Virginia Tech
College of Engineering

VDOT-VT Partnership for Project Scheduling
Charles Edward Via, Jr. Department of
Civil and Environmental Engineering
200 Patton Hall (0105)
Blacksburg, Virginia 24061
540/231-0923 Fax: 540/231-7532
E-mail: scheduling@vt.edu
www.vpps.cee.vt.edu

A Review of State DOT Methods for Determining Contract Times

TR-05-01

A report presented to the Virginia Department of Transportation and the VDOT-VT Partnership for Project Scheduling Advisory Board

March 2005

John C. Hildreth
Virginia Tech

Abstract

The selection of an appropriate contract time has become increasingly important as the portion of resurfacing, restoration, and rehabilitation construction work and the traffic volumes under which this work is performed continues to increase. The methods of 23 state agencies were reviewed to determine how contract times are calculated and the detail of production rate databases. This paper summarizes and presents examples of the methods, databases, and the documents produced.

State DOT Methods for Determining Contract Times

Contract time is the maximum time granted to the contractor to complete all portions of the work described in the contract documents. Selection of a proper contract time has become increasingly important because the portion of resurfacing, restoration, and rehabilitation (3R) construction work and the traffic volumes under which this work is performed continues to increase. Proper selection of contract time also allows optimization of resource allocations and construction engineering costs.

This criticalness of contract times has been recognized across the country. Missouri DOT note in their documented method for contract time determination that insufficient times may:

- Encourage excessive bid prices
- Reduce the number of bids submitted
- Increase the frequency of time overruns and associated claims

while excessive contract times may:

- Subject the traveling public to unnecessary inconvenience and safety concerns
- Encourage contractors to bid more work than can be completed in a timely manner
- Discourage innovative management and/or construction techniques

The *FHWA Guide for Construction Contract Time Determination Procedures* (TA 5080.15) recommends:

1. Establishing production rates and adapting them to project conditions
2. Considering other factors influencing contract time, including traffic maintenance, seasonal limitations, permit acquisitions, shop drawing review, and material procurement
3. Developing a progress schedule in either bar chart or CPM format

State DOT methods are being reviewed to determine how contract times are calculated and the detail of production rate databases. Highway departments in 35 states and the District of Columbia have been contacted and documented methods of 19 departments have been obtained. Additionally, the methods of 4 states have been determined through conversations with DOT representatives. This paper summarizes and presents examples of the methods, databases, and the documents produced.

Methods

Not surprisingly, the format recommended by the FHWA has been widely adopted. A majority of DOTs maintain a database of average production rates or durations based on historical data for typical highway and bridge construction activities. These rates and durations are applied to the quantities of work for a given project to determine the required number of working days for each activity. Some states consider only major work activities and sum the activity durations, while others use the activity durations to build a CPM schedule to determine the total number of working days required for the project. Often the working days are converted to either calendar days or a calendar date. This conversion typically takes into account anticipated work calendars and weather impacts.

Schedule Format

The format of the schedules produced range from spreadsheets to bar charts to CPM diagrams, with some states applying more than one format. Texas DOT has developed spreadsheet templates for smaller projects that include major work activities and the relationships between them for 13 project types. The designer is required to input the quantities and production rates and a bar chart is produced. On larger projects, a CPM is developed making use of the prescribed logic and production rate database.

Spreadsheets

In addition to Texas, South Carolina, Nebraska, and Kentucky use spreadsheets in determining contract time. SCDOT and NDOT consider only major work activities, apply an average production rate, and sum the required working days before factoring the sum for various influences. Kentucky uses spreadsheet templates for 6 project types to calculate activity durations and the results are exported to Microsoft Project for CPM development. A contract time estimate sheet prepared by TxDOT is attached.

Bar Charts

Some states, such as Idaho and West Virginia, use bar charts to depict the project schedule. The activity durations are calculated based on average production rates. The bar charts typically only consider the major work items, but overlapping activities can be considered. An example bar chart from the Idaho Transportation Department is attached.

CPM Schedules

Pennsylvania and Delaware determine contract times from CPM schedules for all projects, while other states develop them only for relatively large projects. However, the methods for developing the schedules differ. PennDOT does not maintain a database of production rates, but rather conducts a scheduling meeting attended by DOT scheduling and design personnel, as well as representatives from affected utilities. Each segment of the work is considered, durations assigned based on anticipated production rates, and logic relationships defined based on the experience of those in attendance. From this information, a CPM is developed.

Delaware, like most other states, makes use of a production rate database to estimate activity durations. Typically, the contract time is set to the length of the critical path. However, Delaware anticipates the number of adverse weather days based on historical data and adds it to the length of the critical path to determine contract time.

Databases

Databases of production rates are maintained in some fashion by nearly every state DOT that has been contacted. While PennDOT does not maintain a published database, it does rely on the knowledge of its personnel, which is an informal experience database.

Most databases are formally developed into table and chart form. The data can be as simple as the number of working days for a given project type and estimated value. Ohio DOT publishes the attached table of average days required to complete a large number of project types of varying values. Similarly, Washington DOT includes the attached chart of project cost versus time in their bridge design manual.

The data typically includes a combination of production rates and durations for many work activities categorized by highway or bridge construction activities and often divided further based on project type. While a number of databases include high and low values, typically an average value is reported. The database description almost always includes explicit language indicating that the data are average values to be used as guides and must be adjusted based on project specific conditions.

Based on the methods reviewed, highway construction activities are described by production rates, bridge construction activities by both production rates and durations, and temporary work and non-work items (e.g. shop drawing review and material procurement) by durations. The table of production rates for highway items from New Jersey DOT is attached as a typical example of production rates and their division by project type.

The relationship between planned quantity and production rate is alluded to by many methods. Typically, average rates will be provided for “small” and “large” quantities. However, in a limited number of instances, the relationship is represented graphically. The Maryland SHA has the most extensive collection of production curves discovered to date, with Florida DOT also making use of curves. A sample of curves published by Maryland is attached.

Schedule Logic

Nearly all of the methods reviewed rely upon the analyst to determine schedule logic for each project. As an exception, Texas and Kentucky use predetermined logic based on project type. Texas considers 13 project types, with a spreadsheet template listing major activities and logic relationships for each. Logic is provided as the preceding activity and percent of it that must be complete to begin the activity. This allows for some concurrency among activities to be included in the resulting bar chart and considered in the contract time. This can be seen on the attached contract time estimate sheet.

Kentucky divides projects into 6 types and provides logic relationships for the major activities. For each activity, the predecessor and relationship (e.g. start-to-start with 3 day lag) are provided. This information allows the data to be exported to and a CPM schedule constructed in MS Project. Contract time is determined from the resulting schedule.

South Carolina, while not providing logic relationships, does consider concurrency among activities through a concurrence factor. This factor generally ranges from 0.6 to 1.0. Only major activities are considered and the durations of all activities are summed and then multiplied by the concurrence factor to determine the contract time. Selection of the factor value is made subjectively by the analyst.

Other reviewed methods either neglect concurrent activities or rely on the analyst to identify and them. Most methods reviewed neglect parallel activities by considering only major activities. Other methods rely on the analyst to identify and subjectively consider simultaneous activities.

Adverse Weather

The delays associated with adverse weather were typically taken into account in the calendar applied to the schedule. Some states consider a set number of workings days per year, for example 150 working days per year for Tennessee and Arkansas. Other states, such as Idaho and Nebraska, assign a different number of working days to each month. The number of available working days varies based on type of work (e.g. highway or bridge construction) and location in some methods. Missouri publishes tables of working days per month by project type for various regions of the state. Washington DOT determines the average number of working days per month based on data from the National Weather Service.

Some states determine the number of working days required and increase that number in some manner to account for weather. WVDOT arbitrarily adds 20 percent to the number of working days to account for weather, while Delaware considers historical weather data. The number of adverse weather days is predicted based on NOAA Climatic History data and added to the number of calendar days required to complete the work to determine the contract time.

Interestingly, PennDOT does not give specific consideration to weather in the schedules developed. Rather, it is assumed to be accounted for in the production rates applied to the project.

Other Factors Considered

A majority of the methods reviewed indicated that the analyst should consider the conditions specific to the project and make subjective adjustments as necessary. These adjustments may be made to the production rates or to the total time calculated to complete the work. The list of factors most commonly recommended for consideration include project location, traffic conditions, utility relocation, anticipated working schedule (e.g. nighttime or weekend work), material acquisition, permit application processes, and submittal review time.

NJDOT also provides production rate factors applied when schedules are accelerated by the contractor. A factor of 1.2 is applied when multiple crews or overtime work is anticipated. Factors of 1.25 and 1.33 are applied when contract provisions include A+B and I/D, respectively.

TxDOT uses factors to reduce production rates based on location, traffic conditions, complexity, soil conditions, and quantity of work. For each major work activity, 2 sensitivity factors are identified and the production rate adjusted. The factors range from a low of 0.65 to a high of 1.0, such that the rates are only reduced by the adjustment.

Summary

The need for appropriate contract times associated with highway construction projects has increased due to increases in reconstruction work and volumes of traffic affected by the work. State DOTs are required by federal law to have an approved method for determining contract time. The FHWA publishes guidelines in this regard recommending that production rate databases are maintained, project schedules are constructed in either bar chart or CPM format, and project specific factors are considered in determining the contract time.

A large majority of the DOT methods reviewed appear to be directly based on these recommendations. The basis for activity durations is developed from databases of average production rates and durations, almost without exception. Adjustments are made to the production rates or resulting activity durations to account for project conditions. The contract time is determined from either a bar chart or the result of CPM calculations and may be adjusted for anticipated weather conditions.

CONTRACT TIME ESTIMATE SHEET

ABILENE AREA OFFICE - 102 E. COLLEGE DRIVE ABILENE, TEXAS 79601
(915) 676-6930 / Fax # (915) 676-6933

CSJ NUMBER 0033-06-094
Date: 3/15/2001

PROJECT INFORMATION

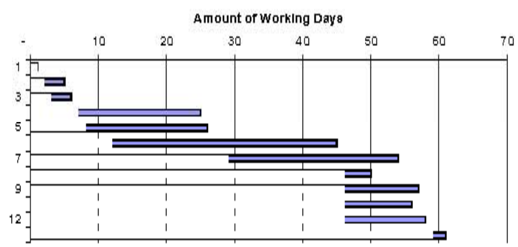
Descriptior FOR THE CONSTRUCTION OF DRIVEWAYS AND CONCRETE CURB AND GUTTER ON FRONTAGE ROADS.
County TAYLOR Project # CD 33-6-94 Highway # US 83
Designer/T SCOTT DARROW

Area Engineer
PAUL HOELSCHER, P.E.
Phone / FAX #
(915)676-6930 Fax#(915)676-6933
Address
102 E. COLLEGE DRIVE, ABILENE, TX 79601

Length of Project

TX Ref. Mark 328 - 1.151 km TO 329 + 0.127 km   Sta. to Sta 8+488.631 TO 11+385.637

ID #'s	Work Description	Quantity	Units	Daily Production rate	Units	Duration of working days	Preceeding Activity's ID#'s & Percent Complete Req'd		Start Day	Finish Day
							Id#	%		
1	PLACE ALL SIGNS AND BARRICADES	1	LS	1	LS	1			1	1
2	PLANE ASPH CONC PAV (0-100MM)	10394	M2	3000	M2	4	1	100	2	5
3	EXCAVATION (SPECIAL)	7326	M3	2000	M3	4	2	25	3	6
4	CONC CURB & GUTTER (TY II)	3791	M	200	M	19	3	100	7	25
5	CEM STABIL BKFL	119	M3	10	M3	12	4	25	8	26
6	DRIVEWAYS	3369	M2	100	M2	34	4	25	12	45
7	COLORIZED TEXTURIZED CONCRETE (125MM)	3825	M2	150	M2	26	6	50	29	54
8	CONCRETE SIDEWALK (WHEELCHAIR RAMP)	208	M2	50	M2	5	6	100	46	50
9	ASPH CONC	559.9	MGR	50	MGR	12	6	100	46	57
11	FURN AND PLAC TPSL (CL-2)(100MM)	15573	M2	1500	M2	11	6	100	46	56
12	BLOCK SOD (PRAIRIE BUFFALO)	15573	M2	1200	M2	13	6	100	46	58
13	CLEANUP	1	LS	0.334	LS	3	12	100	59	61



*All time calculations are in accordance with Txdot Administrative Circular No. 17-93 Dated 7-7-93
**Working Months are calculated utilizing a 18 Working Day Month

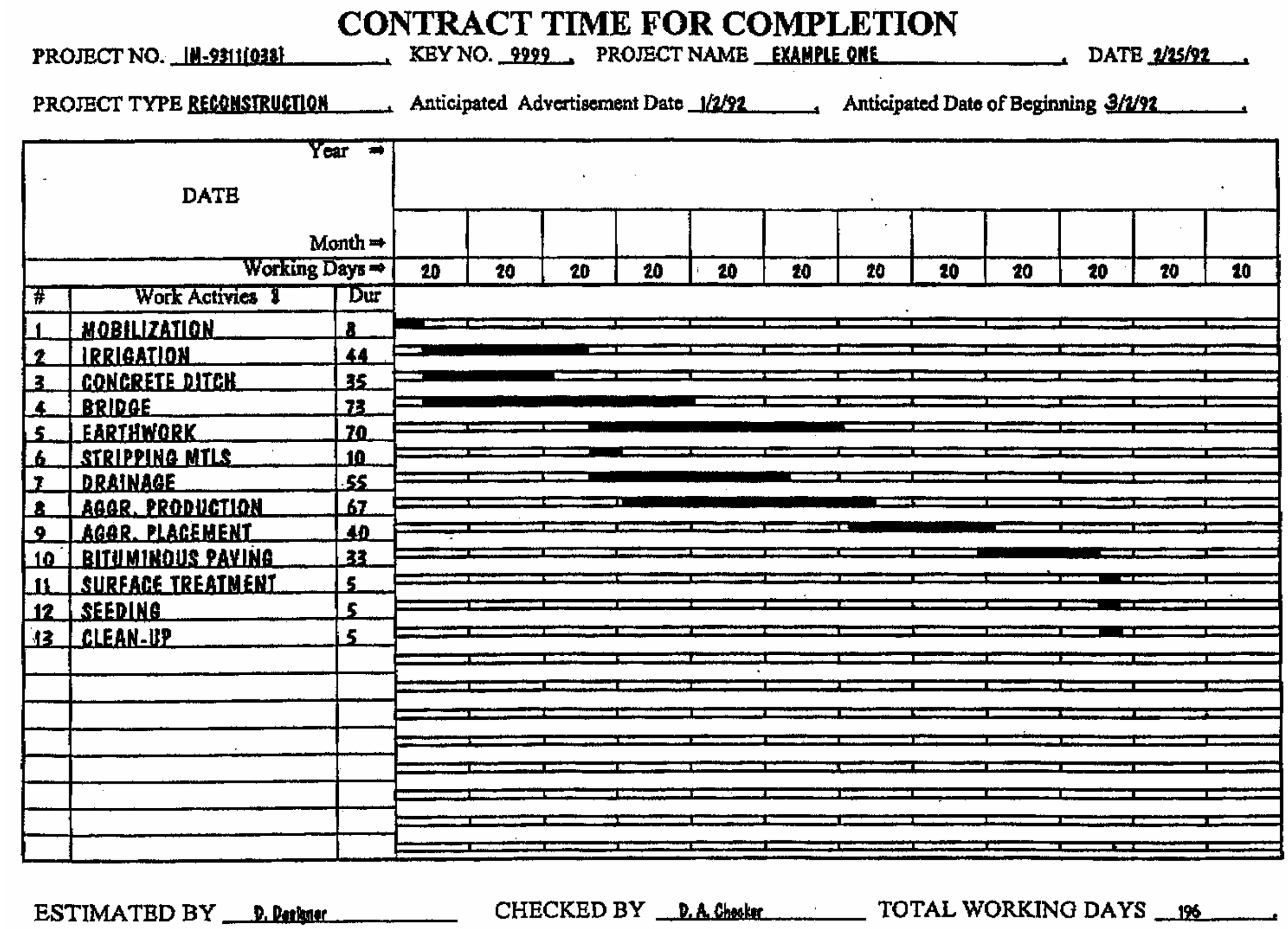
*Total Contract Days 68
**Total Working Months 4

Notes/Remarks

Time Estimate shown is for Design Purposes only

Office Use Only

Figure 1: Texas DOT Worksheet



CONTRACT TIME FOR COMPLETION

PROJECT NO. IM-9311(038) , KEY NO. 9999 , PROJECT NAME EXAMPLE ONE , DATE 2/25/92

PROJECT TYPE RECONSTRUCTION , Anticipated Advertisement Date 1/2/92 , Anticipated Date of Beginning 3/2/92

DATE — Year ⇒ / Month ⇒

Working Days ⇒ 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20

#	Work Activies	Dur
1	MOBILIZATION	8
2	IRRIGATION	44
3	CONCRETE DITCH	35
4	BRIDGE	73
5	EARTHWORK	70
6	STRIPPING MTLS	10
7	DRAINAGE	55
8	AGGR. PRODUCTION	67
9	AGGR. PLACEMENT	40
10	BITUMINOUS PAVING	33
11	SURFACE TREATMENT	5
12	SEEDING	5
13	CLEAN-UP	5

ESTIMATED BY D. Designer CHECKED BY D. A. Checker TOTAL WORKING DAYS 196

Figure 2: Idaho DOT Bar Chart

Average Time in Days to Complete Projects by Ellis Type

Primary Work Category	0 - $500k	$500k-$2M	$2M-$10M	>$10M
Add Sidewalks	121	410		
Attenuator Upgrade	88			
Bikeways	106	639	545	
Bridge Cleaning	90			
Bridge Maintenance	32	15		
Bridge Painting	81	284		
Bridge Repair	96	281	544	1109
Bridge Replacement	122	294	591	902
Building Demolition	134	418		
Buildings - Mix Shed,etc.	39			
Catch basins	240			
Chip Seal	29			
Cleaning/Sweeping Highways	73			
Construct Retro-Fit Noise barrier			730	
Construct Steel Building	44			
Crack Seal	56			
Create Wetlands	683	1759		
Culvert Construction/Reconstr/Repair	85	211		
Debris Removal	152			
Delineation	108			
Ditch Layover	95			
Drainage Improvement			138	
Earthwork	104			
Electrical Maintenance	333			
Facility Renovation	151			
Fairgrounds & Exposition Center	82			
Fencing	527			
Guardrail Rebuilding	276	329		
Herbicidal Spraying	77			
Interchange, New			457	1215
Interchange, Reconstruction			556	
Intersection	183	171	442	
Intersection Improvement	179	203	434	
Interstate Reference Markers	87			
Landscaping	295	444		
Lighting	325	752		
Loop Detector Repair	641	713		
Maint - Resurfacing Runways		510		
Major Reconstruction	133	346	524	1064
Major Widening	106	360	719	996
Mill and Fill	43	243	365	
Minor Rehabilitation - Pavement	36	148	300	694
Minor Widening	103	286	561	
Misc. Traffic Cont.	117	682		
Mitigation Banking	5			
Mowing	462	200		
New Bridge		444	777	
New Construction	104		764	1025

Figure 3: Ohio DOT Time Estimate Table

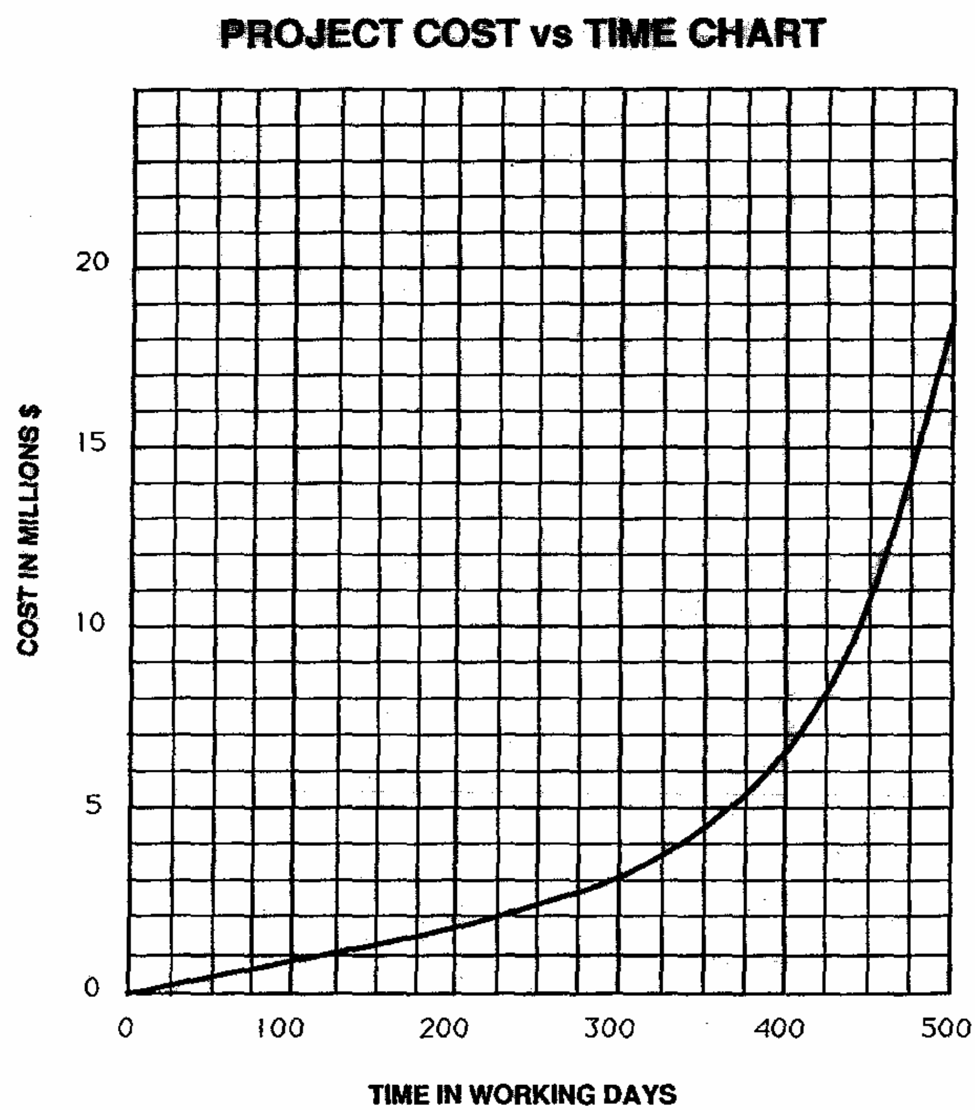


Figure 4: Washington DOT Bridge Estimate Chart

G. VI.a TABLE A (ENGLISH)
CONTRACTOR'S PRODUCTION RATES FOR ROADWAY ITEMS

ITEM	Type 1 Construction	Type 2 Reconstruction	Type 3 Widening	Type 4 Resurfacing	Type 5 Intersections
Mobilization	10 Days*	10 Days*	5 Days	2 Days	2 Days
Clearing Site Including Stripping	4 Acres	4 Acres	4 Acres	N/A	N/A
Removal of Vertical Curb	N/A	1000 LF	700 LF	400 LF	400 LF
Demolition of Buildings	1 Unit	1 Unit	1 Unit	N/A	N/A
Pest Control	10 Days	10 Days	10 Days	N/A	N/A
Asbestos Clean-up					
Resident and Small Commercial	4 Days	4 Days	4 Days	N/A	N/A
Large Commercial	10 Days	10 Days	10 Days		
Removal of Bituminous Concrete Overlay	N/A	2500 SY	2500 SY	2500 SY	300 SY
Roadway Excavation Embankment	3000 CY	1000 CY	1000 CY	N/A	N/A
Wet Excavation	1500 CY	350 CY	350 CY	N/A	N/A
Drainage Pipe Includes 1 Structure					
36 inches and Smaller	300 LF	150 LF	150 LF	N/A	150 LF
Larger than 36 inches	100 LF	60 LF	60 LF	N/A	60 LF
Reset Castings	N/A	5 Units	5 Units	5 Units	5 Units
Extension Frames and Rings	N/A	12 Units	12 Units	12 Units	12 Units
Subbase	350 CY	250 CY	150 CY	N/A	50 CY
Aggregate Base Course	350 CY	250 CY	150 CY	N/A	50 CY
Bituminous Concrete Base or Surface Course	1500 TONS	1000 TONS	750 TONS	1300 TONS	250 TONS
Portland Cement Concrete Base or Surface Course	2500 SY	1000 SY	750 SY	N/A	225 SY

Note: Production Rates are based on 8-hour working day per crew.
TYPE 1 = New construction, additions or major reconstruction of divided or undivided highways.
TYPE 2 = Reconstruction or upgrading existing highways.
TYPE 3 = Widening (less than one lane) and resurfacing existing highways.
TYPE 4 = Resurfacing existing highways with bituminous concrete.
TYPE 5 = Minor construction or reconstruction of street or highway intersections.

* = Use 20 days when $20 million or higher.

32

Figure 5: New Jersey DOT Production Rates

2.2. Excavation

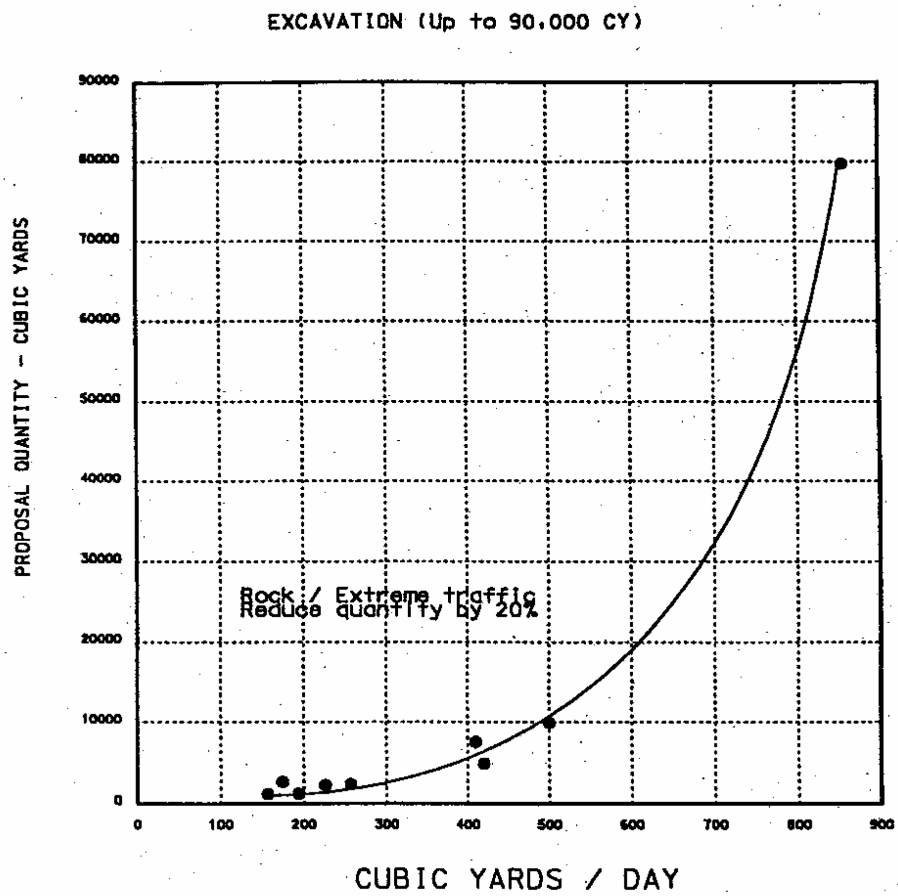


Figure 6: Maryland SHA Production Rate Curve for Excavation less than 90k cy

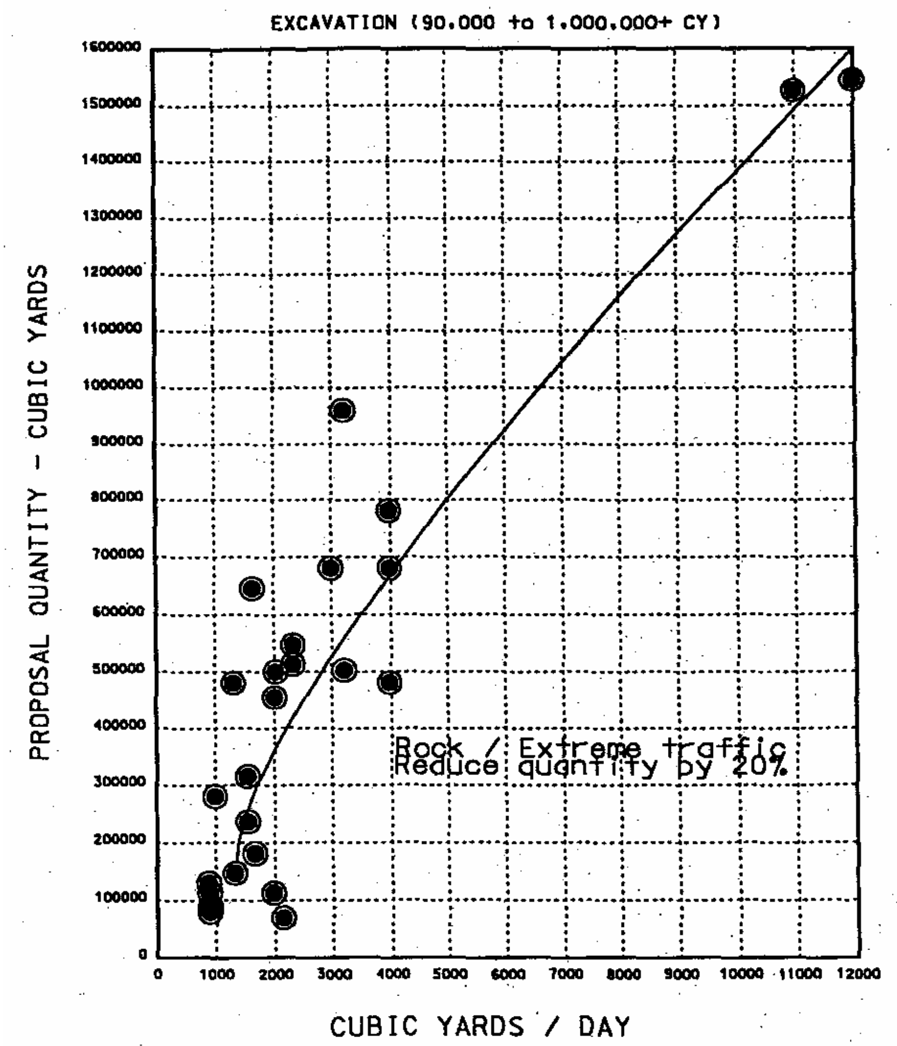


Figure 7: Maryland SHA Production Rate Curve for Excavation greater than 90k cy

2.4. Pile Driving

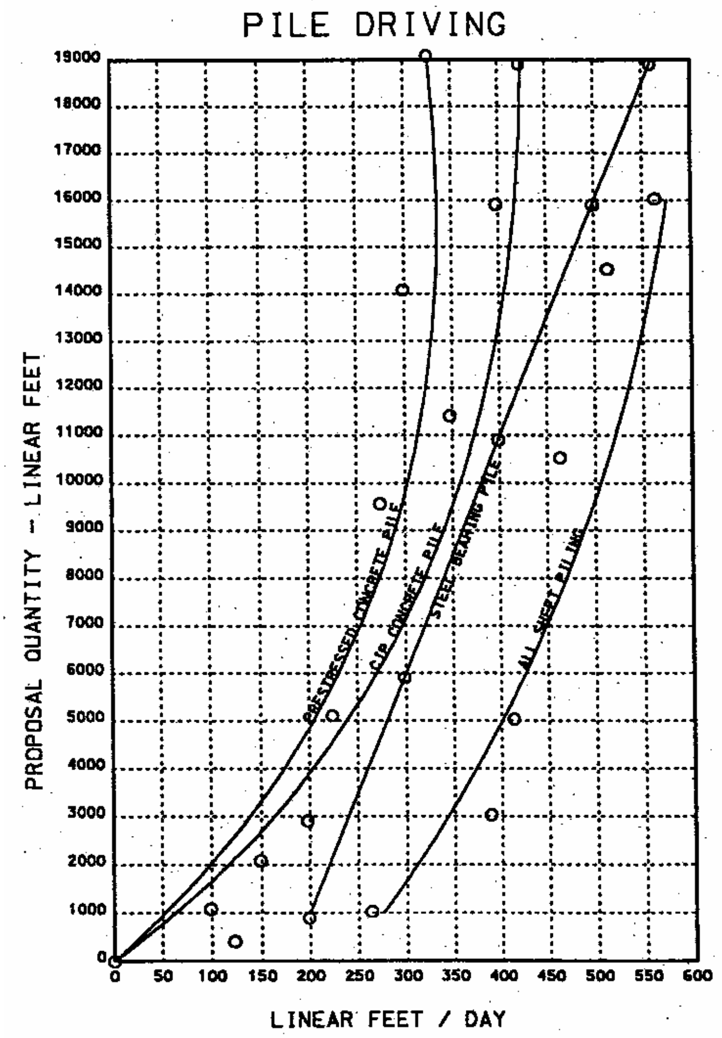


Figure 8: Maryland SHA Pile Driving Production Curves