

grams, bringing market forces to the front.

Some believe that vertical integration by cooperatives might be an alternative to a system coordinated by contracts. But this is a fallacy. Cooperatives face the same types of risks and uncertainties as other general corporations.

With the strong demands that existed in 1973 and 1974 for nearly all crops, farmers may wonder whether they should take a secure price prior to production, or wait until prices are established at harvest time. Individual producers might contract production in advance, or speculate on market demand and price. Few studies have been made of the effects of these alternatives, but the consensus is that producers are better off in most years with production contracts rather than having to search for markets once their crops are harvested or produced.

### Conclusions

Pressures for more coordination in production and marketing decisions will continue. For the most part, these pressures originate from marketing firms rather than from farmers. Contracts are the main method used for coordination, but they are not the ultimate answer, because unless farmers negotiate contracts from a position of strength they may become mere hired hands of big business. Cooperative activity—either through operating cooperatives or bargaining associations—is a viable approach to improving market coordination.

The individual farmer who must choose between contracting or producing independently should keep the following points in mind.

1. Contract rather than produce speculatively when trends indicate future difficulty in long-run access to markets.
2. Contract when doing so will increase the ability of your marketing firm to better represent itself in the marketplace.
3. Contract when the marketing firm must guarantee supplies to its customers.
4. Assume the worst will happen, if you are conservative regarding the future. Of the unfavorable results of each alternative available, select the one most likely to be favorable—or the least unfavorable.
5. Select the alternative with the best potential for highest income, if you are optimistic regarding the future.
6. Select the alternative which provides the largest expected money return,

Land use around the larger cities in California has changed as agriculture has given way to urbanization. From 1950 to 1970 this change was especially rapid in the Berkeley hills, which lie to the east of San Francisco Bay. Streamflow characteristics in the hills have changed significantly as a result. Since knowledge of these changes is important for responsible water planning and aquatic wildlife management, this report summarizes the results of a preliminary study of the impact of urbanization on periodicity of streamflow.

**P**ERIODICITY OF STREAMFLOW refers to variation in discharge from a watershed over time. In this study both annual and daily periodicity were measured. On a wildland watershed annual periodicity of streamflow is largely controlled by precipitation. On agricultural and urban watersheds annual periodicity can also be influenced by the application of irrigation water. Daily streamflow periodicity on wildland watersheds is controlled by variations in evapotranspiration rates. On agricultural and urban watersheds daily streamflow can also be affected by irrigation.

Two streams in Contra Costa County were selected for study: Indian Creek, which drains an agricultural/wildland watershed between Moraga and Canyon, and Ivy Creek, which receives its water from an urbanized watershed in Moraga. The watersheds are 1.25 miles apart. Ivy Creek watershed was developed for single

providing net returns exceed a minimum disaster level. Use your best judgment to predict odds for each alternative.

7. Improve your strength through cooperative bargaining. The equity of contracts for each party is determined by the relative market strength of each party.
8. Contracts are vital to firms, as instruments for reducing uncertainty. Cooperatives, no less than corporations, require a firm commitment from growers.
9. Contracts are as important in coordinating nonperishable commodities as they are for perishables. The ability to store a product enhances the range for speculation, but does not contribute to reducing economic uncertainties.

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# URBANIZATION STREAMFLOW in the

family housing in the 1960s. Before development it was used for livestock grazing and walnut production. The Indian Creek watershed is currently used for cattle. It also contains a large walnut orchard, which is no longer tended.

Annual periodicity of streamflow was determined by weekly observations of both creeks. Ivy Creek was observed where it passes under Moraga Way. Above this point its watershed has an area of 168 acres. Indian Creek was observed at a stream gauging station 1.2 miles upstream from where the creek passes under Canyon Road. Above this point it drains an area of 123 acres. While streamflow in Indian Creek occurred only from mid-October through July (graph 1), Ivy Creek flowed throughout the 1972-73 hydrologic year, because of lawn irrigation on the urbanized watershed.

Daily streamflow periodicity was measured on both creeks for a week beginning August 5, 1973, on the assumption that streamflow from the urbanized watershed would be sensitive to irrigation at this time of year. A portable 45° V-notch weir was installed in each stream channel to measure discharge. The Ivy Creek weir was located about 150 ft upstream from Moraga Way. The Indian Creek weir was placed approximately 400 ft downstream from Canyon Road, because flow had ceased to occur at the upstream gauging location. At the downstream location the area of watershed above the weir was 590 acres. Discharge from the weir was continuously recorded on strip charts for seven days using a Belfort water stage recorder.

A survey of irrigation practices during the period of streamflow measurement on the Ivy Creek watershed was conducted via a mailed questionnaire. Residents were asked to indicate the times and durations of watering. Of the 472 residents in the watershed area, 178 responded to the questionnaire. Averaging the quantity of water discharged each half-hour from midnight to midnight for the seven days of the study, Indian Creek showed a peak discharge at 12 a.m. and a minimum discharge at 1 p.m. (graph 2). This perio-

# DOWN and LOW in the Berkeley Hills

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Streamflow periodicity reflects the daily pattern of evapotranspiration on the watershed, at this time of the year, primarily from the riparian woodland lining the creek. There is no time lag associated with this loss because the riparian woodland species are drawing water from the stream channel. The streamflow periodicity of Ivy Creek is characterized by two peaks, which correspond to the pattern of lawn irrigation on the watershed (figure 2). On the average, the number of residents irrigating lawns reached a maximum at 11:30 a.m., followed by an evening high from 6:30 to 8:00 p.m. The lag time between the center of mass of irrigation and the center of mass of discharge for the Ivy Creek watershed was two hours.

A comparison of the hydrographs for Ivy and Indian creeks illustrates the impact of urbanization on the daily periodicity of streamflow. Peak flow is controlled on the urbanized watershed by lawn irrigation, which results in more than a 100% increase in discharge rate. A daily change of this magnitude would be significant for certain stream fauna, since part of the stream channel is not covered by water at night and in the afternoon between discharge peaks. The irrigation practices of the residents resulting in two discharge peaks should be of concern to agencies interested in water conservation. Lawn irrigation during the late morning hours produces a discharge peak during the middle of the day when evaporative loss from the stream would be high, while the evening discharge peak which follows the late afternoon lawn irrigation is less subject to evaporative loss. More water could be recycled to local reservoirs if lawn irrigation was restricted to the late afternoon or evening.

The change in annual periodicity which results from irrigation of lawns on the urbanized watershed is of significance to the management of reservoirs in the Berkeley hills. These reservoirs are filled in part by water transported via aqueducts from the Sierra Nevada. More water is being returned to the local reservoirs through lawn irrigation and runoff as urbanization takes place on the water-

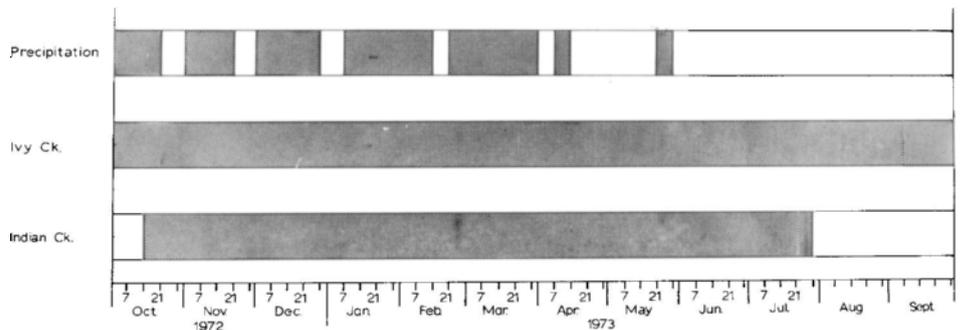


Indian Creek gauging station

sheds. Ivy Creek is just one of many creeks in the Berkeley hills that once was ephemeral but now is perennial as a result of urbanization.

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GRAPH 1. ANNUAL PERIODICITY OF STREAMFLOW AND PRECIPITATION (SHADED ZONES INDICATE PERIOD OF STREAMFLOW, OR WEEKS IN WHICH PRECIPITATION EXCEEDED 0.01 INCH)



GRAPH 2. DAILY PERIODICITY OF STREAMFLOW AND LAWN IRRIGATION

