NATURAL RESOURCES JOURNAL

Volume 4
Issue 1 *New Mexico's Uniform Commercial Code*

Winter 1964

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DETERMINING WATER REQUIREMENTS FOR SETTLING WATER DISPUTES

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Consumptive use (evapotranspiration) is one of the more important elements in the hydrologic cycle of water movement from the time it falls on a drainage basin as rain or snow until it reaches the ocean. It includes all evaporation from lands and water surfaces and all transpiration by vegetation.

The concept of consumptive use is increasingly significant, particularly in the irrigated areas of the western United States and other arid areas of the world. It involves problems of water supply (both surface and underground) as well as those of the management and general economics of irrigation and multiple-purpose projects.

Consumptive water requirements by agricultural crops, native vegetation, and other uses is an important factor in negotiating compacts and treaties and in the litigation and adjudication of the water rights of major river systems, such as the Colorado River,[1] the Upper Rio Grande Basin,[2] and the Pecos River,[3] in which the welfare of people, cities, valleys, states, and even nations is involved. Before the equitable division of the waters of a drainage basin can be made, careful consideration must be given to the consumptive-use requirements for water in the various sub-basins. Consumptive use of water and resultant stream depletions are of utmost importance to the water users sharing the limited supplies.

Data on consumptive use also are useful for determining irrigation requirements, rainfall disposition, safe yields of ground-water basins, and water yields from mountain watersheds.

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1. Blaney & Criddle, Consumptive Use of Water in the Irrigated Areas of the Upper Colorado River Basin (USDA, Soil Conservation Service 1949).

2. Blaney, Ewing, Israelsen, Rohwer & Scobey, *Water Utilization*, Natural Resources Comm., Regional Planning, pt. VI, The Rio Grande Joint Investigation in the Upper Rio Grande Basin in Colorado, New Mexico, and Texas, 1936-1937, at pt. 3, pp. 293-427 (1938).

3. Blaney, Ewing, Morin & Criddle, *Consumptive Water Use and Requirements*, National Resources Planning Bd., Pecos River Joint Investigation, Report of the Participating Agencies, 170-230 (1942).

To more fully understand this article, the reader should keep in mind the following definitions of "consumptive use" and some irrigation terms:

"Consumptive use" (evapotranspiration): The unit amount of water used on a given area in transpiration, building of plant tissue, and that evaporated from adjacent soil, snow, or intercepted precipitation in any specified time. Consumptive use may be expressed in volume per unit area, *e.g.*, acre-inches per acre, or in depth, *e.g.*, inches, millimeters, or acre-feet per acre.

"Irrigation requirement": The quantity of water, exclusive of precipitation, that is required for crop production. It includes surface evaporation and other economically unavoidable wastes. It is usually expressed as depth in inches or feet for a given time.

"Consumptive irrigation requirement": The depth of irrigation water, exclusive of precipitation, stored soil moisture, or ground water, that is required consumptively for crop production.

"Irrigation efficiency": The percentage of irrigation water that is stored in the soil and made available for consumptive use by the crops. When the water is measured at the farm headgate, it is called "farm-irrigation efficiency"; when measured at the field, it is designated as "field-irrigation efficiency"; and when measured at the point of diversion, it may be called "project-efficiency."

"Beneficial use": Any use of water that is reasonable, useful, and beneficial to the appropriator, consistent at the same time with the interests of the public, and therefore the best utilization of water supplies. It includes water needed for beneficial consumptive use plus conveyance and application losses considered reasonable under the present state of technical knowledge, physical conditions, demands for water, and the economic status of the area.

"Beneficial consumptive use of water": Water consumed for beneficial purposes consistent with the public interest, and therefore the best utilization of water supplies. (Water consumed by vegetation having little or no economic value would not be considered as a beneficial consumptive use.)

I

DETERMINING WATER REQUIREMENTS

In water utilization investigations, negotiations, litigation, and adjudication (which are a familiar part of water rights controversies), engineers are frequently called upon to make, within a limited time, estimates of probable past, present, and future consumptive

use and irrigation requirements and stream depletions in river basins. Actual measurements of water use under each of the physical and climatic conditions of any large area are expensive and time consuming. Results of research studies of the consumptive use of water, along with meteorological observations, provide basic data required for developing empirical formulas to compute water requirements where little or no data, except climatological, may be available. Various methods have been used to determine the consumptive use of water without going to the expense or taking the time necessary to make direct measurements of consumptive use.

One such empirical formula[4] was developed by us to determine consumptive use by vegetation from climatological and other data. Although other empirical formulas[5] have been developed for computing consumptive use, the Blaney-Criddle (B-C) formula has been widely used for various hydrologic problems by states and federal agencies in regions such as the Colorado River, Rio Grande, and Pecos River basins.

The procedure for estimating water requirements described in the article may be used to transpose observed consumptive use data from one area to other areas for which only climatological data are available. The amount of water supplied from natural sources is subtracted from the computed total consumptive use, giving the net consumptive irrigation water requirement that must be met for optimum crop production. This net requirement, divided by the irrigation efficiency, gives the irrigation water requirement of the crop.

First published by us in 1945, revised in 1950 and again in 1962,[6] the method to estimate consumptive use of water by irrigated crops from climatological data has been used in most of the United States and in many foreign countries. It has been found quite satisfactory for computing seasonal use. The empirical formula was originally developed for determining only the full seasonal use. However, it was soon recognized that procedures for computing monthly and peak rates of water consumption are also needed to meet the demands of action agencies. Later efforts by us included work on a procedure for estimating shorttime rates of water use by crops and other vegetation.

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4. See Blaney & Criddle, *Determining Consumptive Use and Irrigation Water Requirements* (USDA, Agricultural Research Service Tech. Bull. No. 1275, 1962).

5. See, *e.g.*, Criddle, *Methods of Computing Consumptive Use of Water*, 84 Proceedings Am. Soc'y Civil Engineers 1 (Journal Irr. & Drainage Div. Paper No. 1507, 1958).

6. Blaney & Criddle, *op. cit. supra* note 4.

A. Consumptive Use of Water

Although it is recognized that numerous factors must be taken into consideration to determine accurately the consumptive use of water, the effect of temperature and sunshine upon plant growth as measure of solar radiation is, without doubt, the most important of the climatic factors. Temperature and precipitation records are more readily available than most other climatic data throughout present and potential agricultural areas of the world. Records of actual sunshine are not generally available, but the effect of sunshine is very important on the rate of plant growth and the amount of water that plants will consume.

The effect of sunshine can be introduced by using the length of days during the crop-growing season at various latitudes. For example, the length of the daytime at the Equator varies little throughout the year; whereas at 50°N. latitude, the length of the day in summer is much longer than in winter. Thus, at equal temperatures, photosynthesis can take place for several hours longer each June day at the north latitude than at the Equator. Crop growth and water consumption vary with the opportunity for photosynthesis.

Monthly percentages of annual daytime hours have been computed from possible sunshine hours[7] for latitudes covering most cropland areas of the world. It is realized that computed daytime hours may be somewhat misleading, particularly in areas where heavy fog or stormy weather exists during the crop-growing season; however, temperatures tend to correct this effect. If humidity records are available, these may also be used as a correction.[8]

It is to be understood that if actual data are available, they should be properly correlated and used. Undoubtedly, as records are improved in the future, the theoretical values will be replaced by actual values in many computations.

B. The Blaney-Criddle Consumptive Use Formula

Disregarding many influencing factors, consumptive use varies with the temperature, length of day, and available moisture regardless of its source (precipitation, irrigation water, or natural ground water). Multiplying the mean monthly temperature (t) by the possible monthly percentage of daytime hours of the year (p) gives a

7. *Ibid.*

8. Blaney & Morin, *Evaporation and Consumptive Use of Water Empirical Formulas*, National Academy of Sciences-Nat'l Research Council, American Geophysical Union Transactions, 1942, pt. I, at 76-83 (1942).

monthly consumptive use factor (f). It is assumed that crop consumptive use varies directly as this factor when an ample water supply is available. Expressed mathematically in English units, $u = kf$ and $U = KF = \Sigma kf$ [sum of the monthly consumptive uses (u) during the season] where,

t = mean monthly temperature, in degrees fahrenheit;
p = monthly percentage of daytime hours of the year;
$f = \frac{tp}{100}$ = monthly consumptive use factor;
u = monthly consumptive use, in inches;
U = seasonal consumptive use (or evapotranspiration) in inches;
F = sum of the monthly consumptive use factors for the period (sum of the products of mean monthly temperature and monthly percentage of daytime hours of the year; and
K = empirical consumptive use crop coefficient for irrigation season or growing period. (This has been found to be reasonably constant for all areas.)

In metric units,

$u = kp \frac{(45.7t + 813)}{100}$ = monthly consumptive use, in millimeters, and
t = mean monthly temperature, in degrees centigrade.

Mean monthly temperatures (t) may be obtained from United States Weather Bureau reports or other sources. Table I shows the monthly percentages of daytime hours of the year (p) for latitudes 24° to 50° north. The consumptive use factor (F) may be computed for areas for which monthly temperature records are available, using monthly percentages of daytime hours that are shown in Table I. Then, the total consumptive use (U) of the crop is obtained by multiplying (F) by the empirical consumptive use crop coefficient (K). Average values of (K), computed from many observed data on consumptive use, and temperatures are shown in Table II.

II

APPLICATION OF THE B-C CONSUMPTIVE USE FORMULA IN SPECIFIC AREAS

The amounts of water required to irrigate an individual crop, a single farm, or an entire irrigation project may be estimated by the procedure described above. Also, this method may be used to compute the consumptive use, irrigation requirements, and stream de-

TABLE I

DAYTIME HOUR PERCENTAGES FOR EACH MONTH OF THE YEAR FOR LATITUDES 24 TO 50 DEGREES NORTH OF EQUATOR[9]

Month	Latitudes in degrees north of equator													
	24	26	28	30	32	34	36	38	40	42	44	46	48	50
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
January	7.58	7.49	7.40	7.30	7.20	7.10	6.99	6.87	6.76	6.62	6.49	6.33	6.17	5.98
February	7.17	7.12	7.07	7.03	6.97	6.91	6.86	6.79	6.73	6.65	6.58	6.50	6.42	6.32
March	8.40	8.40	8.39	8.38	8.37	8.36	8.35	8.34	8.33	8.31	8.30	8.29	8.27	8.25
April	8.60	8.64	8.68	8.72	8.75	8.80	8.85	8.90	8.95	9.00	9.05	9.12	9.18	9.25
May	9.30	9.38	9.46	9.53	9.63	9.72	9.81	9.92	10.02	10.14	10.26	10.39	10.53	10.69
June	9.20	9.30	9.38	9.49	9.60	9.70	9.83	9.95	10.08	10.21	10.38	10.54	10.71	10.93
July	9.41	9.49	9.58	9.67	9.77	9.88	9.99	10.10	10.22	10.35	10.49	10.64	10.80	10.99
August	9.05	9.10	9.16	9.22	9.28	9.33	9.40	9.47	9.54	9.62	9.70	9.79	9.89	10.00
September	8.31	8.31	8.32	8.34	8.34	8.36	8.36	8.38	8.38	8.40	8.41	8.42	8.44	8.44
October	8.09	8.06	8.02	7.99	7.93	7.90	7.85	7.80	7.75	7.70	7.63	7.58	7.51	7.43
November	7.43	7.36	7.27	7.19	7.11	7.02	6.92	6.82	6.72	6.62	6.49	6.36	6.22	6.07
December	7.46	7.35	7.27	7.14	7.05	6.92	6.79	6.66	6.52	6.38	6.22	6.04	5.86	5.65
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

9. Computed from *Sunshine Tables*, U.S. Weather Bureau Bull. 805 (1905 ed.).

pletion for entire river basins in connection with the litigation and adjudication of water rights. The following examples illustrate some uses of the B-C method for different purposes:

TABLE II

SEASONAL CONSUMPTIVE USE COEFFICIENTS (K) FOR IRRIGATED CROPS IN THE WESTERN UNITED STATES

Crop	Length of normal growing season or period[10]	Consumptive-use coefficient (K)[11]
Alfalfa	Between frosts	0.80 to 0.90
Bananas	Full year	.80 to 1.00
Beans	3 months	.60 to .70
Cocoa	Full year	.70 to .80
Coffee	Full year	.70 to .80
Corn (Maize)	4 months	.75 to .85
Cotton	7 months	.60 to .70
Dates	Full year	.65 to .80
Flax	7 to 8 months	.70 to .80
Grains, small	3 months	.75 to .85
Grain, sorghums	4 to 5 months	.70 to .80
Oil seeds	3 to 5 months	.65 to .75
Orchard, avocado	Full year	.50 to .55
Orchard, grapefruit	Full year	.55 to .65
Orchard, orange and lemon	Full year	.45 to .55
Orchard, walnuts	Between frosts	.60 to .70
Orchard, deciduous	Between frosts	.60 to .70
Pasture, grass	Between frosts	.75 to .85
Pasture, Ladino clover	Between frosts	.80 to .85
Potatoes	3 to 5 months	.65 to .75
Rice	3 to 5 months	1.00 to 1.10
Sisal	Full year	.65 to .70
Sugar beets	6 months	.65 to .75
Sugar cane	Full year	.80 to .90
Tobacco	4 months	.70 to .80
Tomatoes	4 months	.65 to .70
Truck, small	2 to 4 months	.60 to .70
Vineyard	5 to 7 months	.50 to .60

10. This depends largely on the variety and time of the year when the crop is grown. Annual crops grown during the winter period may take much longer than if grown in the summer.

11. The lower values of K for use in the Blaney-Criddle formula, $U = KF$, are for the more humid areas, and the higher values are for the more arid climates.

A. Water Requirements for Irrigated Areas

An example of computations for seasonal consumptive use (U) and irrigation requirements (I) for nine crops in Safford Area, Gila River Basin, Arizona, are shown in Table III.

TABLE III

EXAMPLE OF COMPUTATIONS OF SEASONAL CONSUMPTIVE USE AND IRRIGATION REQUIREMENTS FOR CROPS IN THE SAFFORD AREA, ARIZONA

Crop	Growing Period	F[12]	K[13]	U[14]	R[15]	U-R	E[16]	I[17]
				Inches	*Inches*	*Inches*	*Percent*	*Inches*
Alfalfa	4/5-11/4	46.31[19]	0.85	39.4[19]	5.2	34.2	0.70	48.9
Alfalfa	2/9-4/4; 11/5-27	10.40[20]	.70	7.3[20]	.6	6.7	.70	9.6
Total for season				46.7	5.8	40.9		58.5
Cotton	4/15-10/31	44.04	.62	27.3	5.1	22.2	0.70	31.7
Fall Grain	11/27-5/31[18]	22.20	.70	15.5	1.2	14.3	.70	20.4
Spring Grain	2/1-5/31	19.99	.70	14.0	1.3	12.7	.70	18.1
Sorghum	6/15-11/4	31.31	.70	21.9	5.1	16.8	.60	28.0
Corn	6/15-10/15	28.30	.75	21.2	4.6	16.6	.60	27.7
Sweet Potatoes	4/5-11/4	46.31	.70	32.4	5.1	27.3	.70	39.0
Pecans	4/5-11/4	46.31	.70	32.4	5.1	27.3	.70	39.0
Native Vegetation	4/5-11/4	46.31	1.00	46.3	5.1	41.2	..	...

Similar computations were made in twenty-five other areas in Arizona.[21] Seasonal coefficients (K) were based on actual measurements

12. $F =$ sum of the monthly consumptive use factors for the period (sum of the products of mean monthly temperatures and monthly per cent of annual daylight hours) $\left(\frac{tp}{100}\right)$.

13. $K =$ consumptive use coefficient.

14. $U =$ consumptive use of crops, in inches, for any period.

15. $R =$ effective rainfall.

16. $E =$ field irrigation efficiency.

17. $I = \frac{U-R}{E} =$ irrigation requirements, in inches.

18. The period from November 28 to February 28 is not used in the computation, since the weather at that time is too cold to permit plant growth; therefore, there is no consumptive use.

19. Alfalfa irrigated and grown without a summer rest period.

20. Alfalfa making some growth and having some consumptive use during winter months or frost period.

21. Blaney & Harris, Consumptive Use and Irrigation Requirements of Crops in Arizona (USDA, Soil Conservation Service 1951).

of consumptive use by crops grown in Salt River Valley, Arizona, and other areas of the country.

Similar computations of water use have been made for areas in New Mexico,[22] Utah,[23] California,[24] and other western states. For example, at the request of the United States Bureau of Reclamation and the New Mexico State Engineer, the B-C method was used to determine the probable irrigation water required at the farm headgates of the proposed Shiprock and South San Juan Projects[25] in New Mexico.

B. Compact Negotiations

Consumptive use of water data were used during the compact negotiations between the states in the Upper Rio Grande, Pecos River, and Colorado River basins.

For example, during the negotiation of the Upper Colorado River Compact, an Engineering Advisory Committee representing Arizona, Colorado, New Mexico, Utah, and Wyoming, and the United States Bureau of Reclamation undertook a study of water consumption by irrigated crops and native vegetation as part of a complete study of water resources of the Upper Colorado Basin.

The consumptive-water requirements, streamflow depletion, and available water supply in each state and sub-basin was needed before an equitable division of the use of the waters of the Upper Colorado Basin could be made. After a field inspection of all the basin areas and conferences with local water users in each area, a report was prepared on the consumptive use of water. Rates of use by irrigated crops and native vegetation were computed by the B-C formula, (U=KF), for fifty-six areas in the Upper Basin,[26] and submitted to the Commission. These rates were applied to the various areas in each state by the Advisory Committee to determine the total acre-feet of water being consumed annually by irrigated crops and water loving vegetation.[27]

On October 11, 1948, at Santa Fe, New Mexico, the Upper

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22. Blaney, Hanson & Litz, Consumptive Use and Irrigation Water Requirements of Crops in New Mexico (USDA, Soil Conservation Service 1950).

23. Criddle, Harris & Willardson, *Consumptive Use and Water Requirements for Utah* (Utah State Engineer Office Tech. Bull. No. 8, rev. ed. 1962).

24. Blaney, *Consumptive Use of Water in Salinas Basin, California*, Salinas Basin Investigation, Appendix C, at 195 (Cal. State Eng'r Bull. No. 52, 1946).

25. Blaney & Diebold, Irrigation Water Requirement of Crops in Shiprock and South San Juan Projects, New Mexico (USDA, Soil Conservation Service 1952).

26. Blaney & Criddle, *op. cit. supra* note 1.

27. Engineerng Advisory Comm. to Upper Colorado River Basin Compact Comm'n, Final Report (1948).

Colorado River Basin Compact was executed by representatives of the five states[28] having territory in the Upper Basin. The major purpose of this Compact is to provide for the equitable division and apportionment of the use of the waters of the upper river system to each state involved. The Compact was later approved by the legislatures of each of the signatory states and by Congress.

C. *Adjudications*

Some state engineers based diversion allocations of agricultural water on computations of consumptive use and irrigation requirements by the Blaney-Criddle method for adjudication purposes.

For example, in Utah the basic consumptive requirements of the crops being grown in the area are computed. The effective rainfall is subtracted from these computed requirements. This gives the net consumptive requirements that must be supplied from irrigation. To this net figure is added necessary and reasonable conveyance and application losses. Such allowed losses are dependent upon the physical and economic conditions, and on the irrigation practice in the area.

With increased legal and economic pressures for water, with technical advances in the science of water use, and with improved training of irrigators, re-evaluation of these allowances may be made. Beneficial use, considered as the basis of a water right in Utah, is not a fixed quantity but needs review periodically in light of the above factors. The Utah courts are always requested by the State Engineer to keep the decree interlocutory in water adjucations so that it can be reopened periodically to take care of changing conditions outlined above. This procedure has been accepted by several of the district courts and upheld by the Supreme Court of Utah.[29]

D. *Litigation*

Computed consumptive use by the B-C formula has been used in the litigation of water rights in Arizona, California, and other states.

During 1951-1952, Blaney and Karl Harris made a study in cooperation with the United States Bureau of Reclamation of the water-consumption rates by agricultural crops and native vegetation

28. Arizona, Colorado, New Mexico, Utah, and Wyoming. The Compact was approved by Congress on April 6, 1949. 63 Stat. 31.

29. *In re* Water Rights of Escalante Valley Drainage Area, 10 Utah 2d 77, 348 P.2d 679 (1960).

in various irrigated areas of Arizona, California, Nevada, New Mexico, and Utah in the Lower Colorado River Basin.[30] Computations of rates of consumptive use for irrigated crops by the B-C method were based primarily on seasonal coefficients (K) developed from measurements of water use by various crops in the Salt River Valley, Arizona, by the United States Soil Conservation Service in cooperation with the University of Arizona. Estimates of water consumption by native vegetation were based for the most part on observations made by the United States Geological Survey in Safford Valley, Arizona. These data were employed by the United States Bureau of Reclamation in a report on the water supply of the Lower Colorado River Basin.[31]

In *Arizona v. California*,[32] The United States Bureau of Reclamation report was introduced early in the hearings by Arizona, and the consumptive use of water values computed by the B-C method were used extensively in the testimony of engineering witnesses. Also, the United States, in presenting its claims for the Indian Reservations in the Lower Basin, used the B-C formula to compute potential consumptive use needed for Indian irrigation projects.

E. *International Negotiations*

1. Lebanon, Syria, Jordan, and Israel

In 1954 and 1955, Criddle served as an engineering advisor for the United States State Department in attempting to negotiate with the riparian states a plan for development of the limited waters of the Jordan River System in the Near East. A basic assumption made was that, insofar as possible, each country was entitled to beneficially use water on all "irrigable" lands within the basin. Once the division was made between the countries, water so allocated could be used on lands either within the basin or out of the basin as the country might choose. Irrigable lands were defined as those having suitable soils, topography, and economic feasibility under standards similar to those used on United States reclamation projects.

Once the land areas were classified, the problem of beneficial water requirements became paramount. Representatives of Lebanon, Syria, and Jordan wanted extremely high diversion allowances on their lands within the basin. Israel wished to use much of her alloted

30. Blaney & Harris, Consumptive Use of Water Rates in the Lower Colorado River Basin (USDA, Soil Conservation Service 1952).

31. USDI, Bureau of Reclamation, Water Supply of Lower Colorado River Basin (1952).

32. 373 U.S. 546 (1963).

water outside the basin and desired that the diversion allowances per unit of land be held to a minimum.

The B-C method of computing the basic consumptive water requirements was used by the State Department for determining the water needs of the lands in each country. The effective rainfall was subtracted from the computed basic consumptive use, giving the net consumptive irrigation water requirement. This net requirement was divided by a reasonable irrigation efficiency to compute the diversion requirements of each country.

Although political agreement on the diversion of the waters of the Jordan River has not been reached (and formal approval may never be possible), it is felt that technical agreement was reached through this rational approach. All developments of water resources in the basin since 1955 have been within the context of this plan which is known generally as the "Johnston plan."

2. Pakistan and India

Beginning a century ago, India, with the help of the British, constructed irrigation systems for vast areas of Indus River Basin lands. Since the widely fluctuating flow of the Indus River was not regulated, adequate water for most of the land was available only during the monsoon season. Water was not available for intensive crop production for most lands even though the climate allows cropping throughout the year.

When India was divided in 1948, most of the irrigated land of the Indus River Basin came under the control of newly-established Pakistan. However, as much of the watershed for the basin was left with India, water disputes seemed inevitable. Mr. Eugene Black of the International Bank for Reconstruction and Development suggested that India be given the waters of the three eastern tributaries to the Indus, and Pakistan be given the waters of the three western tributaries. Since the waters of the eastern rivers had been developed to irrigate lands in what was formerly Punjab, India was to help construct large link canals to lead waters from the western rivers to the old irrigated area. Mr. Black offered the aid of the Bank to try to work out a settlement of the water problems. Before Pakistan would agree to such an arrangement, she wished to be assured that sufficient water would be available to meet the full irrigation requirements of a modern agriculture program on her irrigable lands.

We were asked by Tipton and Kalmbach, Inc., consultants to Pakistan, to determine what the water needs of the Indus River

Basin lands would be. We prepared a report[33] on annual and seasonal requirements of water.

This report indicates a serious deficit in the seasonal amounts of water historically delivered to the farm lands. It does help to indicate that sufficient water can be made available for the more than twenty-five million acres of irrigable land in the basin. With this assurance, plus the data on the many other factors, the Pakistanis agreed to a division of the waters generally along the lines recommended by the Bank. A treaty was signed by officials of both countries in September, 1960.[34] The B-C method of computing water requirements is also being used extensively in the multi-million dollar reclamation and development programs now underway in Pakistan.

33. Blaney & Criddle, Report on Irrigation Water Requirements for West Pakistan (Published by Tipton & Kalmbach, Inc., Denver, Colo. 1957).
34. The Indus Waters Treaty, 1960.