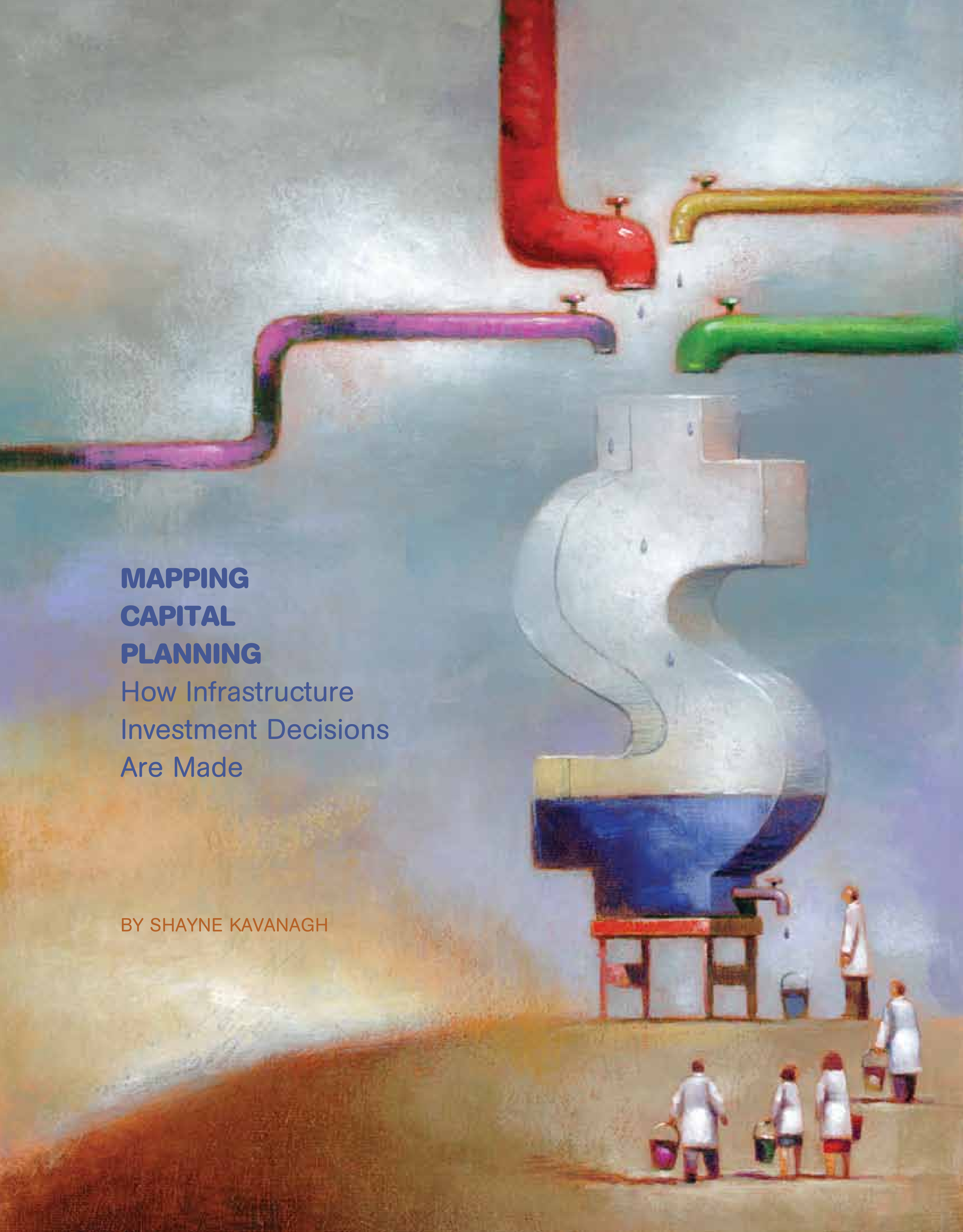

MAPPING CAPITAL PLANNING

How Infrastructure Investment Decisions Are Made

BY SHAYNE KAVANAGH

Eastern Municipal Water District (EMWD) in southern California encompasses about 800,000 people over about 555 square miles, including cities such as Temecula, Hemet, and Moreno Valley. EMWD has about 146,000 accounts and more than $200 million in annual net operating revenue. Water is a potentially scarce commodity in southern California, so EMWD must maintain a strong supply and distribution infrastructure. This article will describe the process EMWD uses to direct its capital dollars to the projects that will provide the best value for its customers. We will start with a "functional deployment," or "swim lane," diagram of the process, shown in Exhibit 1. The diagram shows the participants in the process along the left-hand side, while the flowchart walks through each step, from left to right. The numbers on the steps in the chart correspond to the sections of this article, which explain those particular steps. After the description of EMWD's process, we will review the lessons that can be generalized from EMWD's experiences.

Before visiting the first step in more detail, we should note that EMWD provides other services in addition to potable domestic water. It also provides wastewater services and recycled water (for industrial or agricultural uses). To make the article easier to follow, we have chosen to focus on domestic potable water.

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1) FORECAST DEMAND

As a water utility, EMWD's capital requirements (and revenues to pay for those investments) are determined mostly by the size of its customer base and customers' demand for service. Therefore, the first part of the capital planning process is to forecast that demand. This starts with EMWD's New Business Department working with local land developers to estimate the number of "equivalent dwelling units" (EDUs) they anticipate building and the timeline for development. An EDU is equal to the amount of water used by a typical home, so a development consisting of very large homes might be worth more EDUs than the actual number of homes in the development. Expressing development in EDUs provides a commonly understood and unambiguous metric within EMWD, compared to expressing growth simply in terms of actual units (since water usage can vary significantly between different types of units). EMWD's Water Supply Planning Department maintains a database of proposed development projects.

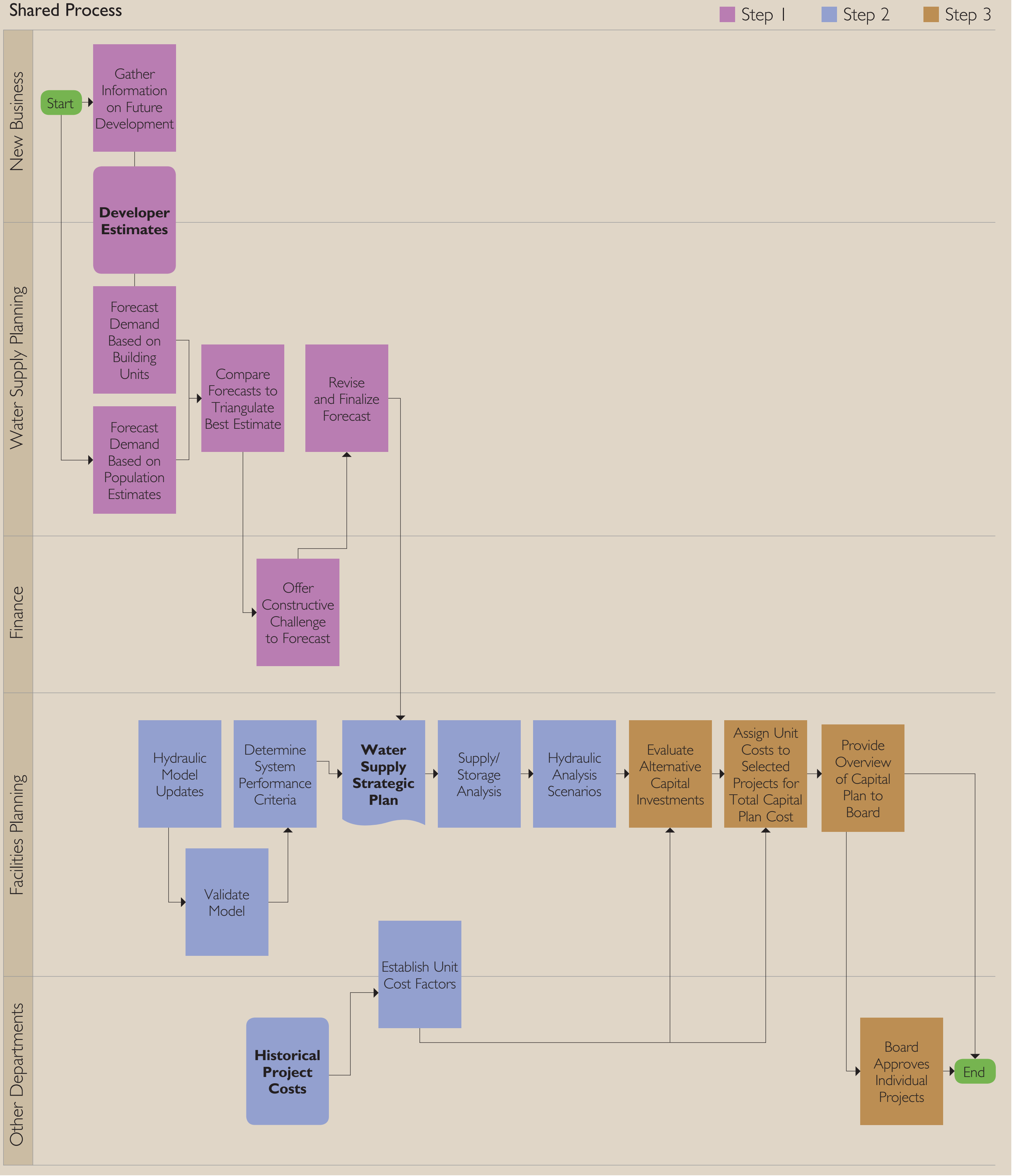
The Water Supply Planning Department forecasts demand using two methods. The first relies primarily on the developer estimates described above, where the average water use per EDU and the total number EDUs are used to project demand. EMWD supplements this with information taken from the official land use plans produced by the municipal governments within EMWD's service boundaries and, to a lesser extent, land use plans produced by the overlapping county government (Riverside County).

The second forecast method is based on population, where it is assumed that changes in population will correspond to changes in total water demand. Population estimates are made for each of the municipal areas within EMWD's service boundaries. EMWD assumes a certain per capita water usage based on its historical experiences.

Both forecasts are then combined because neither forecast model is perfect, and the weaknesses of one might be offset by the strengths of the other. For example, a trend in many communities is that a smaller number of people occupy each household — as the population ages and children move out, the parents live alone as "empty nesters." A forecast based on dwelling units might overestimate usage if the number of people per unit is declining, but a population forecast might help compensate for this. Combining forecasts that use significantly different underlying methods has been proven to improve forecast accuracy.[1]

The Water Supply Planning Department then shares its forecast with the Finance Department, which is charged with offering constructive challenge to the forecast. For example, the Water Supply Planning Department might be prone to

Exhibit 1: Swimlane Diagram of Capital Planning Process for EMWD



overestimating demand, which might lead EMWD to acquire more water supply capacity than it really needs. The Finance Department's job is to guard against overestimating the need for additional supplies or infrastructure, and its review relies on examining historical data to compare forecasts and actual experience, then examining the Water Supply Planning Department's underlying assumptions to see if they are reasonable. This step injects another perspective into the forecasting process, and forecast accuracy usually benefits from multiple perspectives.[2]

> The Water Supply Planning Department forecasts demand using two methods. The first relies primarily on developer estimates described above, and the second is based on population. Both forecasts are then combined because neither forecast model is perfect, and the weaknesses of one might be offset by the strengths of the other.

Finally, the Water Supply Planning Departments incorporates the Finance Department's feedback into the forecast. This recognizes that the best estimate will usually be a combination of the perspectives offered by each department.

2) ANALYZE SYSTEM CAPACITY

EMWD's capital investment needs are a function of water supply and demand. The forecast addresses demand. Analyzing system capacity reveals the extent to which EMWD existing infrastructure can supply that demand. The Facilities Planning Department leads this analysis, starting with updating EMWD's hydraulic model. The hydraulic model is a representation of how water is distributed through EMWD's service area. The model allows EMWD to estimate how the water distribution system will perform under different conditions. The model may need to be updated based on changes to the physical infrastructure, such as new pump stations and pipelines, or in response to other factors, such as changes in demand patterns. For example, a draught or heavy rains might result in significant changes in customers' usage habits.

The model is also validated to ensure that demands are distributed as accurately as possible throughout the water system. If the location of the demand is not estimated correctly across the system, then EMWD might build too much infrastructure and/or put it in the wrong location.

The model is used to assess whether EMWD's water system will meet its performance criteria. Pressure is the most important criterion. An example of a secondary criterion is storage or pumping capacity. Any new assets that EMWD might acquire must help EMWD's system meet these performance criteria.

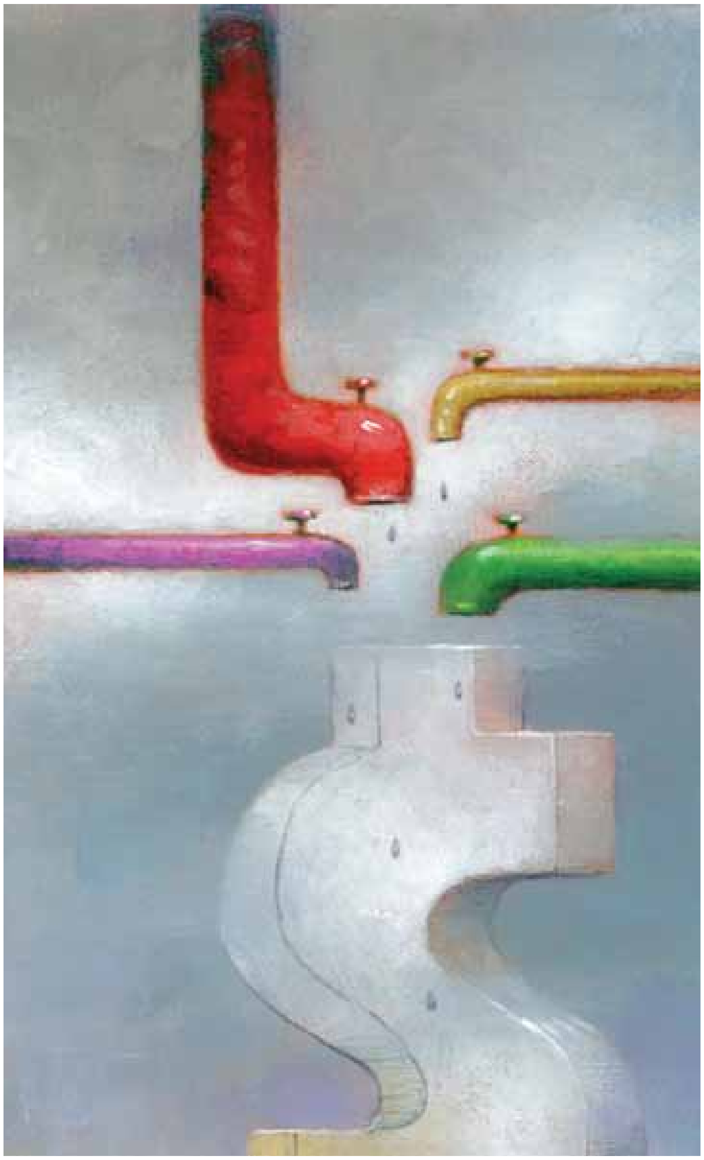
The foregoing steps, plus the demand forecast, help create a water supply strategic plan. The strategic plan forms the basis for an analysis of EMWD's supply and storage capacity, and it documents the results of the analysis. The Facilities Planning Department analyzes the system as a whole to determine if facilities are adequate to maintain the desired pressure, supply, and storage capacity targets, as the targets are defined in the strategic plan.

Forecasts, are, of course, subject to uncertainty. The forecast developed by the Water Supply Planning Department may not be an accurate depiction of what comes to pass. To prepare for scenarios that might differ from the forecast, the Facilities Planning Department develops hypothetical scenarios that suppose different future time horizons and levels of growth in the customer base. The scenarios check whether the water system performs adequately at different points in time and under different levels of demand. The variables of greatest interest include pressure and the rate of storage tank drainage, which could be an indication of a supply shortage.

3) MAKE CAPITAL INVESTMENT DECISIONS

EMWD selects its capital investments based on the current system's ability to meet projected demand. A precursor to evaluating potential capital investments is to create a basis for estimating the potential cost of new infrastructure. Based on historical records of similar projects, the Facilities Planning and Engineering departments develop an assumed cost for a given unit of infrastructure. For example, it might be assumed that a 12-inch pipe will cost $225 per foot. The historical cost information comes from the "Bid Tabulations and Schedules of Values" provided by contractors when bidding (or soon thereafter). This information is stored in a database managed by EMWD's Engineering Services Department. Depending on the project, the costs can be either construction costs or total project costs. Total project costs would include planning, design, construction management and inspection, permitting and California Environmental Quality Act, administration and legal costs, and a contingency.

The best estimate will usually be a combination of the perspectives offered by each department.



With the unit cost estimates in hand, EMWD can evaluate alternative capital investments. If a condition exists where a performance criterion (e.g., water pressure) is not met, then projects would be proposed to improve the system to meet the criterion. There are often multiple options for how infrastructure could be built to meet the criterion. EMWD observes a few principles to arrive at the most cost-effective solutions:

- **Build Infrastructure Sufficient to Serve Build-Out.** New infrastructure should, generally, be sufficient to serve the maximum projected population of the area. For example, it is less expensive to install a larger water pipe now than to build a smaller pipe now and then replace it with a larger one later.

- **Consider Phased or Modular Solutions.** In some cases, it might be possible to build infrastructure in phases so that the costs incurred parallel population growth more closely. For example, if a given area will require six million gallons of storage at build-out, it might be possible to build one three-million-gallon tank sooner and another three-million-gallon tank later.

- **Compare the Total Cost of Options to Move Water from Point A to Point B.** There is usually more than one way to move water around. For example, one route might be shorter but go through more difficult terrain, and another might be longer but go through easier terrain. By considering more than one possibility, EMWD can find the one that offers the best value.

Once the projects necessary to maintaining system performance are selected, the Facilities Planning Department assigns unit costs to the projects in order to get total cost of capital plan. Staff then provides an informational overview of the entire capital infrastructure plan to EMWD's board. The plan is not an appropriations document, so the board formally approves funding for individual projects as the individual projects are required. This concludes EMWD's capital planning process.

LESSONS TO TAKE AWAY

There are a number of lessons other local governments can learn from EMWD's experience, which are summarized below.

The model is validated to ensure that demands are distributed as accurately as possible throughout the water system.

Forecast Demand. EMWD's forecasts demand for its service, providing a basis for determining how much investment in capital infrastructure will be needed to provide that service. EMWD's forecasting process features a number of best practices, including:

- Detailed analysis of the environment, including gathering information directly from land developers and the municipalities that regulate development.
- Combining multiple forecasting methods to reach a single forecast.
- Inviting perspectives from multiple departments.

Though potable water is a more "commoditized" service than many services offered by general governments, the lesson still holds. For example, demand for recreation or road services would be function of factors like population.

Model How the Supply System Will Respond to Demand. A model is a representation of reality. Everyone in the capital planning process will harbor some assumptions about whether the current infrastructure is sufficient, given future demand. Without a formal model, assumptions about how the system will respond to future demand will remain in the minds of each decision maker in the capital planning process. These assumptions may be quite different and difficult to compare because they are not transparent. EMWD makes these assumptions explicit by creating a formal model of how the system will respond to demand, thereby providing a common basis for discussing infrastructure needs.

Again, this lesson also applies to infrastructure for less commoditized services. For example, a government could develop usage models for roadways that account for assumed changes in traffic flows.

Define Performance Targets. EMWD has criteria that define acceptable infrastructure performance (e.g., pressure, storage capacity). This provides a solid basis for evaluating the need for future investment. If EMWD's system is projected to perform below standards, then additional investment is needed. EMWD can also evaluate investments based on the most cost-effective way to reach the standards. EMWD's primary performance target, water pressure, is one that is of immediate interest to the users of EMWD's services. This helps ensure that infrastructure investments will deliver the best possible value to the customer. Almost any

type of asset should have some sort of performance criteria than can help define when additional investment is needed and when it is not.

Develop Standard Costs. EMWD developed a database of standard costs for different types of infrastructure investments based on historical costs. This ensures that cost estimates are rooted in past experience, so they should be reasonably accurate. Standard costs also provide consistency in cost estimates of potential projects, making it easier to weigh the value of one project against another.

> Once the projects necessary to maintaining system performance are selected, the Facilities Planning Department assigns unit costs to the projects in order to get total cost of capital plan.

Create Demand Scenarios. Long-term planning is, by its nature, uncertain. There is the potential for the assumptions underlying long-term forecasts to be materially different from what actually occurs in the future. Developing and considering plausible futures that different from the baseline forecast can promote flexibility in thinking and help the organization be prepared for whatever future does come to pass. EMWD's demand scenarios help it consider how its capital investment strategy might respond to growth patterns that differ materially from what believes is most likely to happen.

Notes

1. Spyros Makridakis and Robert L. Winkler, "Averages of Forecasts: Some Empirical Results," *Management Science*, September 1983.
2. For an overview of research on forecast averaging, see: J. Scott Armstrong, "Combining Forecasts," in J. Scott Armstrong, ed, *Principles of Forecasting* (Kluwer Academic Publishers, 2001).

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