a sample size of 27 similar bridges. Thus, it is recommended that the database be populated with more bridge construction durations to obtain a 95% confidence interval and refine the schedule output generated by the bridge estimating tool.

CHAPTER 1: INTRODUCTION

The Minnesota Department of Transportation (MnDOT) has been actively working in recent years to develop a comprehensive bridge estimating tool for the purpose of accurately estimating contract time for bridge construction. The purpose of this research is to help MnDOT's Bridge Office develop a guidance document and tool for bridge construction time estimation that can be used by district project managers and construction staff. The tool provides production rates based on specific input criteria. The input criteria may be based on preliminary information, with more time risk inclusion, or more detailed information and reduced levels of risk compensation.

As part of this project, we conducted a review of the current state of practice in other states regarding bridge construction contract time determination and identified best practices, and then utilized the information to establish the standard in Minnesota.

States identified for research were Wisconsin, Ohio, Kentucky, Maine, and Tennessee. These states were selected because of their existing bridge contract time determination tools. States surrounding Minnesota were contacted with only one state, Wisconsin, currently using a bridge contract time estimation tool. Iowa, North Dakota, and South Dakota used standards for determining contract time following the Federal Highway Administration (FHWA) standards. This research included a detailed review of available materials listed on each state's website as well as information gathered from a detailed questionnaire.

1.1 ORGANIZATION OF REPORT

This report is organized into the following sections:

- A summary of the research of existing practices of various DOTs and agencies
- A summary and user guide of the developed contract time determination tool
- An overall project and report summary
- Appendices showing bridge case studies
- An Appendix showing activity filers used by the estimating tool

CHAPTER 2: EXISTING LITERATURE REVIEW

2.1 FEDERAL HIGHWAY ADMINISTRATION (FHWA)

Contact(s): *Online*
Website: https://www.fhwa.dot.gov
Research Document(s): FHWA Guide for Construction Contract Time Determination Procedures, 10/15/02, TA 5080.15, Replaces TA 5080.15, dated 10/11/91

Key Functions/Process:
Establish production rates

1. Adapt production rates to a unique project
2. Understand potential environmental constraints
3. Compute contract time with progress schedule
4. Contract Time Determination Techniques:
    - Bar charts
    - Estimated cost method
    - Critical path method

Advantages:

1. It is an accurate technique for determining contract time and verifying that the project can be constructed as designed and with identified construction sequences.
2. It is a useful tool for project managers in monitoring a project, especially when dealing with relationships of work items with respect to time.
3. Activities responsible for delays can be identified and corrective measures to keep a project on schedule can be determined.

Disadvantages:

1. The CPM requires experienced and knowledgeable staff to be used effectively.
2. They require regular updates to assure that the contractor's operation is accurately represented.

2.2 TEXAS DEPARTMENT OF TRANSPORTATION (TXDOT)

Contact(s): James T. O’Connor (TX)
Website: http://www.txdot.gov
Research Document(s): (TX) Development of Improved Information for Estimating Construction Time, October 2004

Key Functions:

1. Production rate estimator.

Advantages:

1. Provides range of production rates calculated based on specific data.

Disadvantages:

1. There is no schedule tool.
2. Many items do not have a large enough data set to provide an accurate estimate.

2.3 WISCONSIN DEPARTMENT OF TRANSPORTATION (WISDOT)

Contact(s):	Provided by MnDOT
Website:	http://wisconsindot.gov
Research Document(s):	WI Productivity Estimation Tool (v2.8) – Excel

Key Functions:

1. If data set is large enough, box plot is produced.
2. If data set is insufficient for confidence of output, a table is produced with the activity's minimum, average and maximum value observed.

Advantages:

1. Productivity rates are individually defined for major/driving activities.
2. Output is easy to understand.
3. Confidence interval is illustrated by complexity of output (box plot or table). The user understands which components had a good data set and which did not.

Disadvantages:

1. Box plot does not appear to eliminate outliers, which we give predicted value less confidence.
2. Output gives productivity rates by major/driving activities, but it is not clear which activities can be performed concurrently and it does not give an overall estimated project duration or activity durations. Manual analysis/calculations of final output to determine this is needed.
3. Some query questions and selection options are vague and not well defined. User interpretation/perspective of selection options could vary drastically.

2.4 WASHINGTON STATE DEPARTMENT OF TRANSPORTATION (WSDOT)

Contact:	Document(s) obtained from website
Website:	http://www.wsdot.wa.gov
Research Document(s):	WSDOT Plans Preparation Manual, M 22-31.05, November 2013, Appendix 6; WSDOT Bridge Design Manual LRFD, M 23-50.17, June 2017, Engineering and Regional Operations Bridge and Structures Office; WSDOT Bridge & Structures Office Accelerated Bridge Construction, September 2015

Key Functions:

1. CPM schedules are used to identify critical activities and eliminate minor items that can be performed concurrently, as well as to determine time determination of activities.
2. Production rates account for regional differences since the attributes of the state's eastern and western region vary significantly.

2.5 KENTUCKY TRANSPORTATION CABINET (KYTC)

Contact(s):	Mark Hite Director, Division of Structural Design 502-654-4560 Mark.hite@mail.state.ky.us
Website:	https://transportation.ky.gov

Research Document(s): Implementation of KYTC Contract Time Determination System, A supplement to KYSPR 11-411 guide;

KY Calculating Duration Tool

Literature Regarding Estimating Tool:
https://transportation.ky.gov/HighwayDesign/Documents/Implementation%20of%20KYTC%20Contract%20Time%20Determination%20System%2007212015.pdf

Key Functions:

1. For both Bridge Replacement and Bridge Rehabilitation work types weather is factored into the estimated working day duration.
2. Cost indices are also available in the estimating tool but were not developed enough in the version that was available at the time of research.

Advantages:

1. User has the ability to select the project type; clearly defined so user knows definition of each option.
2. Output gives low, upper and median durations along with Estimated Completion Dates based on user input letting date.
3. Breaks down how many total calendar days and working days.
4. Factors weather into durations. Need to verify if MnDOT wants to utilize this function in their tool.

Disadvantages:

1. Bridge Rehabilitation work type estimates a working day duration solely on construction estimate Lowest $ value - $73,000 (LD = 8 days, HD = 54 days, mean =31 days) Highest $ Value - $24M (LD=1079 days, HD = 1423 days, Mean = 1251 days).
2. Minimal detail can be used in scoping phase.
3. Bridge Replacement work type estimates by three query questions
    a. Class AA Concrete (CY) (Bridge Deck Overlay Concrete)
    b. Granular Emb. (CY)
    c. Construction Estimate.

2.6 OHIO DEPARTMENT OF TRANSPORTATION (ODOT)

Contact(s): Document(s) obtained from website
Website: http://www.dot.state.oh.us
Research Document(s): Contract Time Determination Tool

Key Functions:

1. Adjustment factors for location, traffic, complexity, soil conditions and quantity are factored into the final working day calculation.

Advantages:

1. Adjustment factors are included to account for variability of environmental and geographical differences.
2. Production rates are clearly stated at each task description level which is a useful evaluation feature.

Disadvantages:

1. The bar chart is structured where the user who inputs the data is required to add logic between the activities. Users must have construction knowledge of sequencing.
2. This tool would be difficult to use at a scoping level for bridges.
3. This tool requires that the user has "hands on" knowledge and experience and is to be used as a supplement to that acquired experience. If the user does not have the level of experience required to use this tool, it is stated that the user is to be in consultation with an industry professional with the correct level of experience. There is ambiguity as to what measure of experience is required.
4. Adjustment factors are calculated based on user opinion of terms such as: large, medium, small, good, fair, poor, low, medium, high, light, moderate, heavy, etc. These terms are not clearly defined and, as such, can be interpreted quite differently from user to user. This would cause inconsistencies on the output of the model.

2.7 MAINE DEPARTMENT OF TRANSPORTATION (MAINE DOT)

Contact(s):	Joshua Hasbrouck Bridge Design Engineer 207-624-3406 Joshua.P.Hasbrouck@maine.gov
Website:	http://www.maine.gov/mdot
Research Document(s):	Bridge Unit Costs database

Key Functions:

1. The Maine Department of Transportation has a bridge cost database that is maintained in Microsoft Access. This database is not used for determining contract time, however, it keeps historical pricing to better refine future engineer's estimates. This tool tracks historical common bid item costs for projects that have been let throughout the state of Maine.

Advantages:

1. This database has two sections: bridge rehabilitation and bridge reconstruction.

Disadvantages:

1. The database does not have a way to sort bridges based on span length and arrangement, would take a database rebuild to accomplish this.\

2.8 TENNESSEE DEPARTMENT OF TRANSPORTATION (TDOT)

Contact(s):	Houston Walker, PE Civil Engineering Manager 2, Structures, Division 615-741-5335 Houston.Walker@tn.gov
Website:	http://www.tn.gov/tdot
Research Document(s):	TN Bridge Access 2016 tool

Key Functions:

1. This tool is a database used to store historical bridge construction data, durations, activities and costs.

Advantages:
1. Cost data can be added to the database through a standard form in Microsoft Access.
2. Can easily search data by multiple query criteria. i.e. let date, bridge type, length.

Disadvantages:
1. This is a great historical cost database and can be used when estimating construction costs for future bridge project, however, does not capture contract time and durations to construct bridges.

2.9 FLORIDA DEPARTMENT OF TRANSPORTATION (FDOT)

Contact(s): Tara Rodriguez, PE
Construction Structures Engineer
850-414-5268
Tara.rodriguez@dot.state.fl.us
Website: http://fdot.gov
Research Document(s): Florida Department of Transportation Guideline for Establishing Construction Contract Duration, July 2010

Key Functions:
1. This document is an overall compilation of main elements in determining construction time, not specific to any type of structure. It gives a general sequence on how to determine contract time, outlining the following: establishing production rates, additional consideration ideas that may affect contract time, adapting production rates to a project, and developing a schedule. The document then discusses the advantages and disadvantages of using of bar charts and CPM schedules as techniques for visualizations and management.

Advantages:
1. The document has a hyperlink at the end that takes the reader to an excel-based database of production rates for roadway, bridge, procurement, utilities, earthwork, base and asphalt activities.

Disadvantages:
1. This document speaks to contract time determination in a very general way, it does not go into a lot of detail for differences between types of projects.
2. The database is useful for determining production rates, but does not instruct, or inform on activities that are dependent on each other, sequencing, etc.

2.10 IDAHO TRANSPORTATION DEPARTMENT (ITD)

Contact(s):
Website: http://itd.idaho.gov
Research Document(s): Contract Time Determination in Project Development, July 2011

Key Functions:

1. This document is a step-by-step written guide to estimating contract time by using production rates for identified activities and establishing critical path. Production rates are given for some activities. Those activities that are not included need to be estimated by user utilizing either their own professional expertise or by consulting the Resident Engineer or other appropriate resources. Worksheets are given to guide the user through this process. The first worksheet prompts the user to manually enter project working day calculations by activity. The second worksheet prompts the user to identify factors that would cause time delay and adjust for those factors. This is not a tool that estimates the delay for the user, the user is responsible for calculating the likely delay.

Disadvantages:

1. This document outlines a process that would be used at final phase of the design process. There is no flexibility for different phases and likely outputs given a minimal stage of information, and then graduating to a more thorough stage of information.
2. The process is manual and requires an advanced level of expertise and experience.

2.11 MASSACHUSETTS DEPARTMENT OF TRANSPORTATION (MASSDOT)

Contact(s):
Website: http://www.massdot.state.ma.us
Research Document(s): MassDOT Construction Contract Time Determination (CTD) Guidelines for Designers/Planners, January 2014

Key Functions:

1. This document is a procedural and standards guide that details the steps to complete contract time determination using Primavera P6. It provides parameters for settings, and work calendars, and milestones to use as a standard.

Advantages:

1. N/A: no internal tool to analyze.

Disadvantages:

1. N/A: no internal tool to analyze.

2.12 MISSOURI DEPARTMENT OF TRANSPORTATION (MODOT)

Contact(s):
Website: http://www.modot.org
Research Document(s): MoDOT Contract Time Determination, March 2004
Key Functions:

1. This document is a procedural and standards guide that details steps to accurately establish contract time using Primavera P6. This document provides guidelines for production rates, seasonal construction limits. This document details working days per month and production rates by MoDOT district.

2.13 VIRGINIA DEPARTMENT OF TRANSPORTATION (VDOT)

Contact(s): Document(s) obtained from website

Website: http://www.virginiadot.org
Research Document(s): Virginia Department of Transportation Contract Time Determination Guidelines, October 2007

Key Functions:

1. This document is a guide on how to produce a Bridge Construction Contract Time Determination Report (CTDR), a report that is required for all contracts submitted to the Scheduling and Contracts Division for advertisement. The report describes the methodology, assumptions and schedule calculations on which the contract requirements will be based. Regarding the contract time determination part of the report, three approaches are discussed. For projects of low complexity, minimal to no disruption to the public, and of linear nature, a cost estimation approach is outlined. For medium-complexity projects, a bar chart approach to schedule is outlined. For high-complexity projects, a CPM schedule approach using Primavera P6 is outlined. Guidelines for determining how a project fits into one of these three categories are outlined. The cost estimation approach is a basic calculation which starts with a similar historic project. It takes the historic total contract value, implements an inflation adjustment, then breaks the total contract value into a daily dollar value. The new contract cost estimate is then divided by the inflated daily dollar value to produce a contract time determination in number of days. For the bar chart approach, VDOT has an excel-based worksheet where the user populates the activities, units, quantities from the proposal, and production rates from a VDOT production rate reference sheet. Logic is included in the worksheet, where preceding activities can be marked on an activity's line. A bar chart is produced from the data. For the complex project approach, guidelines for creating a CPM schedule using Primavera P6 is outlined.

Advantages/Disadvantages:

1. N/A: no internal tool to analyze.

CHAPTER 3: ADDITIONAL AGENCIES CONTACTED

Arizona Department of Transportation
Dave Eberhardt – Arizona State Bridge Engineer
DEberhart@azdot.gov

No response received.

Kansas Department of Transportation
Ron Shurtz – Special Assignments Engineer
Ron.Shurtz@ks.gov

Response: Only tracks bid prices by quarter and working days for each project. No contract time estimating tool has been developed.

Michigan Department of Transportation
Linda Reed – Bridge Scoping Engineer
Reedl@michigan.gov

No response received.

South Dakota Department of Transportation
Steve Johnson – State Bridge Engineer
Steve.Johnson@state.sd.us

Response: Currently there is no estimating tool to establish contract time.

Louisiana Department of Transportation
Charles Nickel – Cost Estimate & Value Engineering Director
Charles.Nickel@la.gov

Response: Currently there is no estimating tool to establish contract time.

Illinois Department of Transportation
Jayme F. Schiff – Engineer of Design
Jayme.Schiff@illinois.gov

Response: Declined to share software developed internally with private entities since it may be a conflict of interest.

CHAPTER 4: CONCLUSIONS AND SUMMARY OF EXISTING CASE STUDY BRIDGE CONSTRUCTION DATA

Interviews were conducted with MnDOT project managers who worked on previous bridge projects. Construction documents, records and diaries were evaluated in these case studies. For most of the bridge projects that were evaluated, electronic access was provided to the MnDOT TRACS database. Bridge plans and electronic diaries were reviewed for each bridge structure type and this information was gathered to identify trends and patterns from which to draw to develop the construction time estimation tool with reasonable accuracy.

Specific data related to bridge construction was reviewed and collected for all case study projects provided by MnDOT. This data was reviewed, analyzed and incorporated into the bridge data collection sheets that were then used to develop the bridge tool data base and filter criteria for estimating bridge construction durations. Bridge construction key dates and timeframes were extrapolated from the data and contractor provided construction schedules were included in the database.

CHAPTER 5: CONTRACT TIME DETERMINATIONAL TOOL USER GUIDE

5.1 BRIDGE TOOL LIST OF SHEETS AND PURPOSE

CTD Input – (Contract Time Determination Input) A sheet that contains all the data points used by the tool and for tracking purposes. Included in these points are the general project data (bridge number, SP number, Letting Date, etc.), Abutment and Pier Data, Substructure and Superstructure data, project specific construction comments, and additional project information for post-construction data collection. By filling this sheet out, you can add new records to the Database (DB) for the tool to use or provide the tool the appropriate bridge information that it needs to run properly. To run the tool, you can click the "Submit Inputs" button near the top of the screen.

Schedule – The Schedule sheet gives you information regarding the various activities related to the bridge configuration being estimated. The data included for each relevant activity are: The estimated start and end dates for the activity, the working day duration, any predecessor lag time (if applicable), and the estimated start/end dates and duration of the project.

Risk and Similar Case Study – This sheet provides a list of other factors (besides production rates) that the Federal Highway Administration advises us to consider when determining the contract time for a bridge. In addition, it provides a list of similar bridges to the one that was entered in the CTD Input page when the tool macro was executed by the user. This allows the user to see if the generated estimate in the schedule sheet is in similar in magnitude as previous projects that have already been completed.

Add New Record to DB – This sheet lists all the variables that are either considered by the tool or used for tracking purposes in the spreadsheet. All cells in row 3 are linked to the appropriate cells on the CTD input page (default values are used if the CTD Input cells are left blank) and can be directly copied and pasted into the DB sheet.

DB – This sheet is a compilation of all the records that have been added to the tool since its inception. It includes the same variables as the "Add New Record to DB" sheet.

DB Transfer – This sheet is a hidden sheet that takes all the variables from the DB sheet that are used by the tool and puts them into a format that will allow the tool to run properly through index and match formulas.

DB_PA – This sheet is hidden, and the purposes of this sheet is used for to filter information in the database to estimate contract time. It contains the same information as the DB Transfer sheet and is updated every time the tool is run. The values in this sheet are copy and pasted values from the DB Transfer sheet and do not contain formulas. This is done to filter out unnecessary data that are irrelevant to the type of bridge you are trying to estimate bridge construction time.

Settings – This sheet is hidden and is used to create the drop-down menus seen on the CTD input sheet as well as determine holidays and estimated non-working days for use in the schedule sheet.

AFSR – This sheet is hidden and is used to run the tool. Using macros, this sheet filters for the relevant variables listed in the CTD Input sheet, copies them into the appropriate activity sheet, then ranks them by production rate.

Activity Sheets – The activity sheets are hidden. Each activity corresponds to a different part of the process of building a bridge. Each activity sheet and what it tracks is listed below (T30xx and T40xx activities are for Abutment 1 & 2 respectively; T50xx, T60xx, T70xx, and T80xx are for Piers 1-4 respectively):

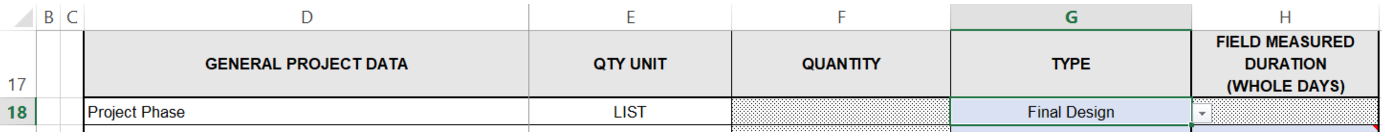
- T3030/4030 – Drive Pile Abutment
- T3040/4040 – Footing
- T3050/4050 – Construct Stem/Parapet/Backwall (F/P/C)
- T5030/6030/7030/8030 – Drive Pile
- T5040/6040/7040/8040 – Construct Footing (F/P/C)
- T5050/6050/7050/8050 – Construct Strut (F/P/C)
- T5060/6060/7060/8060 – Construct Columns (F/P/C)
- T5070/6070/7070/8070 – Construct Cap (F/P/C)
- T9020 – Bridge Deck: Form and Tie Steel
- T9040 – Construct Approach Panels
- T9060 – Concrete Wearing Course
- T9070 – Bridge Deck Planning
- T9080 – Open to Traffic

These sheets include copied data that has been was filtered and ranked by the AFSR sheet after executing the macro on the CTD sheet. The sheet also calculates the predicted duration of the activity is based on the quantities specified on the CTD Input sheet. When quantities are not entered into the CTD input sheet, default values are used. The predicted activity duration is determined and plots showing the data, trendline and whisker plot box charts are generated. The predicted activity durations are what drives the durations on the schedule sheet.

On the “Schedule” sheet in the Bridge Tool, the cells with red text are derived from information in the database. Default values can be manually changed by the user at any time. The default value is listed in cell G13 in each activity sheet. *Please note:* The default value only corresponds to the activity sheet for which it is entered. If a user wants to change the default value for multiple activities, that user must manually alter the default value on each activity sheet for which the default assumption is to be changed.

5.2 ENTERING AND SUBMITTING BRIDGE INPUTS

The Bridge Tool can be used at various levels of design to estimate contract time. On the CTD Input sheet in the tool, the user can select one of three project phases; Scoping, Preliminary Design and Final Design based on the amount of information available to the user.



	B	C	D	E	F	G	H
17			GENERAL PROJECT DATA	QTY UNIT	QUANTITY	TYPE	FIELD MEASURED DURATION (WHOLE DAYS)
18			Project Phase	LIST		Final Design	

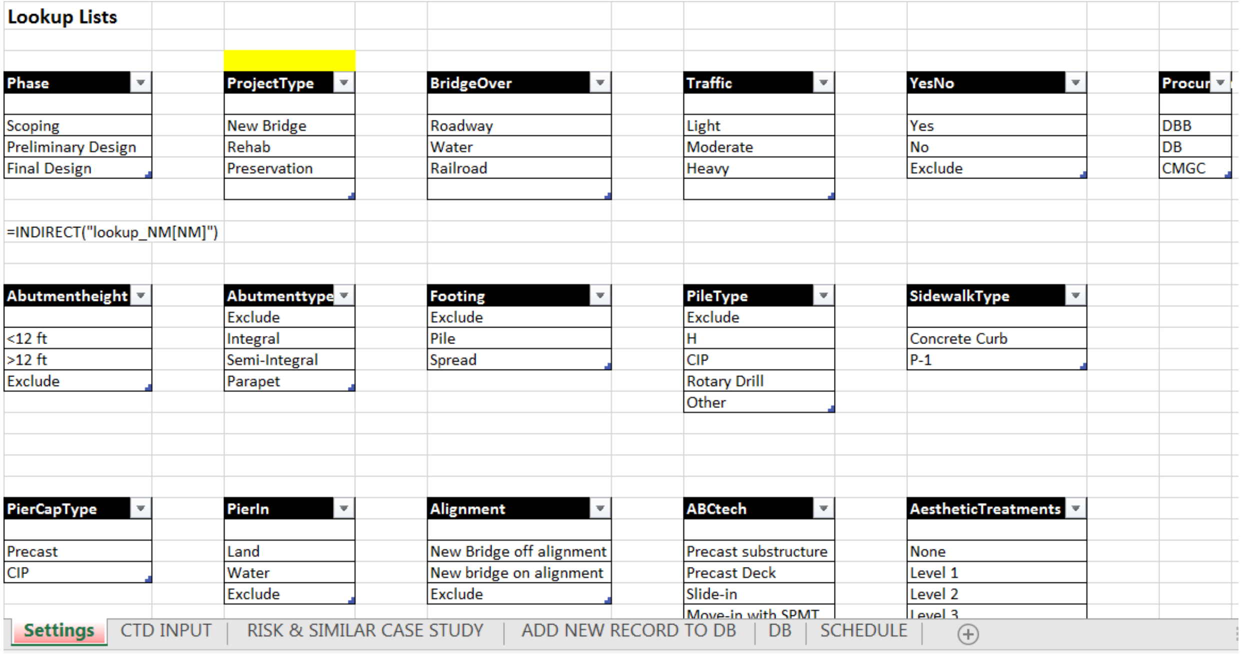
Figure 1: CTD Sheet Selection of Bridge Input Information Level (Under "Type" Column)

The Bridge Tool was designed to have a maximum database capacity of 1,000 standard highway bridges. The initial data set contains 67 bridges of various configurations. As the database is supplemented with more case study bridges, the data should become more refined and production rate output more statistically significant. The Bridge Tool database and CTD Input sheet was set up to collect data for bridges with up to four piers. When determining contract time for more complex bridges, it is recommended that a Critical Path Method (CPM) schedule be developed for estimating the appropriate contract time.

5.3 DROPDOWNS AND REQUIRED FIELDS

The Bridge Tool contains several prepopulated drop-down lists to limit choices and maintain data consistency. The use of dropdowns eliminates grammar errors when entering new records to the database and will provide for better filtering criteria when estimating bridge contract time. These data validation lists were developed in the bridge tool as Excel tables because we wanted the range to dynamically update when the user adds or removes items from the list.

Dropdown lists are able to be observed in a hidden sheet labeled "Settings". New dropdown data entries are discouraged in order to maintain a relevant sample size in the data set. Each unique entry has the ability to limit the data set. If the data in the tables are modified, for example, updating the "Light" traffic condition to "Low", a find and replace would need to occur in the database to account for the naming convention update in the look up list.



Lookup Lists

Phase	ProjectType	BridgeOver	Traffic	YesNo	Procur
Scoping	New Bridge	Roadway	Light	Yes	DBB
Preliminary Design	Rehab	Water	Moderate	No	DB
Final Design	Preservation	Railroad	Heavy	Exclude	CMGC

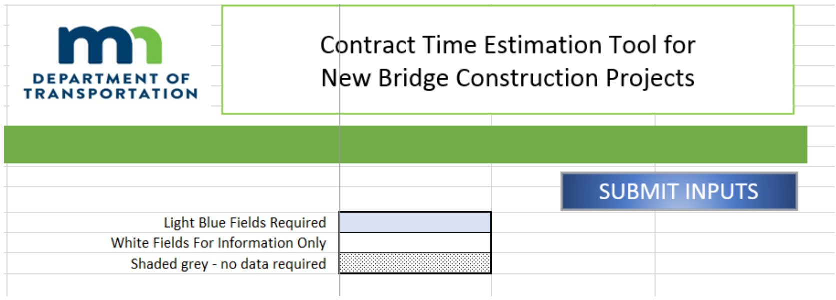
=INDIRECT("lookup_NM[NM]")

Abutmentheight	Abutmenttype	Footing	PileType	SidewalkType
	Exclude	Exclude	Exclude	
<12 ft	Integral	Pile	H	Concrete Curb
>12 ft	Semi-Integral	Spread	CIP	P-1
Exclude	Parapet		Rotary Drill	
			Other	

PierCapType	PierIn	Alignment	ABCtech	AestheticTreatments
Precast	Land	New Bridge off alignment	Precast substructure	None
CIP	Water	New bridge on alignment	Precast Deck	Level 1
	Exclude	Exclude	Slide-in	Level 2
			Move-in with SPMT	Level 3

Figure 5.1 Settings Tab

There are various levels of required information for the bridge tool to properly function. A cell color key is shown on the CTD Input page to define cells as required, not required, or for information only. Figure 3 shows the key from the CTD Input sheet.



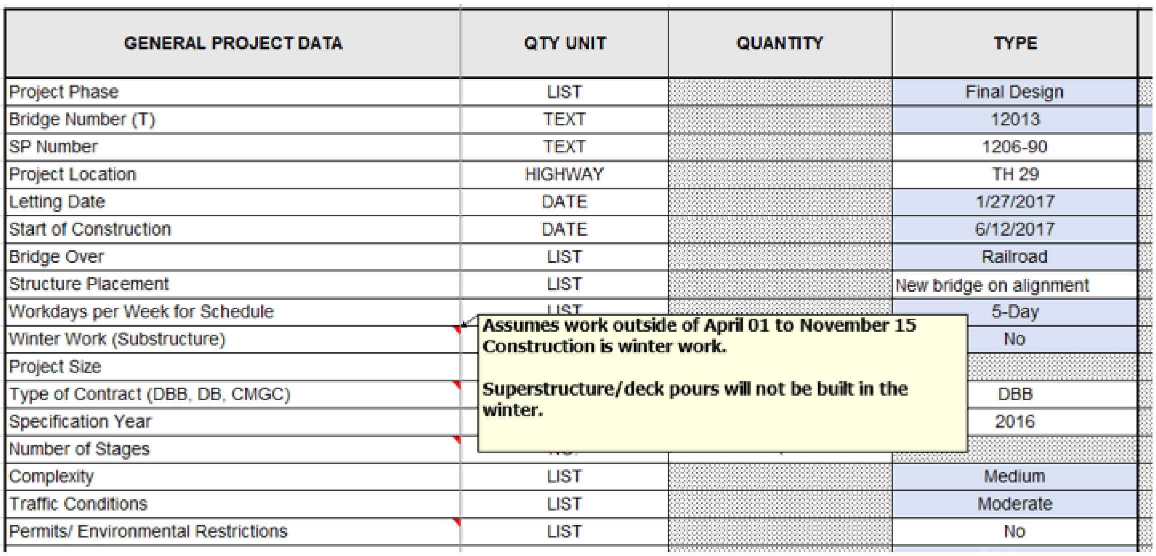
Contract Time Estimation Tool for
New Bridge Construction Projects

Light Blue Fields Required
White Fields For Information Only
Shaded grey - no data required

Figure 5.2 CTD Input Sheet Information Key

5.4 ROLLOVER TEXT

The CTD Input sheet contains rollover text to clarify the intent of some CTD input rows and provide guidance when completing the sheet. The rollover text can be modified by selecting the cell, right click – edit comment. The roll over text contains language from the MnDOT Standard Specifications for Construction and should be reviewed to ensure the most current specification requirements are being used be the bridge tool.



GENERAL PROJECT DATA	QTY UNIT	QUANTITY	TYPE
Project Phase	LIST		Final Design
Bridge Number (T)	TEXT		12013
SP Number	TEXT		1206-90
Project Location	HIGHWAY		TH 29
Letting Date	DATE		1/27/2017
Start of Construction	DATE		6/12/2017
Bridge Over	LIST		Railroad
Structure Placement	LIST		New bridge on alignment
Workdays per Week for Schedule	LIST		5-Day
Winter Work (Substructure)			No
Project Size			
Type of Contract (DBB, DB, CMGC)			DBB
Specification Year			2016
Number of Stages			
Complexity	LIST		Medium
Traffic Conditions	LIST		Moderate
Permits/ Environmental Restrictions	LIST		No

Assumes work outside of April 01 to November 15 Construction is winter work.

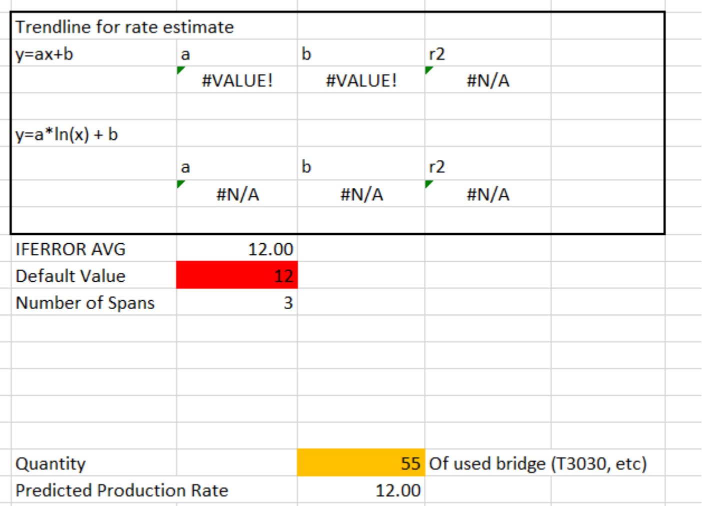
Superstructure/deck pours will not be built in the winter.

Figure 5.3 Roll Over Text

5.5 PRODUCTION RATES

Each filter contains a default production rate and unit of measure. Default production rates are only used by the Bridge Tool if the database does not contain sufficient historical data. The filters and activity descriptions listed below are embedded in hidden sheets within the bridge tool spreadsheet. If needed, ~~these~~ the users can unhide activity filter tabs and modify the default production rates.

If needed the default production rates can be revised on each activity filter. The activity filter sheets are automatically hidden when opening the sheet, so the user will need to unhide the activity filter to update the default production rate.



Trendline for rate estimate				
y=ax+b	a	b	r2	
	#VALUE!	#VALUE!	#N/A	
y=a*ln(x) + b				
	a	b	r2	
	#N/A	#N/A	#N/A	
IFERROR AVG	12.00			
Default Value	12			
Number of Spans	3			
Quantity		55	Of used bridge (T3030, etc)	
Predicted Production Rate		12.00		

Figure 5.4 Modifying a Default Value

5.6 SCHEDULE OUTPUT

Once the CTD input sheet is filled out and the “Submit Inputs” button is clicked, a macro program is started which looks at the inputs and selects case study bridges that are aligned to the selected input. Where no input values are given, default production rates are used. A list of default production rates can be found in Appendix B: Bridge Contract Time Filters. Due to the size of the workbook the macro program can take up to 20 minutes depending on the data set and the computer speed being used. Upon completion of the Macro execution, a bar chart schedule is generated on the “Schedule” tab. Cells that are highlighted yellow on this tab are direct inputs from the “CTD Input” sheet.

The definition of a confidence interval is an estimated range of values determined from a given set of sample data, which is likely to include an unknown population parameter. In order for the bridge tool to estimate a production rate for a range of values, 27 similar case studies are required with the exact same filter applied. If there is an insufficient number of similar case studies in the database, default production rates will be applied to activities when estimating bridge construction time. The logic used in the schedule is based on a standard bridge highway bridge utilizing one crew with some concurrent work.

The “Risk and Similar Case Study” tab in the Bridge Tool notes project factors that are to be considered when estimating construction time. These factors were developed by the Federal Highway Administration and should be considered when determining contract time. In addition to production rates, the user should exercise personal experience and judgement to aid in determining contract time. Factors for consideration include the following:

1. Effects of maintenance of traffic requirements on scheduling and sequencing of operations;
2. Conflicting operations of adjacent project, both public and private;
3. Time for reviewing false-work plans, shop drawings, post tensioning plans, mix designs, etc.;
4. Time for fabrication of structural steel or other specialty items;
5. Coordination with utility owners and potential relocation;
6. Time to obtain necessary permits;
7. Restrictions to nighttime and weekend operations;
8. Additional time for obtaining specialty items or materials along with long lead time requirements;
9. Non-traditional contracting methods such as bonuses and incentives/disincentive specifications for early completion;
10. Geographic locations;
11. When working over the railroad, coordination with the rail company and frequency of train traffic;
12. When working over water, consider frequency of seasonal flooding/high water.

5.7 WORKING DAYS

As mentioned in Section 5.6, once the CTD input sheet is complete and the “Submit Inputs” button is clicked, a macro processes the data and populates an estimated construction schedule on the “Schedule” tab. This tab will give a predicted construction duration in calendar days and working days, as well as a predicted start and finish dates. With the exception of “Winter Work” schedule assumptions, the Bridge Tool does not account for non-working days due to weather impacts. Winter work is defined within the programs schedules as between November 15 and April 15 of each calendar year. During winter work every other day is treated as contingent non-working days. The definition of winter for this reduced production rate is located in the “Settings” worksheet. (

The project location, and estimated project start date, along with the MnDOT Standard Specifications for Construction 1803 should reviewed and added to the Working Day calculation produced by the Bridge Tool.

5.8 SCHEDULE OUTPUT CUSTOMIZATION

Once a schedule is created, the user may verify that the activities appear appropriate and review the start and stop times for each activity. Often the user will want to make schedule modifications to better match the bridge. A created schedule may be customized by the user knowing the specifics of what should be altered. When customizing a schedule, the user should work in a copy of the macro-generated “SCHEDULE” worksheet in order to preserve formulas. Most of these customizations would occur in column G, “WD Duration.” If the user overrides any formulas in the “WD Duration” the ‘Submit Inputs” macro may not generate a new schedule.

Figure 4 below will be used to illustrate the schedule properties and dependencies. Reviewing column G, “WD Duration”, the following information applies:

1. Cells in yellow highlighting indicate default production values that are not dependent on case studies. The user may directly overwrite these.
2. Red text values are those production values obtained by statistical analysis of the filtered case study bridges. It is important the user review these values to understand if a numerical error from using too small a case study data set has occurred. Column C indicates the activity sheet which derives these values.
3. Black text is an input from CTD sheet, which may be a default value if no data is entered.

Reviewing Column C, “Task ID”, the following may be noted:

1. Substructure tasks occupy all tasks between task 2000 and 9000, including task 2000. Deck tasks start at task 9000 and higher and include approach panels
2. The user may copy an entire row and insert it as a new row for a new activity. The formulas will still function properly except that the “Predecessor Task” column, column H, must be updated to reflect the new pre-requisite activity. It is advisable that the new activity should have a unique Task ID, although not required if there are no dependencies on that activity.

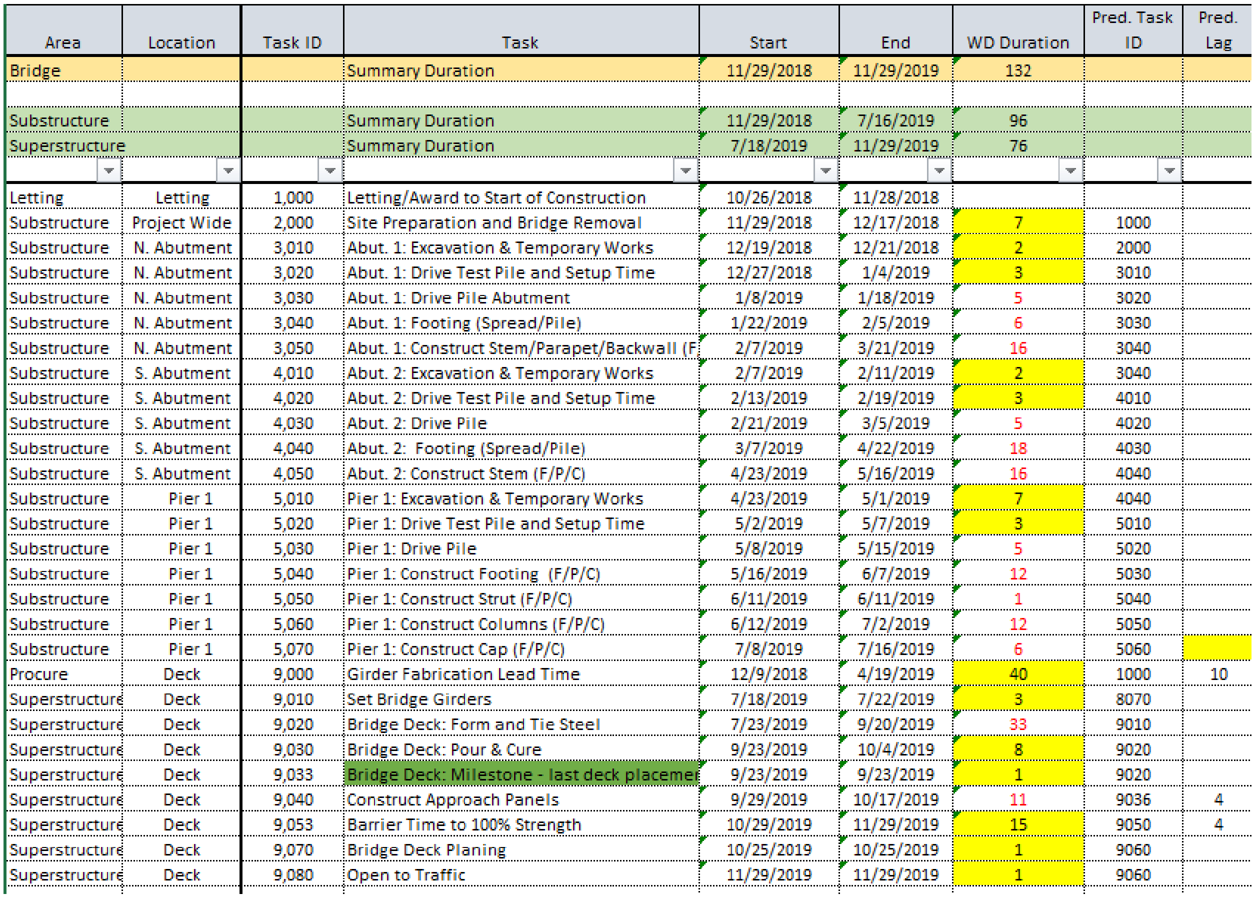
Column H is the predecessor activity (Column heading “Pred. Task ID”) and is the pre-requisite task ID from column C. The user may change the predecessor activity to customize a schedule. One reason to make this change would be to recognize multiple crews for concurrent work. For example, if a separate crew is working on the north abutment for the schedule shown in Figure 5, the user would overwrite the cell H32 (Column H, row 32) value of 3040 to a predecessor task of 2000. Alternatively, for multiple piers the excavation of one pier may closely follow the excavation completion of an adjacent pier. Unless specified in the CTD Input sheet, concurrent work is not assumed, and each substructure is constructed sequentially.

The user may also want to alter construction work calendar assumptions. The work calendar is selection is contained in column J. The program currently includes four available working calendars: Two for summer work and two for winter work, consisting of a 5-day work-week or 6-day work-week. Column J should be modified as a last resort because this column uses a formula and hard-coding a value may alter dependencies with further modifications in the work schedule.

As stated earlier, Column H is the predecessor Task ID. This predecessor task also identifies the logic used in developing calendar days and the starting work day. The Predecessor Task ID in Column H may be changed by the end user to more accurately depict anticipated construction staging. If the user changes column H and needs to restore it to its original values, column J may contains the original values. At time of program opening, column J will be hidden and the user would have to unhide column J in order to see these values.

Lag is used in the schedule output to accurately depict start dates for certain activities in the bridge tool. For example, a four-day lag is used between Task ID 9,033 – Bridge Deck: Milestone – Last Deck Placement and Task ID 9,040 – Construct Approach Panels. The four-day lag represents the minimum reasonable amount of time needed for cure of the bridge deck prior to beginning construction of the approach panels. Actual casting of approach panels would commence typically a minimum 7-day deck cure, or as stipulated in contract specifications.

Columns L through O represent the starting and ending calendar day (CD) and work days (WD) based on the calendar selected.



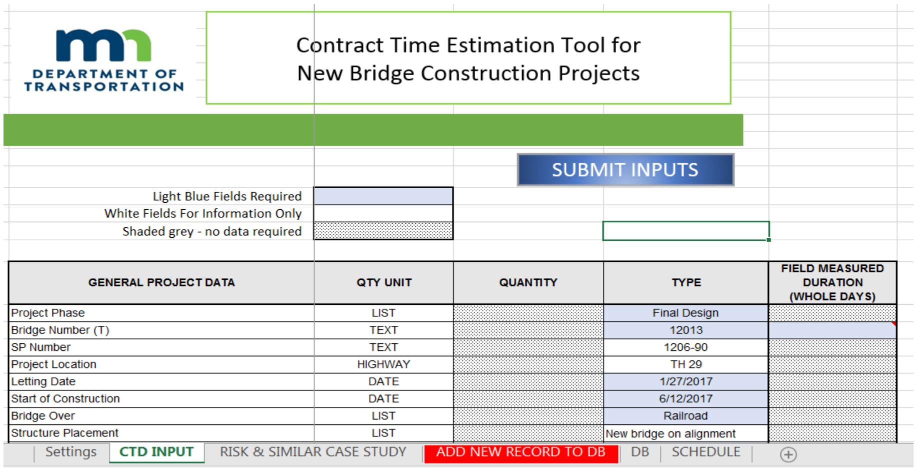
Area	Location	Task ID	Task	Start	End	WD Duration	Pred. Task ID	Pred. Lag
Bridge			Summary Duration	11/29/2018	11/29/2019	132		
Substructure			Summary Duration	11/29/2018	7/16/2019	96		
Superstructure			Summary Duration	7/18/2019	11/29/2019	76		
Letting	Letting	1,000	Letting/Award to Start of Construction	10/26/2018	11/28/2018			
Substructure	Project Wide	2,000	Site Preparation and Bridge Removal	11/29/2018	12/17/2018	7	1000	
Substructure	N. Abutment	3,010	Abut. 1: Excavation & Temporary Works	12/19/2018	12/21/2018	2	2000	
Substructure	N. Abutment	3,020	Abut. 1: Drive Test Pile and Setup Time	12/27/2018	1/4/2019	3	3010	
Substructure	N. Abutment	3,030	Abut. 1: Drive Pile Abutment	1/8/2019	1/18/2019	5	3020	
Substructure	N. Abutment	3,040	Abut. 1: Footing (Spread/Pile)	1/22/2019	2/5/2019	6	3030	
Substructure	N. Abutment	3,050	Abut. 1: Construct Stem/Parapet/Backwall (F	2/7/2019	3/21/2019	16	3040	
Substructure	S. Abutment	4,010	Abut. 2: Excavation & Temporary Works	2/7/2019	2/11/2019	2	3040	
Substructure	S. Abutment	4,020	Abut. 2: Drive Test Pile and Setup Time	2/13/2019	2/19/2019	3	4010	
Substructure	S. Abutment	4,030	Abut. 2: Drive Pile	2/21/2019	3/5/2019	5	4020	
Substructure	S. Abutment	4,040	Abut. 2: Footing (Spread/Pile)	3/7/2019	4/22/2019	18	4030	
Substructure	S. Abutment	4,050	Abut. 2: Construct Stem (F/P/C)	4/23/2019	5/16/2019	16	4040	
Substructure	Pier 1	5,010	Pier 1: Excavation & Temporary Works	4/23/2019	5/1/2019	7	4040	
Substructure	Pier 1	5,020	Pier 1: Drive Test Pile and Setup Time	5/2/2019	5/7/2019	3	5010	
Substructure	Pier 1	5,030	Pier 1: Drive Pile	5/8/2019	5/15/2019	5	5020	
Substructure	Pier 1	5,040	Pier 1: Construct Footing (F/P/C)	5/16/2019	6/7/2019	12	5030	
Substructure	Pier 1	5,050	Pier 1: Construct Strut (F/P/C)	6/11/2019	6/11/2019	1	5040	
Substructure	Pier 1	5,060	Pier 1: Construct Columns (F/P/C)	6/12/2019	7/2/2019	12	5050	
Substructure	Pier 1	5,070	Pier 1: Construct Cap (F/P/C)	7/8/2019	7/16/2019	6	5060	
Procure	Deck	9,000	Girder Fabrication Lead Time	12/9/2018	4/19/2019	40	1000	10
Superstructure	Deck	9,010	Set Bridge Girders	7/18/2019	7/22/2019	3	8070	
Superstructure	Deck	9,020	Bridge Deck: Form and Tie Steel	7/23/2019	9/20/2019	33	9010	
Superstructure	Deck	9,030	Bridge Deck: Pour & Cure	9/23/2019	10/4/2019	8	9020	
Superstructure	Deck	9,033	Bridge Deck: Milestone - last deck placemen	9/23/2019	9/23/2019	1	9020	
Superstructure	Deck	9,040	Construct Approach Panels	9/29/2019	10/17/2019	11	9036	4
Superstructure	Deck	9,053	Barrier Time to 100% Strength	10/29/2019	11/29/2019	15	9050	4
Superstructure	Deck	9,070	Bridge Deck Planing	10/25/2019	10/25/2019	1	9060	
Superstructure	Deck	9,080	Open to Traffic	11/29/2019	11/29/2019	1	9060	

Figure 5.5 Sample Part of Schedule that is Generated

5.9 ADDING A NEW BRIDGE TO THE DATABASE

Adding new bridges to the database will increase the ability of the Bridge Tool to produce a more refined bridge construction time estimate. The Bridge Tool database is set up and coded to allow up to 1,000 bridge records to be stored for estimating contract time. Adding a new bridge to the database can be done by following the following steps:

1. Complete the “CTD Input” sheet with accurate information from a completed bridge project. When the information on this sheet is accurate and complete, switch to the worksheet tab named “Add New Record to DB”.



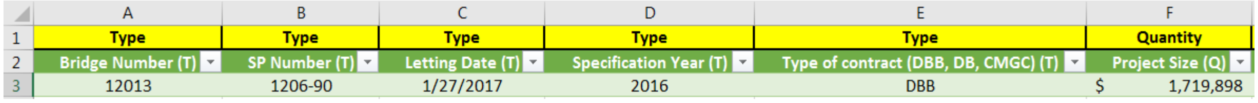
Contract Time Estimation Tool for
New Bridge Construction Projects

Light Blue Fields Required
White Fields For Information Only
Shaded grey - no data required

GENERAL PROJECT DATA	QTY UNIT	QUANTITY	TYPE	FIELD MEASURED DURATION (WHOLE DAYS)
Project Phase	LIST		Final Design	
Bridge Number (T)	TEXT		12013	
SP Number	TEXT		1206-90	
Project Location	HIGHWAY		TH 29	
Letting Date	DATE		1/27/2017	
Start of Construction	DATE		6/12/2017	
Bridge Over	LIST		Railroad	
Structure Placement	LIST		New bridge on alignment	

Figure 5.6 Completed “CTD Input” Sheet

2. The information displayed in the “Add New Record to DB” sheet will be the same data that was entered in the “CTD Input” tab. The information on the “Add New Record to DB” sheet will auto-populate with the information added on the “CTD Input” sheet.



	A	B	C	D	E	F
1	Type	Type	Type	Type	Type	Quantity
2	Bridge Number (T)	SP Number (T)	Letting Date (T)	Specification Year (T)	Type of contract (DBB, DB, CMGC) (T)	Project Size (Q)
3	12013	1206-90	1/27/2017	2016	DBB	$ 1,719,898

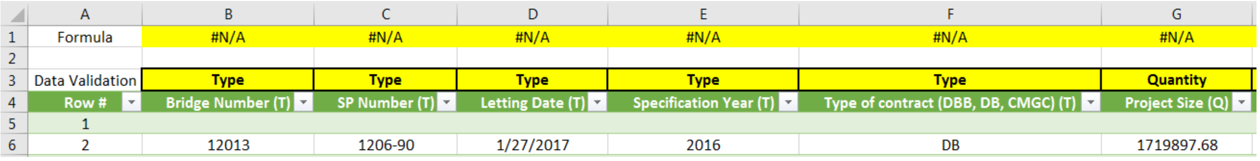
Figure 5.7 “Add New Record to DB” sheet auto-populate

3. To add the new bridge record to the database, copy cells B3 through HT3 on the “Add New Record to DB” sheet. Cell A3 will be auto populated based on the bridge number from the new record that has been added.

	A	B	C	D	E	F
1	Type	Type	Type	Type	Type	Quantity
2	Bridge Number (T)	SP Number (T)	Letting Date (T)	Specification Year (T)	Type of contract (DBB, DB, CMGC) (T)	Project Size (Q)
3	12013	1206-90	1/27/2017	2016	DBB	$ 1,719,898

Figure 5.8 Copy Cells B3-HT3 on “Add New Record to DB” sheet

4. Paste cells from Step 3 into the “DB” sheet in the first available row in ***column B***. This will successfully add the new record to the database. The new bridge record will not be added to the database correctly if the information is pasted into any other cell.



	A	B	C	D	E	F	G
1	Formula	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
2							
3	Data Validation	Type	Type	Type	Type	Type	Quantity
4	Row #	Bridge Number (T)	SP Number (T)	Letting Date (T)	Specification Year (T)	Type of contract (DBB, DB, CMGC) (T)	Project Size (Q)
5	1						
6	2	12013	1206-90	1/27/2017	2016	DB	1719897.68

Figure 5.9 Paste Cells into “DB” sheet

APPENDIX A: EXISTING BRIDGE CASE STUDIES

Two example case study bridges were chosen for this report to demonstrate a successful and unsuccessful Bridge Tool outputs.

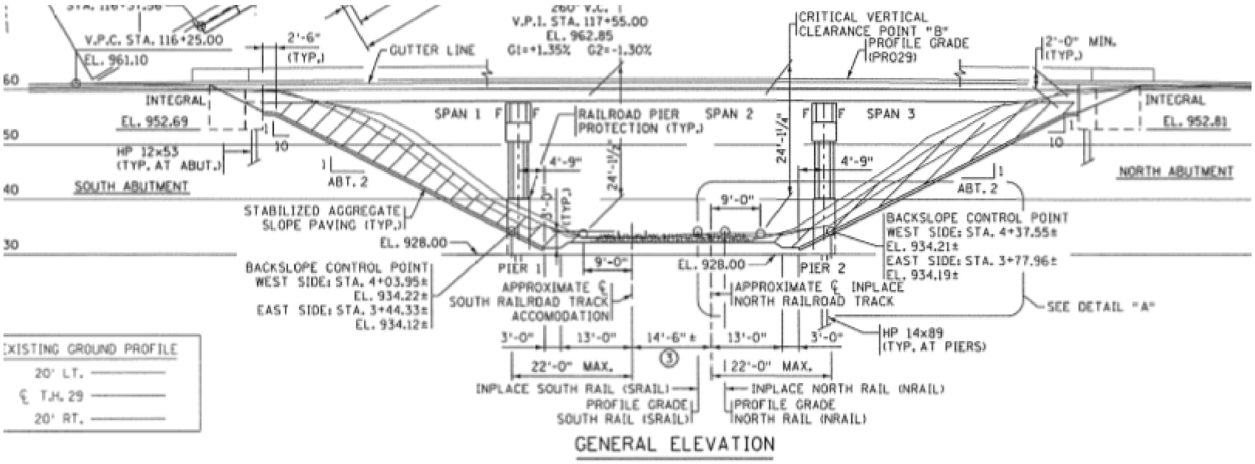
Case Study Bridge Number 1

Case study 1 illustrates a schedule creation attempt for Bridge 12013, which is a new three-span prestressed concrete beam bridge over the T.C.&W railroad in Montevideo, MN. This project consisted of removal of an existing bridge, coordination with the railroad and construction of a new bridge. The construction start date per the Contract documents was June 19, 2017 and allowed 60 working days to complete bridge demolition, reconstruction and opening to traffic. Project specific characteristics are summarized in Table 1 below. This project was constructed during the 2017 construction season.

Table 1: Example case study bridge data

MnDOT S.P.	1206-90
MnDOT District	8
Construction Cost	$1,719,898
Substantial Completion	9/22/17
Bridge Substructure	Pile Supported (H-Pile)
Beam Type	27M Prestressed Concrete Beams
Bridge Deck	7" Structural Deck with 2" Wearing Course
Bridge Contractor	Lunda Construction
Controlling Operation	Bridge

General Elevation from Bridge #12013



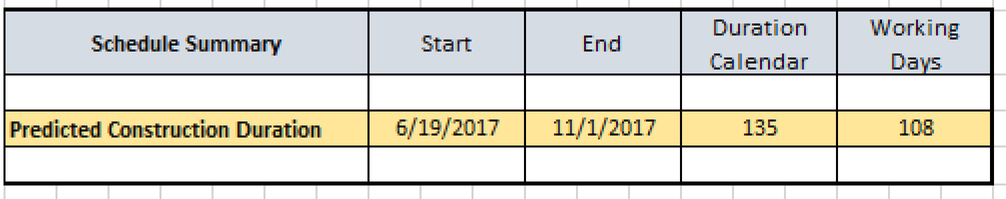
Schedule Inputs used for the Bridge Tool

Bridge tool inputs were provided by MnDOT Bridge Office staff for this case study and were based on estimated quantities provided in the final construction plans as a check to the pre-determined contract time in 1806 of the Special Provisions. A detailed printout of activities entered in the Bridge Tool is included in the document. Elements entered in the Bridge Tool include but are not limited piling, substructure construction; footings, abutments, pier stems, and pier caps. Superstructure elements that were entered into the Bridge Tool include beam erection, form and reinforcement of the bridge deck, approach panel construction and barrier installation.

Outputs Generated from the Bridge Tool

The Special Provisions for the project (S-29) (1806) Determination and Extension of Contract Time states the following: *"Contractor must complete all work required under this Contract, except maintenance work and Final Clean Up, in no more than 60 Working Days."*

Based on the inputs that were derived from the plans, construction diaries and bar chart schedule, the bridge tool estimated that this bridge would take 108 Working Days based on a 6-day work week.



Schedule Summary	Start	End	Duration Calendar	Working Days
Predicted Construction Duration	6/19/2017	11/1/2017	135	108

Summary of Case Study #1

The bridge tool functions properly, but for a more refined estimate of contract time, the database needs to be further populated to increase the level of confidence. FHWA documents recommend a minimum of 27 similar bridges to establish a level of confidence and provide the best estimate of contract time. Currently, the bridge tool has an average of 4 similar bridges for each output, and with data the contract time estimates will only improve. The Bridge Tool assumes a minimum 15% contingency for non-working days due to inclement weather and is dependent on weather conditions during construction. To meet such an aggressive work schedule, schedule logic in the output tab would have to be modified to show concurrent work depending on how many crews the Contractor bid for the contract.

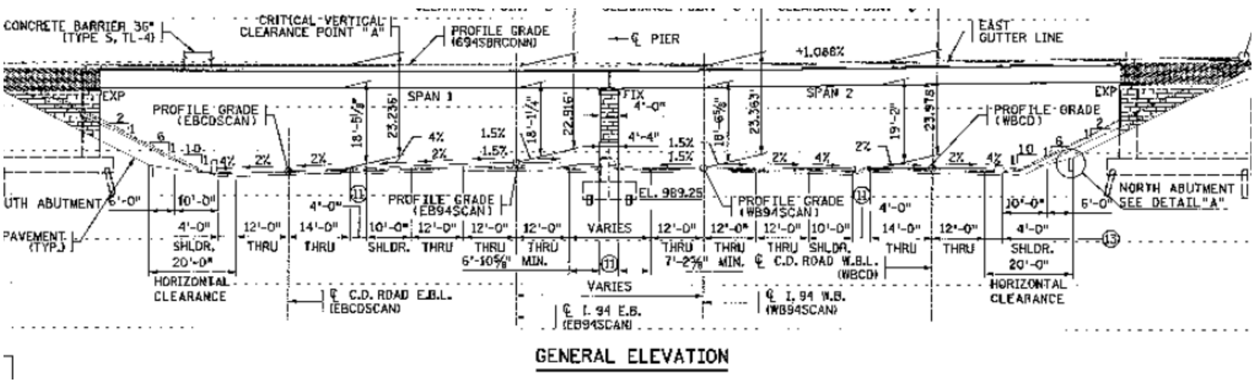
Case Study Number 2

Case study number 2 is a new two-span prestressed concrete beam bridge carrying SB 694 over I-94 and other collector roads in Washington County. This project was let on 12/14/18 as an A+B+C+D+E+F method contract that will replace existing bridges 82831 and 82832 with bridges 82873 and 82874, respectively. Both bridges are to be constructed on current alignment, with bridge 82873 scheduled in the 2019 construction season. This project consists of grading, unbonded concrete overlay, bituminous surfacing and replacement of bridge's 82817, 82831, 82873 and 82874. Project specific characteristics are summarized in Table 2 below.

Table 2: Example case study bridge data

MnDOT S.P.	8286-81
MnDOT District	M
Construction Cost	$35,309,506.05
Project Substantial Completion	6/1/2021
Bridge Interim Completion Milestone	11/18/2019
Bridge Substructure	Pile Supported (CIP)
Beam Type	MN45 Prestressed Concrete Beams
Bridge Deck	Pre-Cast Deck Panels
Bridge Contractor	Kraemer North America
Controlling Operation	Bridge

General Elevation from Bridge 82873 Title Sheet



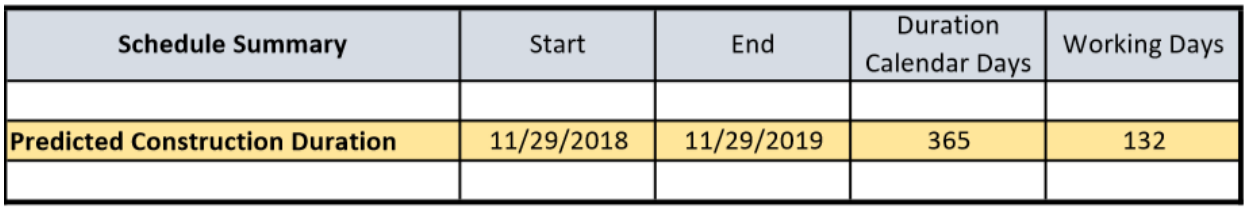
Schedule Inputs used for the Bridge Tool

For the purpose of this case study, only the bridge work of constructing two bridges (82873 and 82874) was input into the schedule. The bridge tool inputs were provided by MnDOT Bridge Office staff and were based on estimated quantities provided in the final construction plans as a check to the pre-determined contract time in 1806 of the Special Provisions. The tool was run to identify if an early spring start would permit both bridges to be completed in a single season. A detailed printout of activities entered in the Bridge Tool is included in Appendix D of this document. Elements entered in the Bridge Tool include but are not limited piling, substructure construction; footings, abutments, pier stems, and pier caps. Superstructure elements that were entered into the Bridge Tool include beam erection, form and reinforcement of the bridge deck, approach panel construction and barrier installation.

Outputs Generated from the Bridge Tool

The Special Provisions for the project (S-42) (1806) Determination and Extension of Contract Time states the following: *"In addition to the other Contract Time requirements, the Contractor must complete all work required to have traffic in the Stage 3 (winter 2019/2020) traffic configuration on or before November 18, 2019."*

Based on the inputs provided by the staff at the MnDOT Bridge Office, the Bridge Tool estimated a construction duration of 365 calendar days or 132 working days based on a 5-day work week.



Schedule Summary	Start	End	Duration Calendar Days	Working Days
Predicted Construction Duration	11/29/2018	11/29/2019	365	132

The estimated completion date for Bridge 82873 is November 29, 2019, which exceeds the allowable construction timeframes established in S-42 (1806) Determination of Contract Time of the Special Provisions by 11 calendar days.

Case Study #2 Summary

The bridge tool functions properly, but there are many factors that impact the actual bridge construction duration. Some of these factors include, but are not limited to number of bridge crews, allowable closure durations and environmental restrictions. The output generated by the bridge contract time tool should always be reviewed by for accuracy. Outputs from the bridge tool for A+B projects will more than likely be skewed due to the Contractor bidding the calendar day durations for construction timeframes that will more than likely require more resources to meet the commitment made at the time of bidding.

APPENDIX B: BRIDGE CONTRACT TIME FILTERS

Appendix B contains the activity filters used within the Bridge Tool to filter information from the database. Each filter contains a default production rate and unit of measure. Default production rates are only used by the Bridge Tool if the database does not contain sufficient historical data. The filters and activity descriptions listed below are hidden sheets in the bridge tool. If needed, the users can unhide hidden worksheets that contain activity filter sheets. Once in the relevant activity sheet, the user can modify the default production rates.

Summary of Bridge Tool Activity Filters

T3030:

Activity - Abut. 1: Drive Pile Abutment
Filters Used – Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Abut: Height and Type (Q), Abut: Height and Type (T), Footing, Drive Pile
Unit of Measurement/Basis for Estimate – Linear Feet
Default Production Rate – 500 linear feet per 8-hour shift

T3040:

Activity - Abut. 1: Footing (Spread/Pile)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Footing, Drive Pile
Unit of Measurement/Basis for Estimate – Cubic Yards (Dependent on MnDOT change)
Default Production Rate – 15 Cubic Yards per 8-hour shift

T3050:

Activity - Abut. 1: Construct Stem/Parapet/Backwall (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Abut: Height and Type (Q), Abut: Height and Type (T)
Unit of Measurement/Basis for Estimate – No. of Pours
Default Production Rate – 0.19 pours per 8-hour shift

T4030:

Activity - Abut. 2: Drive Pile
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Abut: Height and Type (Q), Abut: Height and Type (T), Footing, Drive Pile
Unit of Measurement/Basis for Estimate - Linear Feet
Default Production Rate – 500 linear feet per 8-hour shift

T4040:

Activity - Abut. 2: Footing (Spread/Pile)
Filters Used - Bridge Over, Complexity, Traffic Cond., Superstructure Type, Footing, Drive Pile
Unit of Measurement/Basis for Estimate - Cubic Yards
Default Production Rate – 15 Cubic Yards per 8-hour shift

T4050:

Activity - Abut. 2: Construct Stem (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Abut: Height and Type (Q), Abut: Height and Type (T)
Unit of Measurement/Basis for Estimate – No. of Pours
Default Production Rate – 0.19 pours per 8-hour shift

T5030:

Activity - Pier 1: Drive Pile
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T), Pier Footing, Pier Drive Pile
Unit of Measurement/Basis for Estimate – Linear Feet
Default Production Rate – 500 linear feet per 8-hour shift

T5040:

Activity - Pier 1: Construct Footing (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T), Pier Footing
Unit of Measurement/Basis for Estimate – No. of pours
Default Production Rate – 0.14 pours per 8-hour shift

T5050:

Activity - Pier 1: Construct Strut (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T)
Unit of Measurement/Basis for Estimate – No. of Pours
Default Production Rate – 7 Cubic Yards per 8-hour shift

T5060:

Activity - Pier 1: Construct Columns (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T)
Unit of Measurement/Basis for Estimate – No. of Pours
Default Production Rate – .75 pours per 8-hour shift

T5070:

Activity - Pier 1: Construct Cap (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T)
Unit of Measurement/Basis for Estimate – No. of Pours
Default Production Rate – 0.75 pours per 8-hour shift

T6030:

Activity - Pier 2: Drive Pile
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T), Pier Footing, Pier Drive Pile
Unit of Measurement/Basis for Estimate - Linear Feet
Default Production Rate – 500 linear feet per 8-hour shift

T6040:

Activity - Pier 2: Construct Footing (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T), Pier Footing
Unit of Measurement/Basis for Estimate - Cubic Yards
Default Production Rate – 12 Cubic Yards per 8-hour shift

T6050:

Activity - Pier 2: Construct Strut (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T)
Unit of Measurement/Basis for Estimate – No. of Pours
Default Production Rate – 0.14 pours per 8-hour shift

T6060:

Activity - Pier 2 Construct Columns (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T)
Unit of Measurement/Basis for Estimate - No. of Pours
Default Production Rate – 0.75 pours per 8-hour shift

T6070:

Activity - Pier 2: Cap (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T)
Unit of Measurement/Basis for Estimate - No. of Pours
Default Production Rate –0.75 pours per 8-hour shift

T7030:

Activity - Pier 3: Drive Pile
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T), Pier Footing, Pier Drive Pile
Unit of Measurement/Basis for Estimate - Linear Feet
Default Production Rate – 500 linear feet per 8-hour shift

T7040:

Activity - Pier 3: Construct Footing (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T), Pier Footing
Unit of Measurement/Basis for Estimate - Cubic Yards
Default Production Rate – 12 Cubic Yards per 8-hour shift

T7050:

Activity - Pier 3: Construct Strut (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T)
Unit of Measurement/Basis for Estimate – No. of Pours
Default Production Rate – 0.14 Pours per 8-hour shift

T7060:

Activity - Pier 3: Construct Columns (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T)
Unit of Measurement/Basis for Estimate - No. of Pours
Default Production Rate – 0.75 pours per 8-hour shift

T7070:

Activity - Pier 3: Cap (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T)
Unit of Measurement/Basis for Estimate - No. of Pours
Default Production Rate – 0.75 pours per 8-hour shift

T8030:

Activity - Pier 4: Drive Pile
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T), Pier Footing, Pier Drive Pile
Unit of Measurement/Basis for Estimate - Linear Feet
Default Production Rate – 500 linear feet per 8-hour shift

T8040:

Activity - Pier 4: Construct Footing (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T), Pier Footing
Unit of Measurement/Basis for Estimate - Cubic Yards
Default Production Rate – 12 Cubic Yards per 8-hour shift

T8050:

Activity - Pier 4: Construct Strut (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T)
Unit of Measurement/Basis for Estimate – No. of Pours
Default Production Rate – 0.14 pours per 8-hour shift

T8060:

Activity - Pier 4: Construct Columns (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T)
Unit of Measurement/Basis for Estimate – No. of Pours
Default Production Rate – 0.75 pours per 8-hour shift

T8070:

Activity - Pier 4:, Cap (F/P/C)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type, Pier: Type and Location (Q), Pier: Type and Location (T)
Unit of Measurement/Basis for Estimate – No. of Pours
Default Production Rate – 0.75 pours per 8-hour shift

T9020:

Activity - Bridge Deck: Form and Tie Steel
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type
Unit of Measurement/Basis for Estimate – Square Feet
Default Production Rate – 1000 Square Feet per 8-hour shift

T9040:

Activity - Construct Approach Panels
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type
Unit of Measurement/Basis for Estimate – No. of Pours per shift
Default Production Rate – 0.2 pours per 8-hour shift

T9060:

Activity - Concrete Wearing Course
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type
Unit of Measurement/Basis for Estimate - Days
Default Production Rate – 9 days per pass

T9070:

Activity - Bridge Deck Planing (Texture Grinding)
Filters Used - Bridge Over, Complexity, Traffic Conditions, Superstructure Type
Unit of Measurement/Basis for Estimate - List
Default Production Rate – 135 square feet per 8-hour shift

APPENDIX C: CASE STUDY 1 INPUTS - BRIDGE 12013

DEPARTMENT OF TRANSPORTATION

Contract Time Estimation Tool for New Bridge Construction Projects

SUBMIT INPUTS

Light Blue Fields Required
White Fields For Information Only
Shaded grey - no data required

GENERAL PROJECT DATA	QTY UNIT	QUANTITY	TYPE
Project Phase	LIST		Final Design
Bridge Number (T)	TEXT		12013
SP Number	TEXT		1206-90
Project Location	HIGHWAY		TH 29
Letting Date	DATE		1/27/2017
Start of Construction	DATE		6/19/2017
Bridge Over	LIST		Railroad
Structure Placement	LIST		New bridge on alignment
Workdays per Week for Schedule	LIST		6-Day
Winter Work (Substructure)	LIST		No
Project Size	DOLLARS	$1,719,898	
Type of Contract (DBB, DB, CMGC)	LIST		DBB
Specification Year	YEAR		2016
Number of Stages	NO.	1	
Complexity	LIST		High
Traffic Conditions	LIST		Moderate
Permits/ Environmental Restrictions	LIST		No
Superstructure Type	LIST		PS Beam
Structure Length	FT	179.4	
Out to Out Width	FT	47.7	
Bridge Deck Area	SF	8557.38	
Number of Spans	EA	3	
Skew (Deg)	DEG.	30.5	
Structural Concrete (Project Total)	CY	422	
Reinforcement Bars (Project Total)	POUNDS	130610	
Architectural Complexity	LIST		Level 1
Mass Concrete	LIST		No
Accelerated Bridge Construction	LIST		Exclude
Additional Design Comments:			

SUBSTRUCTURE	QTY UNIT	QUANTITY	TYPE
Total Substructure Construction Time	DAYS		
Site Preparation and Bridge Removal	DAYS	7	

ABUTMENT #1	QTY UNIT	QUANTITY	TYPE
Abut. 1: Height & Type	LIST	<12 ft	Integral
Abut. 1: Excavation & Temporary Works	DAYS	2	
Abut. 1: Pile Splice Required	DAYS / LIST	0	No
Abut. 1: Drive Test Pile and Setup Time	DAYS	1	
Abut 1: # of Test Pile	EACH	1	
Abut. 1: Drive Pile	LF	325	H
Abut. 1: Footing	NO. OF POURS	1	Pile
Abut. 1: Construct Footing (F/P/C)	CY	45	
Abut. 1: Abutment Length along Skew	FT	57.58	
Abut. 1: Stem/ Parapet/Backwall	CY	0	
Abut. 1: Construct Stem/ Parapet/Backwall (F/P/C)	NO. OF POURS	1	

ABUTMENT #2	QTY UNIT	QUANTITY	TYPE
Abut. 2: Height & Type	LIST	<12 ft	Integral
Abut. 2: Excavation & Temporary Works	DAYS	2	
Abut. 2: Pile Splice Required	DAYS / LIST	0	No
Abut. 2: Drive Test Pile and Setup Time	DAYS	1	
Abut 2: # of Test Pile	EACH	1	
Abut. 2: Drive Pile	LF	325	H
Abut. 2: Footing	NO. OF POURS	1	Pile
Abut. 2: Construct Footing (F/P/C)	CY	45	
Abut. 2: Abutment Length along Skew	FT	57.58	

Abut. 2: Stem/ Parapet/Backwall	CY	0	
Abut. 2: Construct Stem/ Parapet/Backwall (F/P/C)	NO. OF POURS	1	

PIER	QTY UNIT	QUANTITY	TYPE
Pier 1: Type and Location	LIST	Land	Multi-Column
Pier 1: Excavation & Temporary Works	DAYS	2	
Pier 1: Pile Splice Required	DAYS / LIST	1	No
Pier 1: Drive Test Pile and Setup Time	DAYS	1	
Pier 1: # of Test Pile	EACH	1	
Pier 1: Drive Pile	LF	500	H
Pier 1: Footing	CY	54	Pile
Pier 1: Strut	CY	54	
Pier 1: Construct Strut (F/P/C)	NO. OF POURS	1	
Pier 1: Columns	CY	22	
Pier 1: Construct Columns (F/P/C)	NO. OF POURS	1	
Pier 1: Construct Cap	CY	90	
Pier 1: Construct Cap (F/P/C)	NO. OF POURS	1	CIP
Pier 1 Cap: 70% Strength Gain Time From Pour	DAYS	5	
Pier 2: Type and Location	LIST	Land	Multi-Column
Pier 2: Excavation & Temporary Works	DAYS	2	
Pier 2: Pile Splice Required	DAYS / LIST	1	
Pier 2: Drive Test Pile and Setup Time	DAYS	1	
Pier 2: # of Test Pile	EACH	1	
Pier 2: Drive Pile	LF	500	H
Pier 2: Footing	CY	54	Pile
Pier 2: Strut	CY	54	
Pier 2: Construct Strut (F/P/C)	NO. OF POURS	1	
Pier 2: Columns	CY	22	
Pier 2: Construct Columns (F/P/C)	NO. OF POURS	1	
Pier 2: Construct Cap	CY	90	
Pier 2: Construct Cap (F/P/C)	NO. OF POURS	1	
Pier 2 Cap: 70% Strength Gain Time From Pour	DAYS	5	
Pier 3: Type and Location	LIST		
Pier 3: Excavation & Temporary Works	DAYS		
Pier 3: Pile Splice Required	DAYS / LIST		
Pier 3: Drive Test Pile and Setup Time	DAYS		
Pier 3: # of Test Pile	EACH		
Pier 3: Drive Pile	LF		
Pier 3: Footing	CY		
Pier 3: Strut	CY		
Pier 3: Construct Strut (F/P/C)	NO. OF POURS		
Pier 3: Columns	CY		
Pier 3: Construct Columns (F/P/C)	NO. OF POURS		
Pier 3: Construct Cap	CY		
Pier 3: Construct Cap (F/P/C)	NO. OF POURS		
Pier 3 Cap: 70% Strength Gain Time From Pour	DAYS		
Pier 4: Type and Location	LIST		
Pier 4: Excavation & Temporary Works	DAYS		
Pier 4: Pile Splice Required	DAYS / LIST		
Pier 4: Drive Test Pile and Setup Time	DAYS		
Pier 4: # of Test Pile	EACH		
Pier 4: Drive Pile	LF		
Pier 4: Footing	CY		
Pier 4: Strut	CY		
Pier 4: Construct Strut (F/P/C)	NO. OF POURS		
Pier 4: Columns	CY		
Pier 4: Construct Columns (F/P/C)	NO. OF POURS		
Pier 4: Construct Cap	CY		
Pier 4: Construct Cap (F/P/C)	NO. OF POURS		
Pier 4 Cap: 70% Strength Gain Time From Pour	DAYS		

SUPERSTRUCTURE, DECK AND APPROACH PANEL	QTY UNIT	QUANTITY	TYPE
Girder Fabrication Lead Time	WORKING DAYS	30	
Total Number of Beams or Girder Picks	EACH	18	27M
Set Bridge Girders	DAYS	3	
Bridge Deck: Form and Tie Steel	SF	8557.38	
Bridge Deck: Pour & Cure	DAYS		
Bridge Deck: Wait Between Pours	DAYS	0	
Bridge Deck: Cure Time Each Pour	DAYS	7	
Bridge Deck: Placement Time	DAYS	1	
Bridge Deck: Last Placement Begin From 1st Placement	DAYS		
Number of Deck Pours	POURS	1	
Bridge Deck: 65% Strength Gain Time From Pour	DAYS	4	
Bridge Deck: 100% Strength Gain Time From Pour	DAYS	6	
Construct Barriers (Slipform) (F/P/C)	LF	407	
Form & Pour Barriers Hand-Formed	DAYS	0	
Barrier 100% Strength Gain Time	DAYS	7	
Install Anchored Metal Railing	DAYS	0	
Install Bridge Sidewalk/Median (F/P/C)	LF	0	
Construct Approach Panels (F/P/C)	NO. OF POURS	2	
Extra time for Bridge Coatings (SSF or other)	DAYS	2	
Concrete Wearing Course	# OF PASSES	2	
Concrete Wearing Course (F/P/C)	DAYS	12	
Bridge Deck Planing	LIST		No
Install E8 Joint	DAYS	2	
Total Superstructure Construction Time	DAYS		

EXHIBIT A

CONTRACT TIME DETERMINATION GANTT CHART		Project Let Date	1/27/2017	Schedule Summary	Start	End	Duration Calendar Days	Working Days
Bridge Number (T)	**12013**	Update Period	Month					
SP Number	**1206-90**	Workdays per Week	5-Day	**Predicted Construction Duration**	3/28/2017	9/26/2017	182	90
Project Location	**TH 29**	Winter Work (Substructure)	no					

									'17	'17	'17	'17	'17	'17	'17	'17	'17	'17	'17	'17	'18	'18	'18	'18	'18	'18	'18
Area	Location	Task ID	Task	Start	End	WD Duration	Pred. Task ID	Pred. Lag	1/1	2/1	3/1	4/1	5/1	6/1	7/1	8/1	9/1	10/1	11/1	12/1	1/1	2/1	3/1	4/1	5/1	6/1	7/1
			None	94																							
Bridge			Summary Duration	3/28/2017	9/26/2017	90					🟩	🟩	🟩	🟩	🟩	🟩	🟩										
Substructure			Summary Duration	3/28/2017	7/7/2017	56					🟩	🟩	🟩	🟩	🟩												
Superstructure			Summary Duration	8/1/2017	9/26/2017	34										🟩	🟩										
Letting	Letting	1,000	Letting/Award to Start of Construction	1/27/2017	3/28/2017				🟩	🟩	🟩																
Substructure	Project Wide	2,000	Site Preparation and Bridge Removal	3/28/2017	4/6/2017	7	1000				🟩	🟩															
Substructure	N. Abutment	3,010	Abut. 1: Excavation & Temporary Works	4/7/2017	4/11/2017	2	2000					🟩															
Substructure	N. Abutment	3,040	Abut. 1: Footing (Spread/Pile)	4/14/2017	4/20/2017	4	3030					🟩															
Substructure	N. Abutment	3,050	Abut. 1: Construct Stem/Parapet/Backwall (F/P/C)	4/21/2017	4/28/2017	6	3040					🟩															
Substructure	S. Abutment	4,010	Abut. 2: Excavation & Temporary Works	4/21/2017	4/24/2017	2	3040					🟩															
Substructure	S. Abutment	4,040	Abut. 2: Footing (Spread/Pile)	4/25/2017	4/28/2017	4	4030					🟩															
Substructure	S. Abutment	4,050	Abut. 2: Construct Stem (F/P/C)	5/1/2017	5/9/2017	6	4040						🟩														
Substructure	Pier 1	5,010	Pier 1: Excavation & Temporary Works	5/1/2017	5/2/2017	2	4040						🟩														
Substructure	Pier 1	5,040	Pier 1: Construct Footing (F/P/C)	5/11/2017	5/12/2017	2	5030						🟩														
Substructure	Pier 1	5,050	Pier 1: Construct Strut (F/P/C)	5/15/2017	5/25/2017	7	5040						🟩														
Substructure	Pier 1	5,060	Pier 1: Construct Columns (F/P/C)	5/26/2017	6/7/2017	6	5050						🟩	🟩													
Substructure	Pier 1	5,070	Pier 1: Construct Cap (F/P/C)	6/8/2017	6/20/2017	7	5060							🟩													
Substructure	Pier 2	6,010	Pier 2: Excavation & Temporary Works	5/15/2017	5/16/2017	2	5040						🟩														
Substructure	Pier 2	6,040	Pier 2: Construct Footing (F/P/C)	5/25/2017	5/26/2017	2	6030						🟩														
Substructure	Pier 2	6,050	Pier 2: Construct Strut (F/P/C)	5/30/2017	6/12/2017	7	6040						🟩	🟩													
Substructure	Pier 2	6,060	Pier 2 Construct Columns (F/P/C)	6/13/2017	6/21/2017	6	6050							🟩													
Substructure	Pier 2	6,070	Pier 2: Construct Strut, Columns, Cap (F/P/C)	6/22/2017	7/7/2017	7	6060							🟩	🟩												
Procure	Deck	9,000	Girder Fabrication Lead Time	4/7/2017	7/31/2017	60	1000	10				🟩	🟩	🟩	🟩												
Superstructure	Deck	9,010	Set Bridge Girders	8/1/2017	8/2/2017	2	8070									🟩											
Superstructure	Deck	9,020	Bridge Deck: Form and Tie Steel	8/7/2017	8/22/2017	10	9010									🟩											
Superstructure	Deck	9,030	Bridge Deck: Pour & Cure	8/23/2017	8/30/2017	4	9020									🟩											
Superstructure	Deck	9,036	Deck Dtrength Gain Before AP and Barrier	8/23/2017	9/7/2017	9	9034									🟩	🟩										
Superstructure	Deck	9,040	Construct Approach Panels	8/27/2017	9/15/2017	10	9020	4								🟩	🟩										
Superstructure	Deck	9,050	Install Bridge Rail/Walkway	8/27/2017	9/1/2017	2	9020	4								🟩	🟩										
Superstructure	Deck	9,053	Barrier Time to 100% Strength	8/27/2017	9/26/2017	15	9020	4								🟩	🟩										
Superstructure	Deck	9,060	Concrete Wearing Course	9/5/2017	9/14/2017	7	9050										🟩										
Superstructure	Deck	9,070	Bridge Deck Planing	9/15/2017	9/15/2017	1	9060										🟩										
Superstructure	Deck	9,075	Install E8 Joint	9/15/2017	9/19/2017	2	9060										🟩										
Superstructure	Deck	9,080	Open to Traffic	9/26/2017	9/26/2017	1	9060										🟩										

APPENDIX D: CASE STUDY 2 INPUTS - BRIDGE 82873

DEPARTMENT OF TRANSPORTATION

Contract Time Estimation Tool for New Bridge Construction Projects

SUBMIT INPUTS

Light Blue Fields Required	🟦
White Fields For Information Only	☐
Shaded grey - no data required	☐

GENERAL PROJECT DATA	QTY UNIT	QUANTITY	TYPE	FIELD MEASURED DURATION (WHOLE DAYS)
Project Phase	LIST		Final Design	
Bridge Number (T)	TEXT		82873	
SP Number	TEXT		8286-81	
Project Location	HIGHWAY		TH694/TH494	
Letting Date	DATE		10/26/2018	
Start of Construction	DATE		11/28/2018	
Bridge Over	LIST		Roadway	
Structure Placement	LIST		New bridge on alignment	
Workdays per Week for Schedule	LIST		5-Day	
Winter Work (Substructure)	LIST		Yes	
Project Size	DOLLARS	$35,000,000		
Type of Contract (DBB, DB, CMGC)	LIST		DBB	
Specification Year	YEAR		2018	
Number of Stages	NO.	1		
Complexity	LIST		High	
Traffic Conditions	LIST		Heavy	
Permits/ Environmental Restrictions	LIST		No	
Superstructure Type	LIST		PS Beam	
Structure Length	FT	239.0833		
Out to Out Width	FT	62		
Bridge Deck Area	SF	14823.1646		
Number of Spans	EA	2		
Skew (Deg)	DEG.	2.59		
Structural Concrete (Project Total)	CY	1266		
Reinforcement Bars (Project Total)	POUNDS	158480		
Architectural Complexity	LIST		Level 2	
Mass Concrete	LIST		No	
Accelerated Bridge Construction	LIST		Exclude	
Additional Design Comments:				
SUBSTRUCTURE	**QTY UNIT**	**QUANTITY**	**TYPE**	**FIELD MEASURED DURATION**
Total Substructure Construction Time	DAYS			
Site Preparation and Bridge Removal	DAYS	7		
ABUTMENT #1	**QTY UNIT**	**QUANTITY**	**TYPE**	**FIELD MEASURED DURATION**
Abut. 1: Height & Type	LIST	>12 ft	Semi-Integral	
Abut. 1: Excavation & Temporary Works	DAYS	2		
Abut. 1: Pile Splice Required	DAYS / LIST	0	No	
Abut. 1: Drive Test Pile and Setup Time	DAYS	3		
Abut 1: # of Test Pile	EACH	3		
Abut. 1: Drive Pile	LF	2080	CIP	
Abut. 1: Footing	NO. OF POURS	1	Pile	
Abut. 1: Construct Footing (F/P/C)	CY	186		
Abut. 1: Abutment Length along Skew	FT	176.33		
Abut. 1: Stem/ Parapet/Backwall	CY	277		
Abut. 1: Construct Stem/ Parapet/Backwall (F/P/C)	NO. OF POURS	3		
ABUTMENT #2	**QTY UNIT**	**QUANTITY**	**TYPE**	**FIELD MEASURED DURATION**
Abut. 2: Height & Type	LIST	>12 ft	Semi-Integral	
Abut. 2: Excavation & Temporary Works	DAYS	2		
Abut. 2: Pile Splice Required	DAYS / LIST	0	No	
Abut. 2: Drive Test Pile and Setup Time	DAYS	3		
Abut 2: # of Test Pile	EACH	3		
Abut. 2: Drive Pile	LF	2180	CIP	
Abut. 2: Footing	NO. OF POURS	3	Pile	
Abut. 2: Construct Footing (F/P/C)	CY	100		

Abut. 2: Abutment Length along Skew	FT	176.33		
Abut. 2: Stem/ Parapet/Backwall	CY	315		
Abut. 2: Construct Stem/ Parapet/Backwall (F/P/C)	NO. OF POURS	3		

PIER	QTY UNIT	QUANTITY	TYPE	FIELD MEASURED DURATION
Pier 1: Type and Location	LIST	Land	Multi-Column	
Pier 1: Excavation & Temporary Works	DAYS	7		
Pier 1: Pile Splice Required	DAYS / LIST	2	No	
Pier 1: Drive Test Pile and Setup Time	DAYS	3		
Pier 1: # of Test Pile	EACH			
Pier 1: Drive Pile	LF	1135	CIP	
Pier 1: Footing	CY	136	Pile	
Pier 1: Strut	CY	66		
Pier 1: Construct Strut (F/P/C)	NO. OF POURS	1		
Pier 1: Columns	CY	35		
Pier 1: Construct Columns (F/P/C)	NO. OF POURS	2		
Pier 1: Construct Cap	CY	59		
Pier 1: Construct Cap (F/P/C)	NO. OF POURS	1	CIP	
Pier 1 Cap: 70% Strength Gain Time From Pour	DAYS	5		

SUPERSTRUCTURE, DECK AND APPROACH PANEL	QTY UNIT	QUANTITY	TYPE	FIELD MEASURED DURATION
Girder Fabrication Lead Time	WORKING DAYS	40		
Total Number of Beams or Girder Picks	EACH	18	MN45	
Set Bridge Girders	DAYS	3		
Bridge Deck: Form and Tie Steel	SF	14823.1646		
Bridge Deck: Pour & Cure	DAYS			
Bridge Deck: Wait Between Pours	DAYS	0		
Bridge Deck: Cure Time Each Pour	DAYS	7		
Bridge Deck: Placement Time	DAYS	1		
Bridge Deck: Last Placement Begin From 1st Placement	DAYS			
Number of Deck Pours	POURS	1		
Bridge Deck: 65% Strength Gain Time From Pour	DAYS	5		
Bridge Deck: 100% Strength Gain Time From Pour	DAYS	0		
Construct Barriers (F/P/C)	LF	605		
Barriers Hand-Formed	DAYS	3		
Barrier 100% Strength Gain Time	DAYS	15		
Install Anchored Metal Railing	DAYS	0		
Install Bridge Sidewalk/Median (F/P/C)	LF	0		
Construct Approach Panels (F/P/C)	NO. OF POURS	2		
Extra time for Bridge Coatings (SSF or other)	DAYS	1		
Concrete Wearing Course	# OF PASSES	0		
Concrete Wearing Course (F/P/C)	DAYS	0		
Bridge Deck Planing	LIST		No	
Install E8 Joint	DAYS	0		
Total Superstructure Construction Time	DAYS			

EXHIBIT A

DEPARTMENT OF TRANSPORTATION

CONTRACT TIME DETERMINATION GANTT CHART			Project Let Date	**10/26/2018**	**Schedule Summary**	Start	End	Duration Calendar Days	Working Days
	Bridge Number (T)	**82873**	Update Period	**Month**					
	SP Number	**8286-81**	Workdays per Week	**5-Day**	**Predicted Construction Duration**	4/15/2019	10/18/2019	186	107
	Project Location	**TH 694**	Winter Work (Substructure)	**no**					

									'18	'18	'18	'19	'19	'19	'19	'19	'19	'19	'19	'19	'19	'19	'19	'20	'20	'20	'20
Area	Location	Task ID	Task	Start	End	WD Duration	Pred. Task ID	Pred. Lag	10/1	11/1	12/1	1/1	2/1	3/1	4/1	5/1	6/1	7/1	8/1	9/1	10/1	11/1	12/1	1/1	2/1	3/1	4/1
			None	94																							
Bridge			Summary Duration	4/15/2019	10/18/2019	107									🟩	🟩	🟩	🟩	🟩	🟩	🟩						
Substructure			Summary Duration	4/15/2019	8/7/2019	62									🟩	🟩	🟩	🟩	🟩								
Superstructure			Summary Duration	8/8/2019	10/18/2019	45													🟩	🟩	🟩						
Letting	Letting	1,000	Letting/Award to Start of Construction	10/26/2018	12/25/2018				🟩	🟩	🟩																
Substructure	Project Wide	2,000	Site Preparation and Bridge Removal	4/15/2019	4/24/2019	7	1000								🟩												
Substructure	N. Abutment	3,010	Abut. 1: Excavation & Temporary Works	4/25/2019	4/26/2019	2	2000								🟩												
Substructure	N. Abutment	3,040	Abut. 1: Footing (Spread/Pile)	5/13/2019	5/21/2019	6	3030									🟩											
Substructure	N. Abutment	3,050	Abut. 1: Construct Stem/Parapet/Backwall (F/P/C)	5/22/2019	6/21/2019	17	3040									🟩	🟩										
Substructure	S. Abutment	4,010	Abut. 2: Excavation & Temporary Works	5/22/2019	5/23/2019	2	3040									🟩											
Substructure	S. Abutment	4,040	Abut. 2: Footing (Spread/Pile)	5/28/2019	6/6/2019	6	4030									🟩	🟩										
Substructure	S. Abutment	4,050	Abut. 2: Construct Stem (F/P/C)	6/7/2019	7/11/2019	17	4040										🟩	🟩									
Substructure	Pier 1	5,010	Pier 1: Excavation & Temporary Works	6/7/2019	6/13/2019	4	4040										🟩										
Substructure	Pier 1	5,040	Pier 1: Construct Footing (F/P/C)	6/27/2019	6/28/2019	2	5030										🟩										
Substructure	Pier 1	5,050	Pier 1: Construct Strut (F/P/C)	7/1/2019	7/15/2019	7	5040											🟩									
Substructure	Pier 1	5,060	Pier 1: Construct Columns (F/P/C)	7/16/2019	7/25/2019	6	5050											🟩									
Substructure	Pier 1	5,070	Pier 1: Construct Cap (F/P/C)	7/26/2019	8/7/2019	7	5060											🟩	🟩								
Substructure	Pier 2	6,010	Pier 2: Excavation & Temporary Works	7/1/2019	6/28/2019	0	5040											🟩									
Substructure	Pier 2	6,040	Pier 2: Construct Footing (F/P/C)	7/1/2019	6/28/2019	0	6030											🟩									
Substructure	Pier 2	6,050	Pier 2: Construct Strut (F/P/C)	7/1/2019	6/28/2019	0	6040											🟩									
Substructure	Pier 2	6,060	Pier 2 Construct Columns (F/P/C)	7/1/2019	6/28/2019	0	6050											🟩									
Substructure	Pier 2	6,070	Pier 2: Construct Strut, Columns, Cap (F/P/C)	7/1/2019	6/28/2019	0	6060											🟩									
Procure	Deck	9,000	Girder Fabrication Lead Time	4/25/2019	6/21/2019	30	1000	10							🟩	🟩	🟩										
Superstructure	Deck	9,010	Set Bridge Girders	8/8/2019	8/15/2019	5	8070												🟩								
Superstructure	Deck	9,020	Bridge Deck: Form and Tie Steel	8/19/2019	9/18/2019	17	9010												🟩	🟩							
Superstructure	Deck	9,030	Bridge Deck: Pour & Cure	9/19/2019	9/25/2019	4	9020													🟩							
Superstructure	Deck	9,036	Deck Dtrength Gain Before AP and Barrier	9/19/2019	10/2/2019	9	9034													🟩	🟩						
Superstructure	Deck	9,040	Construct Approach Panels	9/23/2019	10/11/2019	10	9020	4												🟩	🟩						
Superstructure	Deck	9,050	Install Bridge Rail/Walkway	9/23/2019	9/27/2019	2	9020	4												🟩							
Superstructure	Deck	9,053	Barrier Time to 100% Strength	9/23/2019	10/18/2019	15	9020	4												🟩	🟩						
Superstructure	Deck	9,060	Concrete Wearing Course	9/30/2019	10/9/2019	7	9050													🟩	🟩						
Superstructure	Deck	9,070	Bridge Deck Planing	10/11/2019	10/11/2019	1	9060														🟩						
Superstructure	Deck	9,075	Install E8 Joint	10/11/2019	10/14/2019	2	9060														🟩						
Superstructure	Deck	9,080	Open to Traffic	10/18/2019	10/18/2019	1	9060														🟩						