6. L.M. Nelson. A Practical Road Improvement Pro-
gram. Public Works, Vol. 102, No. 9, Sept. 1971,
pp. 98-99, 134.
7. C.V. Zegeer and R.L. Rizenbergs. Priority Pro-
gramming for Highway Reconstruction. In Trans-
portation Research Record 698, TRB, National Re-
search Council, Washington, D.C., 1979, pp.
15-23.

8. C.V. Zegeer and R.L. Rizenbergs. Iowa Rural Sec-
ondary Road Mileage: As of January 1, 1982.
Planning and Research Division, Iowa Department
of Transportation, Des Moines, 1982.

A System for Forecasting and Monitoring Cash Flow as an Aid to Rational Financial Planning

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ABSTRACT

The research on which this paper is based was performed as part of a study to
develop an improved system for generating a 2-year forecast of monthly cash
flows for the Virginia Department of Highways and Transportation. It revealed
that current techniques used by the department to forecast right-of-way pay-
ments; salaries and wages; and allocations to cities, counties, other state
agencies, and transit properties require no change. On the other hand, it
showed that forecasts of expenditures on materials, supplies and equipment, and
maintenance contracts have overestimated actual cash outlays by significant
margins. In addition, this research revealed that success in forecasting fed-
eral revenue reimbursements is, at best, likely to be spotty and that fore-
casts typically will be overly optimistic. For state revenues, official fore-
casts approved by the Office of the Secretary of Transportation of Virginia
serve as the basis of the official cash forecast; nevertheless a technique is
proposed for early identification of significant changes in state revenue col-
lections. The use of techniques derived from this research in a December 1983
forecast of cash flows for January through July 1984 showed that the estimated
cash balance for the end of the period was within $4 million of the actual bal-
ance. As of August 1985 the forecast was within $11 million of the actual bal-
ance. Among the major recommendations is that it may be reasonable to establish
cash balances at contingency levels consistent with the expected excess of ex-
penditures over revenues for the months of July through October.

Methods for forecasting and managing cash flow are
well established in the private sector where inade-
quate cash balances can mean bankruptcy and exces-
sive balances can result in forgone business oppor-
tunities. In the public sector, until fairly
recently there was less perceived need for close
forecasting and monitoring of cash flow. However,
during the past several years, revenues for most

transportation departments have become volatile and
unpredictable, and construction expenditures have
been subject to unprecedented rates of inflation.
During such periods, a public works agency such as
the Virginia Department of Highways and Transporta-
tion (VDHT) runs a serious risk of encountering in-
appropriate cash balance levels in carrying out its
construction and maintenance program.

This risk can be minimized by (a) maintaining
large cash balances that divert funds from current
needs or (b) developing and using reliable manage-
ment tools for short-term forecasting and monitoring

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of cash inflows and outflows. From the standpoint of sound public finance principles, the latter alternative is preferred. However, comparisons made of the cash balances that were forecast in July 1983 and the balances that actually occurred show a consistent tendency to underestimate cash balances over the forecast period. This stems from underestimates of revenues, overestimates of total expenditures, or offsetting errors in estimates of federal aid and state revenues. For example, the forecast for the period from May to September 1983 overestimated federal aid by $28.1 million, underestimated state revenue by $28.5 million, and overestimated total outlays by $62.0 million. From October 1983 through June 1984, this July 1983 forecast overestimated federal aid by $53.8 million, underestimated state revenue by $44.3 million, and overestimated total outlays by $71.6 million.

PURPOSE AND SCOPE OF STUDY

A major objective of the study was to develop an improved system for forecasting, monitoring, and managing cash flow over the short run. An equally important objective was to provide guidelines for estimating and establishing reasonable minimum cash balances for contingency purposes. A third objective was to create a heightened awareness on the part of both management and the staff responsible for the programming, scheduling, and advertisement of construction projects that an improved cash flow forecast can be a significant aid in implementing the construction program.

In this paper are described the techniques proposed for forecasting monthly variations in state revenue collections; federal aid reimbursements; contract maintenance payout; expenditures on materials, supplies, wages, equipment, and right-of-way; and payments to localities, state agencies, transit properties, and contract consultants. Also described is the performance of the contract construction payout forecasting technique implemented by the VDHT as a result of earlier work (1).

STUDY APPROACH

The forecasting techniques proposed in this paper are based on an examination of the historical pattern exhibited by each line item in the VDHT's Revenue, Expenditures, and Cash Balances Report. For most revenue and expenditure items, 52 months of data were collected. Each line item was subjected to at least two kinds of tests. First, the estimate of total payout was examined to determine its stability as a percentage of a major line item, such as total state revenue, in the department's budget. Second, the U.S. Department of Commerce, Bureau of Economic Analysis's Seasonal Adjustment Program (2) was used to test the monthly variations for a stable seasonal pattern and to estimate monthly distribution factors that would accurately mirror seasonal payout variations. In addition, regression analysis was used to test the accuracy of previously used techniques for forecasting monthly variations in state revenue and federal aid reimbursements.

The technique for forecasting contract construction payout alluded to in this paper is described fully elsewhere (1).

FORECASTING MONTHLY VARIATIONS IN REVENUE

State Revenue

Performance of Current Technique

The official forecast of revenues that comprise the Highway Construction and Maintenance Fund is issued through the Office of the Secretary of Transportation of the commonwealth and is based on estimates of the major revenue sources prepared by the Division of Motor Vehicles and the Corporation Commission.

Estimates of monthly revenue collections for the cash forecast have historically been calculated by multiplying the percentage of annual revenue that has, on average, been collected for each month by the official estimate of total revenue. This forecasting technique has two sources of error: (a) errors in the official forecast of total revenue and (b) errors in the estimates of the monthly percentages that are applied to the forecast. The reader should note that even if seasonality (monthly percentages of collections) is perfectly forecast, a 24-month cash forecast can be no more accurate than the official forecast.

Statistical analysis was used to examine the accuracy of the estimates of monthly variations in revenue based on applying the department's seasonal distribution factors to the official forecast. The results showed that a March 1982 forecast of revenue flows for the following 20 months explained only 47 percent of the variation in actual collections. The standard error was $7.5 million per month. Using official updates of the original forecast throughout the period improved performance somewhat, but the standard error remained high at $5.03 million per month. With the official updates, 77 percent of the monthly variation was tracked by the forecast.

Proposed Improvements

Potential improvements in the revenue flow forecast were examined from the standpoint of the two sources of error noted in the previous section—the seasonality of the collections and the aggregate forecast.

Monthly variations in the revenue collection pattern were examined for stable seasonality by applying the Bureau of Labor Statistics (BLS) seasonal adjustment and analytical software program to a data set consisting of 48 months of state revenue receipts. The analysis revealed a highly stable seasonal collection pattern, and the seasonally adjusted monthly factors estimated using the BLS technique differed somewhat from the factors used by the VDHT Budget Division. These seasonally adjusted distribution factors are given in Table 1.

TABLE 1 Seasonal Factors for
State Revenue and Contract
Maintenance

Month	Revenue	Maintenance
January	0.0785	0.017
February	0.0845	0.012
March	0.0995	0.004
April	0.0816	0.005
May	0.0909	0.023
June	0.1119	0.103
July	0.0521	0.124
August	0.0795	0.168
September	0.0828	0.168
October	0.0862	0.169
November	0.0795	0.147
December	0.0731	0.061

Note: Factors are based on 48 months of data.

With respect to the aggregate estimate of revenue to which the seasonal factors are applied, the law requires that the official forecast serve as the basis for the department's budget and as the basis of geographic allocations. Nevertheless, for contingency planning in the context of the programming,

scheduling, and advertisement of construction projects, some effort should be made to determine the extent to which the near-term official revenue forecast is likely to target actual revenue collections. Such an effort would give an early test, in the current fiscal year, of the reliability of the official forecast that has been made for the following fiscal year in advance of official updates, which typically are made as often as quarterly. A technique that is well suited to such an early testing effort is based on the finding that actual state revenue collections in the third quarter of a fiscal year (January, February, and March) exhibit a highly stable proportion of actual collections in the following fiscal year. Since FY 1978 this proportion has averaged 24.835 percent and its standard error has been 1.02 percent.

Results from applying this test technique as a planning tool show that over the 7 fiscal years beginning in 1978, the estimation error averaged 2.85 percent of actual collections. The underestimates averaged from $580,000 to $2.0 million per month, and the overestimates from $1.0 million to $2.4 million per month. For the last 3 fiscal years for which official forecasts from the Secretary's Office of the VDHT are readily available, that error averaged 6.5 percent of actual collections, was an overestimate in FY 1982 ($37.5 million), an underestimate in FY 1983 ($16.7 million), and an underestimate in FY 1984 ($63.6 million) even though the FY 1982 forecast was revised in February 1982, the FY 1983 forecast was revised in September 1982 and April 1983, and the FY 1984 forecast was revised in December 1983 and April 1984.

Clearly, official forecasts need to be updated; but, just as clearly, contingency planning in the form of early tests of the potential of actual revenue being significantly different from the official forecast is a prudent contingency planning exercise. In this context it is interesting to note that an FY 1985 forecast of state revenue based on collections in January through March of 1984 (the new contingency planning technique) yielded an estimate of $728.0 million. The official forecast updated in March 1984 was $709.1 million. It was updated again in August 1984 to $723.772 million, an amount only slightly less than the estimate yielded by the third-quarter collections technique.

Multiple regression and correlation analyses were employed on a data set consisting of the latest 24 months' revenues as a way of testing the forecasting accuracy that can be expected from the application of the monthly distribution factors derived from the BLS seasonal adjustment program to aggregate revenue estimates derived from both the official forecasts (including updates) and the third-quarter collections technique. The results are noted in the items that follow.

1. Using the monthly factors employed by the VDHT Budget Division and the updates to the official forecasts during the 24-month test period, monthly estimates explained 84 percent of the variation in actual collections and had a standard error of $4.32 million per month. The cumulative error was $25.4 million and this was exhibited for much of the period. It should also be noted that this degree of accuracy was afforded only by frequent updates of the official forecast.

2. Using the seasonally adjusted distribution factors derived in this work applied to a forecast based on third-quarter collections, monthly estimates were within 1 percent of actual collections, explained 84 percent of the monthly variation, and exhibited a standard error of $3.75 million per month. The cumulative error was $15.0 million but was removed in 4 months and remained under $5.0 million for the balance of the test period.

3. Even if the aggregate forecast is perfect, the standard error of estimated monthly collections can be, at best, in the neighborhood of $3.67 million per month.

Forecast Employing Proposed Techniques

In this section is presented a comparison of actual collections for January to July 1984 with the results of forecasting state revenues by the techniques available to the budget division before December 1983 and under the third-quarter forecasting technique using seasonally adjusted monthly factors. For purposes of identification, the techniques in use by the VDHT Budget Division have been denoted by "23 MNTH.," a name taken from the department's previous 23-month construction payout forecasting method. The proposed techniques are labeled "MNTH. FACTORS," representing a monthly factors distribution technique. When examining Figures 1 and 2, the reader should note that the forecast could have been prepared as early as April 1983, 9 months before the beginning of the forecast period and 8 months before the last official forecast revision before the beginning of the forecast period.

Notwithstanding that the official forecast was revised in December 1983, Figures 1 and 2 show that the proposed techniques perform much better than the 23-month payout. Over the 7-month period, the 23-month technique consistently underestimated monthly revenue. Errors ranged from $2.0 million to $22.7 million. The monthly factors forecast error ranged from $0.7 million to $6.3 million.

Federal Aid Reimbursements

Recent Forecast Performance

Forecasting federal aid reimbursements has been and likely will continue to be among the most difficult tasks of the monthly cash flow estimation process. The budget division forecast for April 1982 through December 1983 captured only 5 percent of the monthly variation in federal aid reimbursements and exhibited a cumulative overestimation error in excess of $100.0 million. That forecast was based on an estimate of aggregate construction payout in the federal aid category, an assumed average federal participation rate, and a 1-month lag between payout and reimbursement. The overly optimistic reimbursement forecast can be traced to the inaccuracy of the contract construction forecast technique that was in use in 1982 (1).

In January 1984, the budget division implemented a new contract construction payout forecasting technique as a result of work completed in an earlier phase of this study (1). Concurrently, a new federal aid forecasting technique was implemented. Because federal aid reimbursements are a direct function of the federal aid portion of the construction program, the current forecast is estimated as the multiplicative product of the expected monthly payout for each construction contract and its specific participation rate summed over all federal aid projects. Reimbursements are estimated to lag payout by 1 month. Figure 3 shows the performance of the new forecasting technique implemented in January 1984. In comparison with the 23-month payout technique used before that time, the monthly factors model appears to perform well. For the first 7 months of 1984, the cumulative error in the new forecast was $13.0 million. The error using the former technique was $49.7 million. Through September 1984 these cumulative overestimates had grown to $30.7 million for the new technique and $85.6 million for the former method.
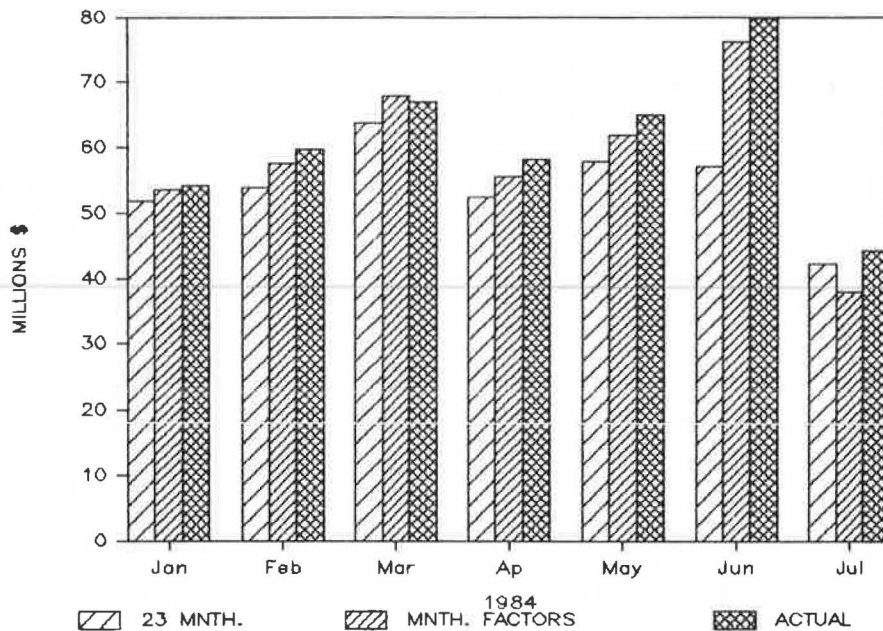
FIGURE 1 Estimated state revenue, January 1984.

Notwithstanding that errors that result from the monthly factors technique are likely to be significantly smaller than those under the formerly used 23-month payout model, the tendency of the forecast to consistently overestimate actual reimbursements is not desirable should it be found to persist. It is quite reasonable to hypothesize that the difficulty in estimating reimbursements stems largely from the fact that the lag structure, which typically applies to federal aid receipts (around 39 days), is made significantly longer and highly variable by reimbursements that fall into three "adjustment" categories: (a) charges to projects for which no federal aid agreement exists, such as advance construction; (b) charges the appropriateness of which has been questioned by the FHWA and for which the VDHT has returned federal funds while the matter is reviewed; and (c) cost overruns not covered by an existing federal aid agreement and for which a modified agreement must be negotiated. When a charge falls into one of these categories, several months to several years may elapse before reimbursement is received. The best information available to the author indicates that as much as $15.0 million to $20.0 million falls into the cost overrun category at any point in time and that much of this money is not reimbursed until the final FHWA audit 2 years after project completion.
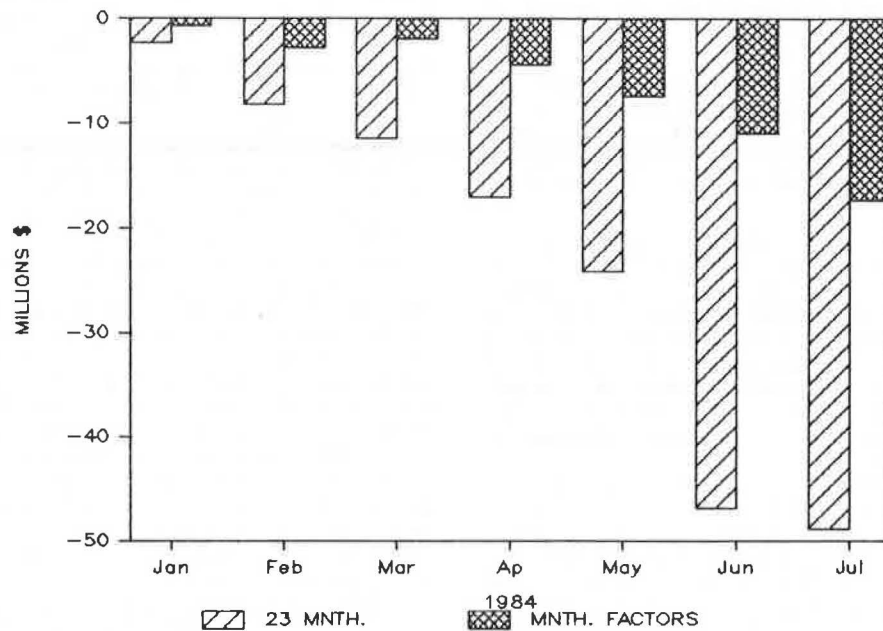

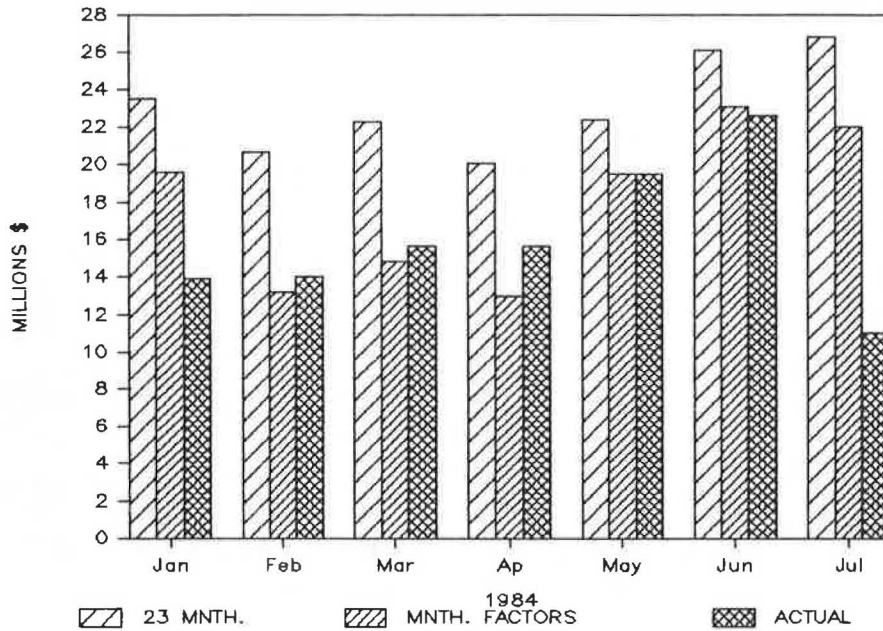FIGURE 2 Cumulative state revenue error, January 1984.

FIGURE 3   Estimated federal aid, January 1984.

Proposed Improvements

Consistent overestimation is an undesirable characteristic of the federal aid forecast. Two alternatives are proposed here as avenues for correcting this tendency. The first relates to the currently used monthly factors technique and the second to a technique based on federal aid apportionments.

Logic strongly suggests that the monthly factors technique currently being used by the VDHT Budget Division (1) should produce an accurate forecast. Nevertheless, the tendency of the technique to overestimate might be corrected somewhat by two adjustments. The first relates to cost overruns. In the monthly factors construction payout technique developed in the first phase of this study, disbursements are based on a final contract estimate that includes an estimate of cost overruns. Because cost overruns are typically not part of negotiated federal aid agreements, the federal aid monthly factors model should be adjusted so that contract participation rates are multiplied by a contract estimate that excludes the estimate of cost overruns. The second adjustment relates to those instances in which the VDHT initiates and designates a construction project as a federal aid participating project in advance of the approval of a negotiated federal agreement. Such projects should be included in the estimation pool for federal aid reimbursement only after the negotiated agreement has been approved.

A second technique that offers potential for improving the federal aid forecast should be employed in addition to the monthly factors technique now in use until the latter can be tested over a longer period of time. This technique is predicated on the assumption that the VDHT will continue to obligate all available federal aid and on the recognition that reimbursements received in a particular fiscal year stem from apportionments and obligation authority spanning 5 years (3). This trickle of reimbursements begins with the apportionment announcement and ends 4 or 5 years later when the last charges to a construction project have been submitted, approved, and reimbursed. The proposed technique consists of the following steps:

1. Reimbursement in each month is assumed to consist of a seasonally stable percentage of the apportionment in the current and previous 4 fiscal years.

2. Monthly distribution factors are derived by applying the BLS statistical package (2) to a data set consisting of actual federal aid reimbursements. Because reimbursement in a particular month is comprised of obligation authority available over a 5-year period, the estimated monthly factors are divided by 5. The resulting factors are given in Table 2.

3. Preliminary estimates of monthly federal aid for a particular year are derived by summing the apportionment bundles for that year and the previous 4 fiscal years and multiplying the sum by the factor given in Table 2 for the month in question.

TABLE 2   Monthly Factors for 5-Year
Federal Aid Reimbursement Estimation

Month	Factor	Month	Factor
October	0.0272	April	0.0168
November	0.0208	May	0.0148
December	0.0184	June	0.0192
January	0.0160	July	0.0198
February	0.0120	August	0.0110
March	0.0102	September	0.0138

4. Final monthly estimates of federal aid are derived by using the equation:

$$\text{Final estimate} = 1.06 \text{ (preliminary estimate)} - 5.18$$

This equation was developed with the aid of multiple regression analysis, explains 67 percent of the variation in monthly federal aid for the 28-month period beginning in November 1981, and has a standard regression error of $3.51 million per month.
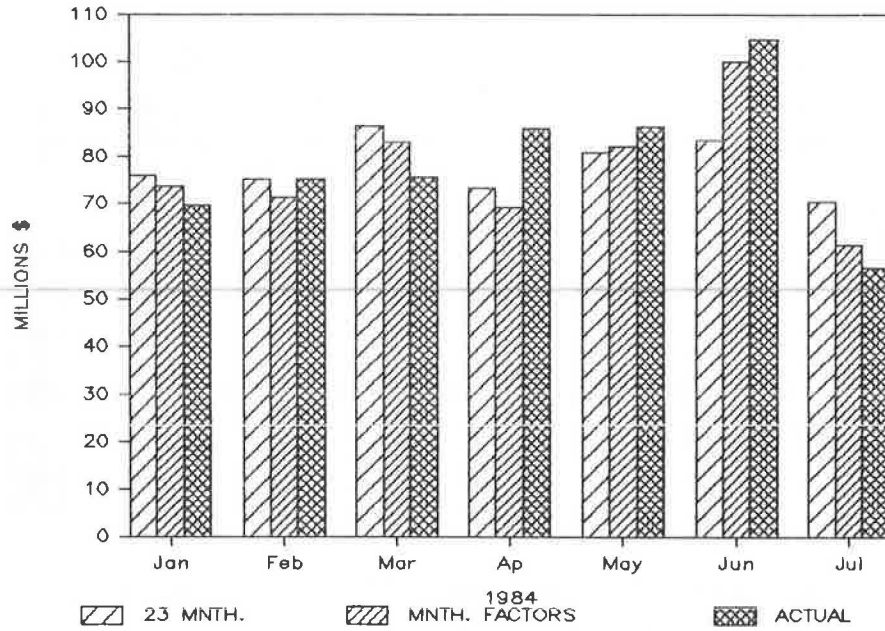
Employing Steps 1 through 4 results in a forecast

FIGURE 4 Estimated total revenue, January 1984.

for January through September 1984 that cumulatively underestimates federal aid collections by $7.9 million.

Total Revenues

The results of using the techniques proposed for forecasting state revenue and federal aid are shown in Figure 4. The errors in estimating total revenues are much smaller under the proposed techniques than under techniques used by the VDHT before December 1983. The average error for the previously used techniques is $10.11 million with a standard error of $6.84 million per month. Under the proposed tech-

niques, the average error is $6.56 million with a standard error of $4.6 million per month.

FORECASTING CONTRACT CONSTRUCTION

As a result of an earlier phase of this study (1), the VDHT Budget Division implemented a new forecasting technique for estimating contract construction payouts. This technique, called the "monthly factors model," has been the basis of the construction payout forecast since January 1984 and has performed extremely well.

Performance of the forecast is shown in Figure 5. Through July 1984, the monthly factors model over-
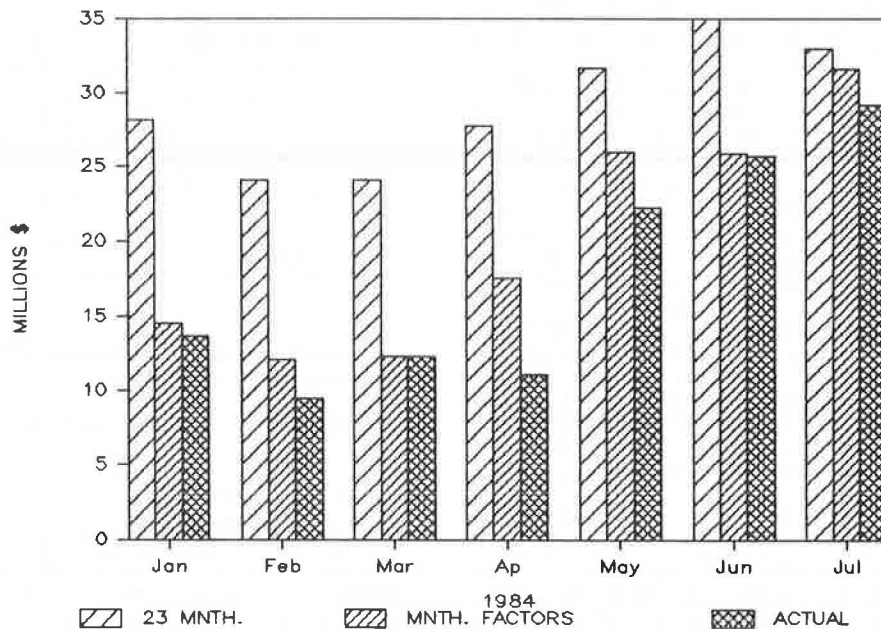

FIGURE 5 Estimated construction, January 1984.

estimated payout by an average of $2.31 million per month. The standard error was $2.25 million and the cumulative error $16.2 million. The technique used previously overestimated actual payout by $11.46 million per month and resulted in a cumulative over-estimate of $80.2 million. As of the end of September 1985, the monthly factors model showed a cumulative error of $13.2 million. Clearly, the monthly factors model is exhibiting excellent performance.

FORECASTING PAYMENTS TO LOCALITIES, OTHER AGENCIES, AND TRANSIT PROPERTIES AND EXPENDITURES ON SALARIES, WAGES, EQUIPMENT, AND RIGHT-OF-WAY

The budget division forecasts for a number of line items in the cash forecast have performed well and require no change. These are

　　1. Payments to the counties of Arlington and Henrico,
　　2. Payments to cities for street maintenance,
　　3. Payments to other state agencies,
　　4. Payments to transit properties,
　　5. Expenditures on salaries and wages,
　　6. Expenditures on equipment, and
　　7. Expenditures on right-of-way.

FORECASTING MAINTENANCE CONTRACTS

Performance of Current Technique

Contract maintenance is not a line item in the de-partment's budget, although it is a line item in the cash forecast. Over the past 3 fiscal years, the budget division has based estimates of monthly pay-out for maintenance contracts on figures provided by the maintenance division. These estimates have con-sistently been overly optimistic in terms of the amount of maintenance that would be performed under contract, and in the first 7 months of 1984 payouts were overestimated by $11.2 million.

Proposed Improvements

The BLS seasonal adjustment program (2) was used to analyze historical data on contract maintenance pay-out. The analysis revealed that payout exhibits a highly stable seasonal pattern. Monthly factors that can be applied to the total estimate of contract maintenance were given in Table 2.

　　The historical pattern of contract maintenance serves as an appropriate technique for arriving at an aggregate estimate of payout for a particular fiscal year. In FY 1984 contract maintenance was 24.3 percent of the maintenance budget; from FY 1979 to FY 1984, excluding flood damage, the average was 26.1 percent. Until such time as the maintenance division can provide estimates that do not tend to be overly optimistic, averaged historical payout can serve as a reasonable aggregate estimating tech-nique. Applying an estimate of 27 percent of the maintenance budget results in total payout estimates of $75.53 million for FY 1984 and $81.98 million for FY 1985. The results of a forecast using the monthly factors given in Table 2 are shown in Figure 6. Over the forecast period, the cumulative error of this proposed technique is a $1.7 million underestimate. As of September 1984 the forecast exhibited an over-estimate of only $100,000.

FORECASTING CONSULTANT CONTRACTS, MISCELLANEOUS CONTRACTS, AND OTHER EXPENDITURES

Performance of Current Technique

In addition to contract maintenance, several other line items in the cash forecast do not correspond to line items in the VDHT program budget. Among these are the line items "consultants," "miscellaneous contracts," and "other expenditures."

　　Obtaining data with which to develop a forecast-ing method for these line items proved impossible, partly because the historical data lacked continu-ity. Verification of the "consultant" line item pre-sented an additional complication because the re-ported expenditures for accounting object codes,
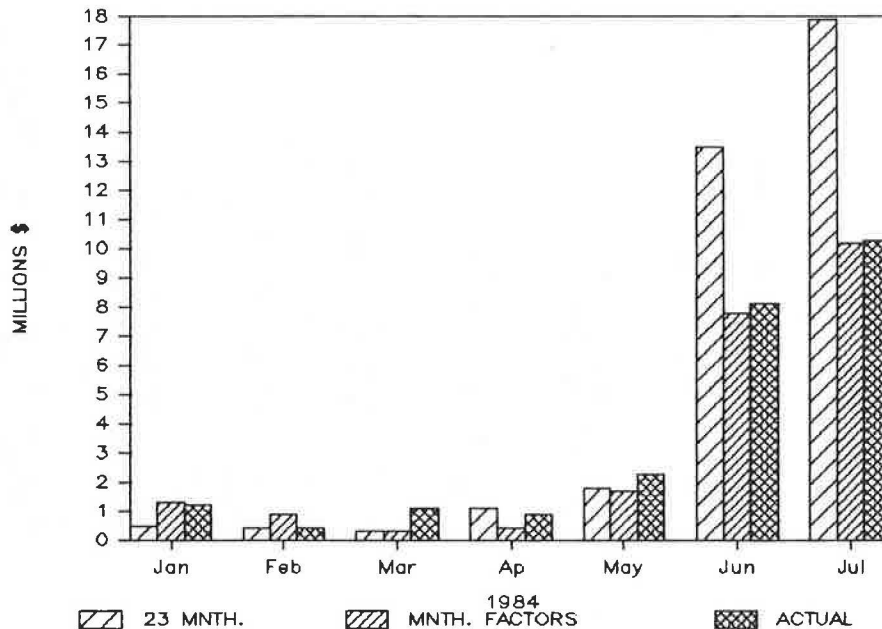

FIGURE 6 Estimated maintenance contracts, January 1984.

which presumably correspond to expenditures for consultants, average about $300,000 per month, an amount significantly less than the $2.8 million per month average indicated by the July 1982 through December 1983 cash balance reports prepared by the fiscal division. Finally, the line item "other expenditures" frequently contains negative entries.

Proposed Improvements

Because consultant contracts, miscellaneous contracts, and other expenditures appear to lack a seasonal pattern and because of the inclusion of negative entries for other expenditures, the cash forecast could be simplified by combining these three line items into one item, estimating the aggregate fiscal year payout as equal to from 5.5 to 6.5 percent of the arithmetic sum of state revenue and "other" revenue, and distributing the payout in equal proportions throughout the months of the fiscal year.

FORECASTING EXPENDITURES ON MATERIALS AND SUPPLIES

Performance of Current Technique

Examination of the forecast of expenditures on materials and supplies for January through July 1984 revealed that the monthly estimate always exceeded the payout, in some months by as much as $10.0 million.

Purchase of materials and supplies is a line item in the department's program budget, and the cash forecast of the payout on materials and supplies historically has been derived by distributing the budgeted amount proportionately throughout each month of the fiscal year. From January 1984 through June 1984, the forecast payout was $97.8 million; payout for this period was, however, only $39.6 million.

Proposed Improvements

Using budget figures provided by the VDHT Administrative Services Division as the basis for forecast-

ing payout on materials and supplies appears to be quite reasonable. Nevertheless, this approach shows an apparent tendency to overestimate actual expenditures. It is not clear that the budgeted amount is the cause of this tendency. Several changes have been made in the format of the monthly expenditures and cash balances report during the past 2 years and these may have been responsible for the fact that, since July 1982, reported expenditures do not track recorded purchases of materials and supplies even if reasonable time lags are allowed between purchase dates and payment dates.

Two options are available to improve the forecast. The first, which has been initiated in the VDHT's latest cash forecast, is to somewhat reduce the budgeted amount for materials purchases for purposes of cash payout forecasting. This option was pursued for testing purposes and the results are shown in Figure 7. When the reduction in the materials budget was incorporated into the total payout forecast (shown in Figure 7), the outcome was encouraging: total payout through July 1984 is overestimated by $2.7 million and data collected through September 1984 showed an overestimate of $6.2 million for the forecast period beginning in January 1984. The second option for improvement is for the fiscal, administrative services, and budget divisions to cooperate in identifying the cause of the disparity between reported purchases and reported expenditures on materials and supplies.

CASH BALANCES

January 1984 to July 1984

The techniques proposed in the previous sections, including the adjustment for materials purchases, were applied to derive a cash balance forecast for January 1984 to July 1984. The accuracy of this forecast is shown graphically in Figure 8. Data available through September 1984 showed the cumulative error to be approximately $20.0 million, most of which resulted from overestimates of federal aid ($18.3 million) in September. For the forecast pe-
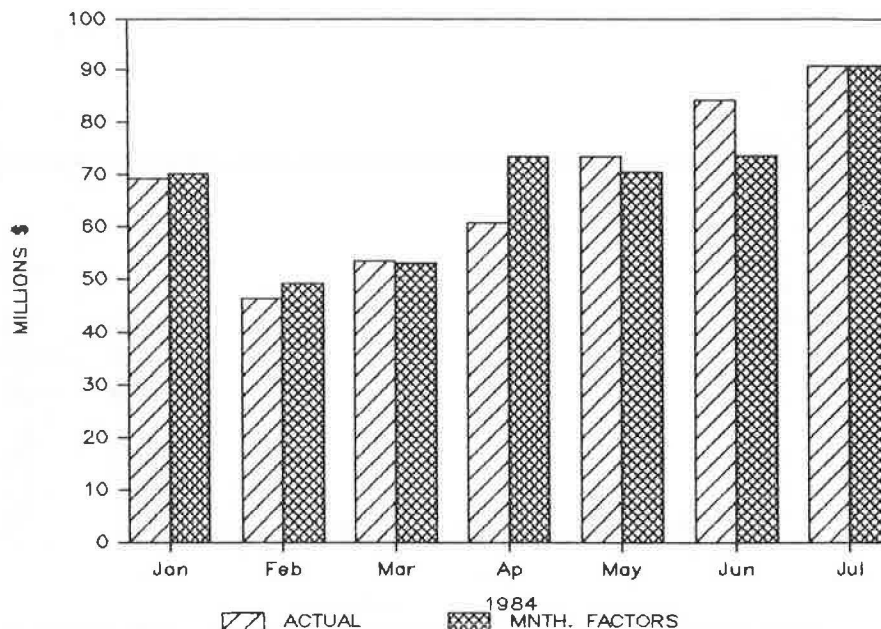

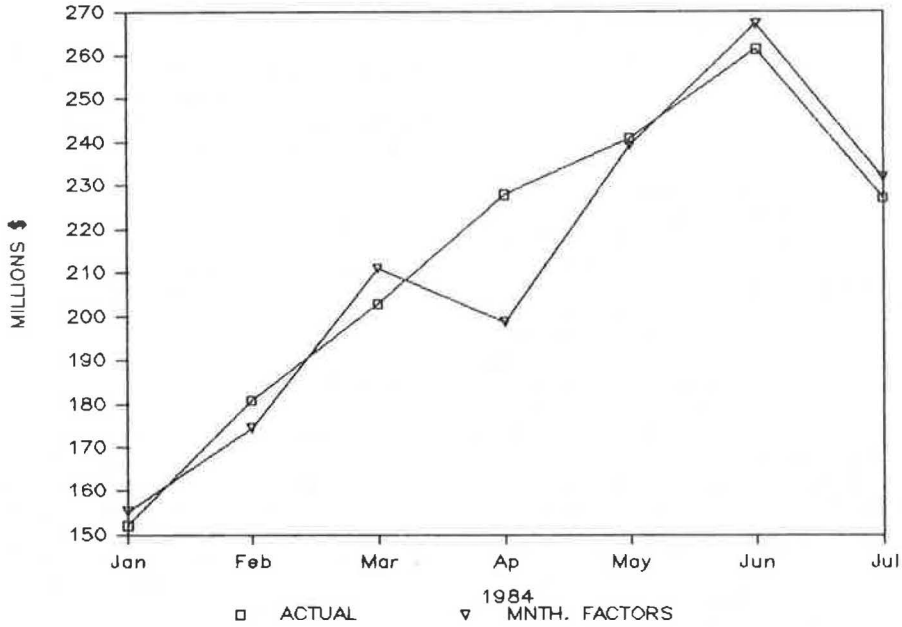FIGURE 7 Total versus material-adjusted payout, January 1984.

FIGURE 8 Cash balance, January 1984.

riod, the error averaged ±$8.3 million per month and had a standard deviation of $9.1 million.

FY 1985 and FY 1986

The techniques proposed in this paper offer the potential for much more accurate forecasts than have been the case in the past. For the forecast period from July 1984 through June 1986 cash balances should be significantly above levels predicted by the techniques previously used by the VDHT. This forecast is shown in Figure 9. The following can be expected for the forecast period:

• Under the techniques formerly used, federal aid is estimated to be $992.0 million. The estimate is $756.0 million under that obtained with the proposed techniques.

• Under the techniques formerly used, contract construction payout is estimated to be $1.1 billion. The estimate is $801.0 million under that obtained with the proposed techniques. Through December 1985, this forecast was within 4 percent of actual payout.

• Under the techniques formerly used, total payout is estimated to be $1.953 billion. The estimate is $1.860 billion under the proposed techniques.

• Under the techniques formerly used, the cash balance is not expected to be less than $145.0 million. Under the proposed techniques the balance is expected to remain substantially higher, peaking at close to $300.0 million.
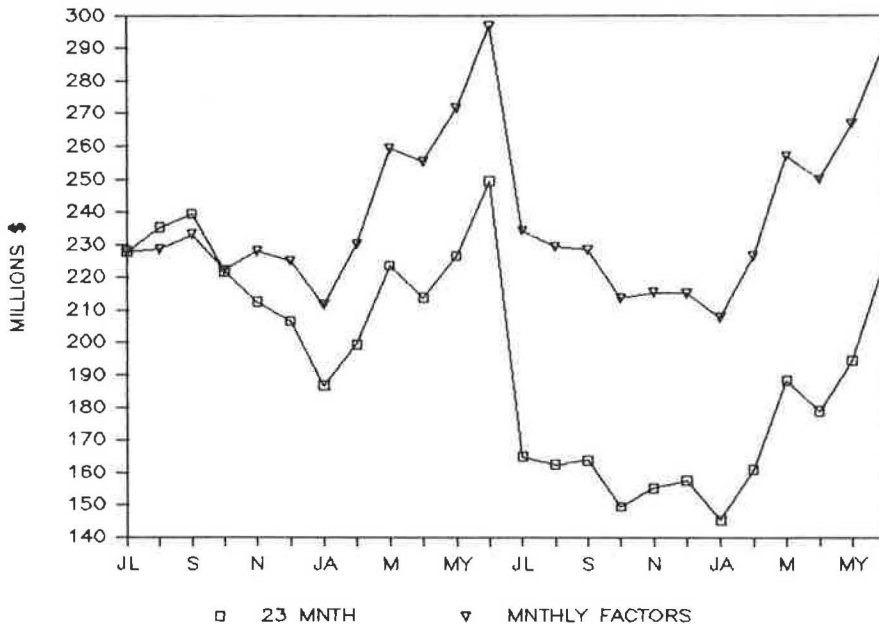

FIGURE 9 Cash balance July 1984 to June 1986, payout curve versus monthly factors.

• As of the date of writing, data reveal that through December 1985 the forecast made in January 1984 is within $11.0 million of the actual cash balance.

What Are Reasonable Cash Balances?

In addition to maintaining a contingency to take advantage of unanticipated federal aid, another criterion by which to gauge the reasonableness of cash balances for contingency purposes is stability in the pattern of the periods during which expenditures exceed monthly revenues. Since July 1980, expenditures have exceeded revenues for the months of July, August, September, and October. Revenues have exceeded expenditures for the months of November through June. Thus it may be reasonable to design the programming and scheduling of the construction program to ensure that the cash balance accumulated on June 30 of each fiscal year approximates, with a reasonable margin of error, the expected excess of expenditures over revenues for the following months of July through October. Approximately $70.0 million might have been a reasonable balance for this purpose for June 30, 1984. Approximately $90.0 million to $100.0 million may not be excessive for June 30, 1985, assuming the proposed advertisement schedule proceeds on target and the seasonality of revenue follows its historical pattern. Additional amounts would be necessary for a federal aid contingency.

Maintaining cash balances at reasonable contingency levels is consistent with maximizing the benefits from revenues available from user taxes, and establishing mechanisms to ensure the implementation of a construction program consistent with maintaining such balances is an appropriate goal to be achieved through the finance, programming, and scheduling functions of the department. However,

extreme caution must be exercised in proposing, at a glance, that balances are too high or too low. Nevertheless, with the aid of the forecasting techniques proposed in this study, "what if" scenarios can be developed to determine the extent to which changes in the construction program result in unacceptably low or high cash balances.

REFERENCES

1. A. Shapanka and G.R. Allen. Method of Forecasting Payments on Construction Contracts. In Transportation Research Record 955, TRB, National Research Council, Washington, D.C., 1984, pp. 26-35.
2. The X-11 Variant of Census Method II Seasonal Adjustments Program. Technical Paper 15. Bureau of Economic Analysis, U.S. Department of Commerce, Feb. 1967.
3. Financing Federal Aid Highways. FHWA, U.S. Department of Transportation, Oct. 1983.

The opinions, findings, and conclusions are those of the author and not necessarily those of the sponsoring agencies.