

City ENGINEERING

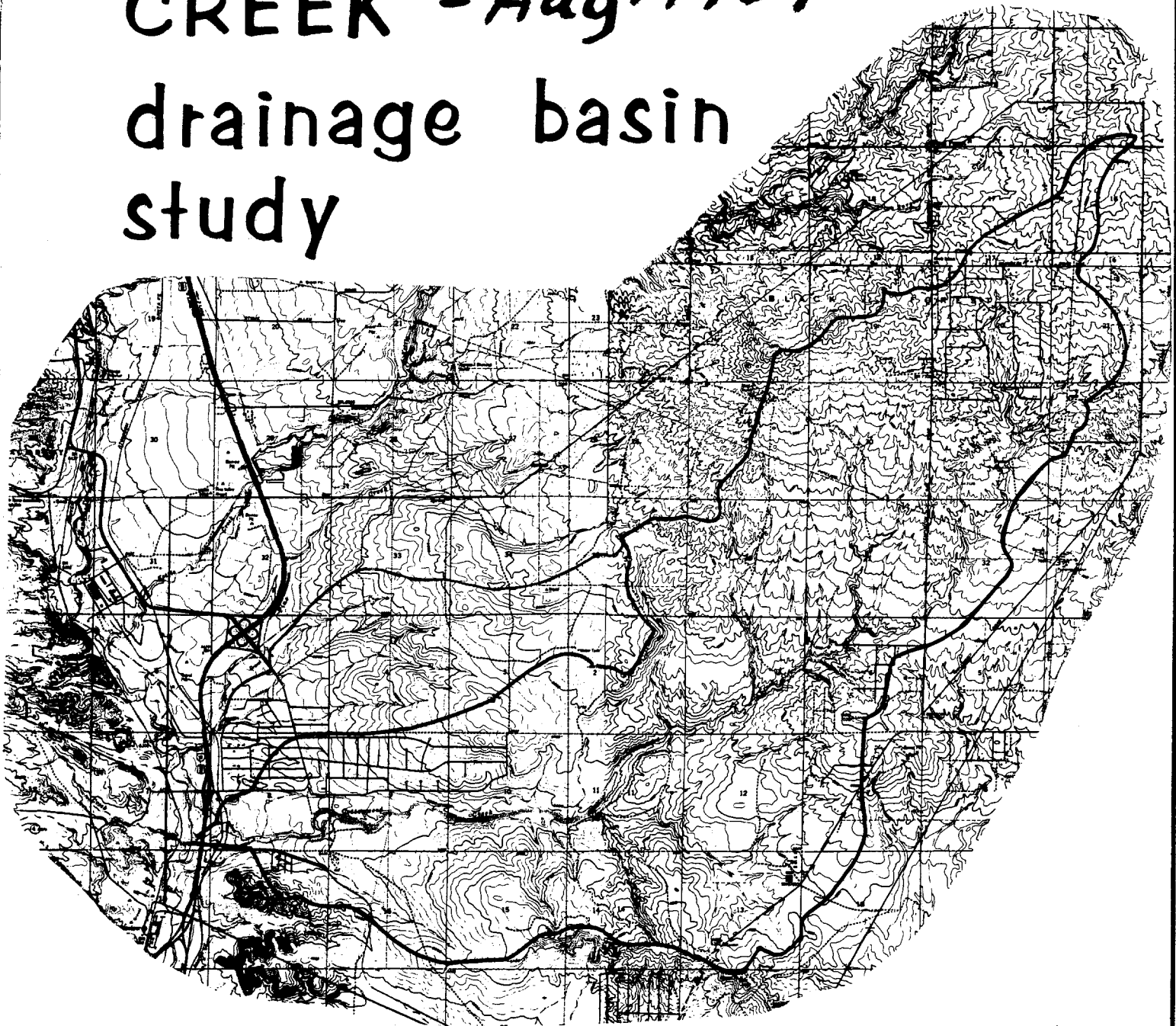
Library Copy

Do Not Remove

#107

COTTONWOOD CREEK - Aug. 1969

drainage basin study

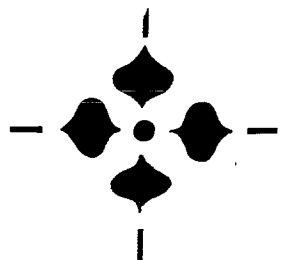


r. keith hook & associates, inc.

ENGINEERS

PLANNERS

CONSULTANTS



HYDROLOGIC ENGINEERING STUDY

of the

COTTONWOOD CREEK
DRAINAGE BASIN

for

THE DEPARTMENT OF PUBLIC WORKS
COLORADO SPRINGS, COLORADO

August, 1969

R. Kieth Hook & Associates, Inc.
2545 East Platte Place
Colorado Springs, Colorado

Engineers-Planners-Consultants

TABLE OF CONTENTS

Letter of Transmittal	
Location Map	
Drainage Basin Plan	
Hydrograph Location	
	Page Numbers
Description	1 thru 5
Sub-Basin Description	6 thru 9
Calculations	10 thru 13
Hydrographs	14 thru 18
Major Drainage Structures Table No. 1	19
Storm Sewer Piping Table No. 2	20 thru 21
Hydrograph Charts	
Typical Ditch Sections	
Cost Estimate	22 thru 23

August 25, 1969

Mr. Deke Miller
Acting Director of Public Works
City Hall
Colorado Springs, Colorado 80902

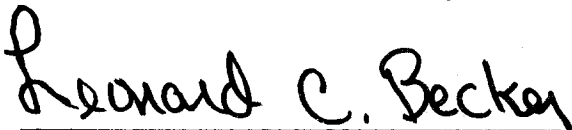
Dear Sir:

Enclosed herewith is the engineering study of Cottonwood Creek
Drainage Basin System.

This report described precipitation run-off conditions as affected
by existing terrain and as will affect proposed development areas within
the basin and methods of conveying subject run-off.

Very truly yours,

R. KEITH HOOK & ASSOCIATES, INC.



Leonard C. Becker, P.E.

LCB/vaj



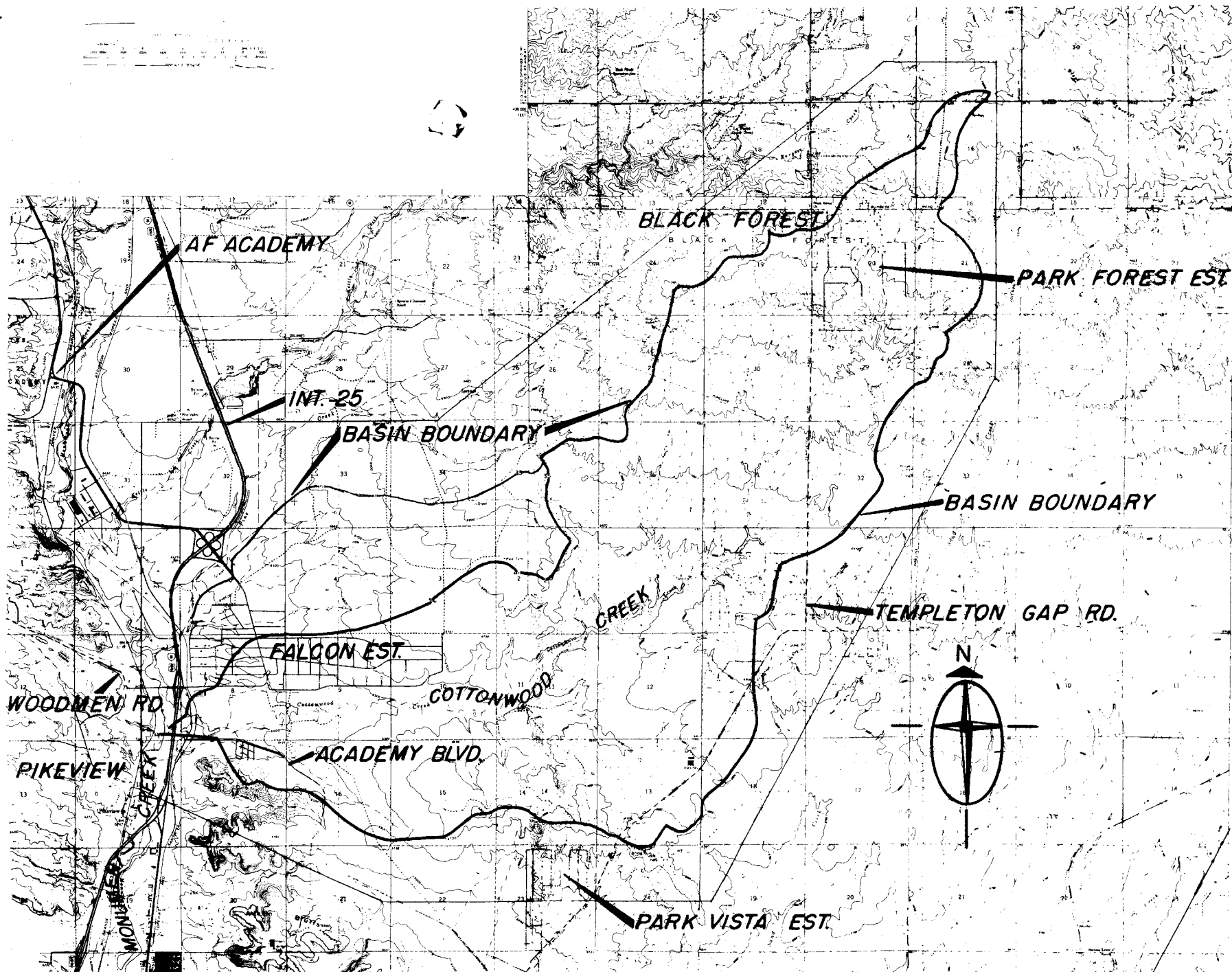
PHONE 473-5633

250 E. PLATTE AVE

COLORADO SPRINGS, COLORADO 80909

R. Keith Hook & Associates, Inc.

VICINITY MAP



Cottonwood Creek
Drainage Basin

HYDROGRAPH LOCATIONS

POINT I	Section 29, Township 12 South, Range 65 West of the 6th P.M.
POINT II	Section 32, Township 12 South, Range 65 West of the 6th P.M.
POINT III	Southwest corner of Section 32, Township 12 South, Range 65 West of the 6th P.M., crossing at Templeton Gap Road.
POINT IV	Section 6, Township 13 South, Range 65 West of the 6th P.M.
POINT V	Section 1, Township 13 South, Range 65 West of the 6th P.M.
POINT VI	Section 36, Township 12 South, Range 66 West of the 6th P.M.
POINT VII	Section 1, Township 13 South, Range 66 West of the 6th P.M.
POINT VIII	Section 1, Township 13 South, Range 66 West of the 6th P.M.
POINT IX	Southwest corner of Section 1, Township 13 South, Range 66 West of the 6th P.M.
POINT X	Section 13, Township 13 South, Range 66 West of the 6th P.M.
POINT XI	Section 11, Township 13 South, Range 66 West of the 6th P.M.
POINT XII	Section 11, Township 13 South, Range 66 West of the 6th P.M.
POINT XIII	Section 10, Township 13 South, Range 66 West of the 6th P.M.
POINT XIV	West line of Section 9, Township 13 South, Range 66 West of the 6th P.M.
POINT XV	Section 8, Township 13 South, Range 66 West of the 6th P.M.
POINT XVI	Section 7, Township 13 South, Range 66 West of the 6th P.M. at Monument Creek.
POINT XVII	Section 4, Township 13 South, Range 66 West of the 6th P.M.
POINT XVIII	Section 5, Township 13 South, Range 66 West of the 6th P.M. crossing at Academy Boulevard
POINT XIX	Section 5, Township 13 South, Range 66 West of the 6th P.M.
POINT XX	Section 7, Township 13 South, Range 66 West of the 6th P.M. crossing at Interstate No. 25.

DRAINAGE REPORT

Cottonwood Creek
Drainage Basin

I. DESCRIPTION

A. Scope and Purpose

This report has been prepared to establish a drainage criteria showing all major and minor drainage systems lying within the Cottonwood Creek Basin and minor basins lying within the Falcon Estates area.

Primarily, the undeveloped areas' drainage systems, as shown and as described will affect future land development with regard to proposed street systems, drainage structures and greenbelt systems.

It is the intent of this report to show location of systems and structures to best suit drainage through the Cottonwood Creek area.

Final subdivision of land may vary from the guide lines established in this report, however, general requirements should be maintained.

Within the boundaries of the Cottonwood Creek and Falcon Estates areas, subdivisions have been developed and drainage structures and piping installed by the State, County, developer or building contractors.

Our design analysis in this drainage report will consider only those existing drainage facilities occurring at major points in the basins as to whether they are of sufficient capacity to handle surface run-off, or require replacing.

Other drainage structures and facilities existing within developed subdivisions that may be deficient, should be analyzed by a detailed drainage study and report of that particular area, as determined by the Department of Public Works, who, at that time can determine the responsibility and cost for performing the necessary work.

B. Basin Description

The Cottonwood Drainage Basin systems covers approximately 24 square miles or 15,372 Acres, lying within Townships 12 and 13 South, Range 65, 66

Cottonwood Creek
Drainage Basin

(B. Continued).

West of the 6th P.M.

The drainage channel of Cottonwood Creek is wide and sandy at the lower portions, particularly from Academy Boulevard, Easterly for approximately 21,120 feet. At the confluence with Monument Creek, East to Academy Boulevard, the channel is relatively deep with irregular banks and stream alignment. In this area, subdivisions have been developed or are in the process of developing.

In the Easterly portion of the Cottonwood drainage channel, the terrain gradually increases and the channel branches in several areas and gradually diminishes in sub-basin E area.

Some of the minor drainage channels emptying into Cottonwood Creek are more deep and narrow in lieu of wide and shallow in comparison to Cottonwood Creek channel.

Along Cottonwood Creek channel, large Cottonwood trees are evident, though tree cover in the basin is not heavy and in some areas quite sparse.

The minor channels as described, will not be designated greenbelts and at the time of development of these basins and areas where these channels are located. The decision to make them drainage easements or greenbelts should then be determined.

The costs of developing these channels include some re-alignment and cleaning but in most cases, it is apparent they should be retained in their natural state.

The minor basins A, B, and C are located in relative moderate to rolling terrain, with a portion of Falcon Estates lying within basin C;

The surface drainage in these areas where undeveloped, follows natural drainage courses and in intermittent flow. Concentration of run-off is not particularly evident and therefore, greenbelt systems will not be established by this report. As the area is developed, it can then be determined if drainage easements are required or if surface flow can be contained in street systems. Lower areas may require drainage easements.

C. Geological Formation and Soils

The basin area soil consists mainly of sandy-gravelly materials with some overburden of disintegrated granite.

Cottonwood Creek
Drainage Basin

(C. Continued)

Along the existing Cottonwood Creek, some Dawson (classification) outcropping is evident.

This rock is decomposed and subject to erosion and scaling.

Along the channel area, the sands are relatively fine graded and predominate through-out the coarse of the main channel.

The smaller channels contributing to Cottonwood Creek are also of sandy-gravelly soil classification, though somewhat more stable.

In general, the main channel area, sands are unstable and with high flows will be dissipated and suspended in stream flow.

D. Rainfall

Design criteria for this drainage study is a storm of one (1) hour duration, with two (2) inch intensity and occurring on a 50-year storm basis.

The soil conservation service synthetic hydrograph method has been used to determine surface flow quantities and velocities in accordance with the requirements of the Colorado Springs Department of Public Works.

Source of information:

"Design of Small Dams"

United States Department of Interior Bureau of Reclamation.

U.S. Weather Bureau records indicate this area has from 14.0 to 16.0 inches of rainfall per year as an average. Highest precipitation occurring in August.

Average high has been measured in July at 2.94 inches in one hour duration period.

E. Surface Flow Criteria

The entire Cottonwood Creek Basin has been divided into 26 major basins and 3 minor basins as shown on the plan. These basins flow criteria and recommended improvements will be individually described.

Peak run-off has been computed for each minor basin and hydrographs constructed at major confluence points of all basins. These hydrograph locations are shown on the drainage plan and also charted in this report.

Cottonwood Creek
Drainage Basin

(E. Continued)

The combination of hydrographs will give the quantity of surface flow of each sub-basin, the time of run-off through the minor basin to the peak time of run-off, and the combined quantity and time of all flows as the run-off proceeds through the basin.

Surface run-off quantities can be determined at any point in the basin during a storm duration.

F. Greenbelt System

The major greenbelt systems have been designated on the drainage plan with recommended right-of-way widths.

These widths are set so as to provide a channel with a water level not to exceed 2.5 feet at design storm conditions and sufficient access along both sides of the channel for maintenance.

It is proposed that the major greenbelt systems be shaped and aligned as required to allow a non-restricted surface run-off with as little rip-rapping or lining as possible. Many portions of the entire major greenbelt systems should be left in their natural configuration with the exception of channel stabilization by lining, shaping and rip-rapping in certain erosion points.

The minor channels, emptying into the greenbelt system require no re-alignment or shaping and it is recommended these channels be maintained in their natural state.

As the Cottonwood Creek area is developed, it may be an advantage to lessen the right-of-way widths as shown on the drainage plan, to save land area and/or better suited to subdivision development. However, if the channel configuration is narrowed then the channel would require lining with concrete or equal as velocity and depth of flow would be increased. If this is presented during subdivision development, consideration must be given to adjoining areas particularly down stream, as the areas may maintain wider right-of-ways, thereby creating a transition in the greenbelt.

Total length of the greenbelt system is approximately 45,200 feet.

G. Improvements

The proposed improvements included in this report consists of the following:

Cottonwood Creek
Drainage Basin

(G. Continued)

- a--Greenbelt channel system, shaping and alignment.
- b--Proposed roadways, extension and new.
- c--Drainage structures and piping.
- d--Drainage channels
- e--Drainage outlets and catch basins.
- f--Miscellaneous drainage appurtenances.

Drainage facilities are tentatively located in present undeveloped areas to best suit anticipated land development and to contain surface run-off in greenbelt systems, piping or minor channels in order that street systems are not overloaded during storm run-off. In the case of major arterial street systems, the majority of surface run-off will be removed from the streets.

The location of proposed street extensions and new street systems including drainage structures and piping, are shown as a guide only to be able to establish drainage costs and subsequent drainage fees. Final subdivision development may vary street systems as shown on the drainage plan, however, the basic drainage requirements should be maintained.

The sizing of pipes and drainage structures allow a safety factor as final profiles are not known at this time. Some adjustment in sizing may be required when actual hydraulic gradients have been established. No entrance losses, headwater, submerged inlet or outlet conditions have been considered. Compensation for these factors have been made in sizing culverts and piping to allow all structures to flow less than full as design storm conditions.

Existing retention reservoirs as shown are used for watering livestock and irrigation and have not been considered in our hydraulic computations for run-off flows.

Cottonwood Creek
Drainage Basin

II. SUB-BASIN DESCRIPTION

- Basin A: Portion of Sections 16 and 17, Containing 419.5 Acres, 388.8 CFS at the South boundary Located in the Southerly portion of Black Forest. Relative rolling slope to moderate steep hills. Portion of area is developed, contains five (5) sub-basins.
- Basin B: Portion of Sections 20 and 29, containing 820.2 Acres, 383.0 CFS, at Southerly boundary, located in Park Forest Estates-filed subdivision. Moderately rolling terrain. Contains three (3) sub-subdivisions.
- Basin C: Portion of Sections 21, 28 and 29, containing 356.4 Acres, 150.0 CFS, at Southerly boundary, portion of Park Forest Estates. Contains no minor basins, moderate sloping terrain.
- Basin D: Portion of Sections 28 and 29, containing 125.3 Acres, 55.3 CFS, at Southerly boundary, moderate sloping terrain undeveloped area.
- Basin E: Portion of Section 29 and 32, containing 420.3 Acres, 230.3 CFS, at Southerly boundary, moderate sloping terrain, undeveloped area.
- Basin F: Portion of Sections 19, 20, 29, 30, 31, 32, and 6, Township 13 South, containing 604.9 Acres, 193.6 CFS, at Southerly boundary, moderate to steep terrain, undeveloped area.
- Basin G: Portion of Sections 4, 6, Township 13 South, 19, 24, 25, 30, 31, 36, containing 1682.2 Acres, 676.3 CFS, at Southerly boundary, moderate to steep terrain, undeveloped area. Contains five (5) sub-basins.
- Basin H: Portion of Sections 5 and 6, Township 13 South, 31 and 32, containing 388.0 Acres, 167.8 CFS, at Southwesterly boundary moderate sloping terrain, portions developed (Holiday Hills) no minor basins.
- Basin I: Portion of Section 6, containing 165.1 Acres, 82.0 CFS at Westerly boundary, moderate sloping terrain, portions developed.

Cottonwood Creek
Drainage Basin

- Basin J: Portion of Section 6, containing 84.0 Acres, 42.0 CFS, at Northwesternly boundary, moderate sloping terrain, portion developed.
- Basin K: Portion of Sections 1 and 6, containing 146.1 Acres, 74.7 CFS, at Northwesternly boundary, moderate to steep terrain portions developed, (Westview Estates).
- Basin L: Portion of Section 25 and 36, and 1, Township 13 South, containing 975.1 Acres, 393.8 CFS at Southerly boundary moderate to steep sloping terrain, undeveloped area, four (4) sub-basins.
- Basin M: Portion of Section 35, 36, and 2, Township 13 South, containing 344.0 Acres, 146.0 CFS, at Southerly boundary, moderate to steep sloping terrain, undeveloped area.
- Basin N: Portion of Section 36, 2, and 4, Township 13 South, containing 390.5 Acres, 164.3 CFS, at Southerly boundary, moderate to steep sloping terrain, undeveloped area.
- Basin O: Portion of Section 1, 11, and 12, Containing 269.3 Acres, 117.0 CFS, at Southerly boundary, moderate sloping terrain undeveloped area.
- Basin P: Portion of Sections 6, 7, 11, 12, 13, 14, containing 2018.5 Acres, 979.5 CFS, at Westerly boundary, moderate to steep sloping terrain, portion developed, nine (9) sub-basins (Templeton Gap Heights).
- Basin Q: Portion of Section 3, 4, 10, 11, containing 331.8 Acres, 138.3 CFS, at Southerly boundary, relatively steep terrain undeveloped area.
- Basin R: Portion of Section 11, 14, containing 380.1 Acres, 165.1 CFS, at Northerly boundary, steep terrain, undeveloped area.
- Basin S: Portion of Section 10, 11, 14, 15, containing 151.2 Acres, 70.8 CFS, at Northerly boundary, steep terrain, undeveloped area.
- Basin T: Portion of Section 10, 15, containing 370.3 Acres, 283.1 CFS, at Northerly boundary, steep terrain, undeveloped area.

Cottonwood Creek
Drainage Basin

- Basin U: Portion of Section 3, 10, containing 757.2 Acres, 470.7 CFS, at Southerly boundary, moderate to steep terrain, portion developed (Falcon Estates).
- Basin V: Portion of Section 9, 10, 15, 16, containing 424.7 Acres, 263.3 CFS, at Northerly boundary, moderate to steep terrain, undeveloped area.
- Basin W: Portion of Section 15, 16, containing 744.7 Acres, 247.0 CFS, at Northwesterly boundary, moderate sloping terrain, portion developed.
- Basin X: Portion of Sections 3, 4, 9, 10, containing 316.4 Acres, 211.1 CFS, at Southerly boundary, moderate sloping terrain, developed area, (Falcon Estates and Brookwood).
- Basin Y: Portion of Section 8, 9, containing 302.0 Acres, 202.5 CFS, at Southerly boundary, moderate sloping terrain, developed area (Falcon Estates and Brookwood).
- Basin Z: Portion of Section 8, containing 312.6 Acres, 195.5 CFS, at Southerly boundary, moderate sloping terrain, developed area, (Falcon Estates, and Yorkshire).
- Basin A₁:
Minor Portion of Sections 32, 33, 34, 35, -Township 12 South, and 2, 3, 4, 5, Township 13 South, containing 987.1 Acres, 387.9 CFS, at Southwesterly boundary, moderate sloping terrain, undeveloped area, three (3) sub-basins.
- Basin B₁:
Minor Portion of Sections 32, 33, 34, Township 12 South, and 4 and 5, Township 13 South, containing 399.3 Acres, 150.8 CFS, at Southwesterly boundary, moderate to steep sloping terrain, undeveloped area.
- Basin C₁:
Minor Portion of Sections 3, 4, 5, Township 13 South, containing 343.8 Acres, 136.1 CFS, at Westerly boundary, moderate sloping terrain, developed area, (Falcon Estates).
- Basin D₁:
Minor Portion of Section 5, 8, Township 13 South, containing 341.6 Acres, 231.7 CFS at Southwesterly boundary, moderate sloping terrain, developed area, (Falcon Estates).

Cottonwood Creek Drainage Basin

No detail design of drainage structures is included in this report. The actual construction design, size and configuration should be determined where specific areas requiring drainage structures are developed. At that time, detailed drainage reports will be prepared.

It is intended in this report to calculate run-off quantities using nominal run-off (Q) of 0.4 to 0.6. These percentages are based on areas within the Cottonwood Creek Basin to be developed, or that are developed in a manner of larger than normal tracts, lots or acreages and without extensive roadway surfacing or curb and gutter.

In future development, if areas are subdivided in denser tracts or lots and paved streets with curb and gutter, a higher run-off factor should be used and the square foot opening requirements of structures checked for capacity.

The design of pipe and structures in this report has considered the possibility of increased flows in the future and have therefore applied a safety factor in sizing these structures.

Cottonwood Creek
Drainage Basin

<u>Basin</u>	<u>Acre</u>	<u>Sq. Mi.</u>	<u>L (Ft.)</u>	<u>H (Ft.)</u>	<u>Tc (Hrs.)</u>	<u>Tp (Hrs.)</u>	<u>Q (In.)</u>	<u>Qp (CFS)</u>
A1	246.69	.39	5600	200	.325	.6950	.4	108.64
A2	68.60	.11	2800	100	.200	.520	.4	40.9
A3	58.02	.09	2000	70	.155	.593	.4	29.5
A4	36.12	.06	1400	45	.130	.578	.4	20.1
A5	10.08	.016	800	20	.09	.554	.4	7.04
B1-West	188.31	.29	2400	120	.160	.596	.4	95.15
B1-East†	188.31	.29	3600	120	.240	.644	.4	87.7
B2	276.86	.43	3800	110	.270	.662	.4	126.13
B3	166.69	.26	4800	160	.30	.680	.4	74.02 (H-1)
C	356.36	.56	7300	260	.360	.716	.4	150.6 (H-1)
D	125.29	.20	5400	220	.340	.704	.4	55.31 (H-1)
E	420.25	.66	4800	160	.300	.580	.4	230.30 (H-2)
F	604.88	.95	15600	520	.750	.950	.4	193.6
G1	521.90	.82	8600	360	.420	.752	.4	211.10
G2	356.61	.56	7200	400	.360	.716	.4	151.42
G3	284.71	.45	6800	200	.420	.752	.4	115.82

Cottonwood Creek
Drainage Basin

<u>Basin</u>	<u>Acre</u>	<u>Sq. Mi.</u>	<u>L (ft.)</u>	<u>H (ft.)</u>	<u>Tc (hrs)</u>	<u>Tp (hrs)</u>	<u>Q (in.)</u>	<u>Qp (CFS)</u>
G4	185.12	.29	8200	240	.500	.800	.4	70.2
G5	333.88	.52	8600	280	.480	.788	.4	127.76
H	388.02	.61	4000	80	.340	.704	.4	167.75
I	165.12	.26	2800	100	.190	.614	.4	81.98
J	83.97	.13	3600	160	.170	.602	.4	41.81
K	146.12	.23	2900	180	.160	.596	.4	74.71
L1	199.34	.31	6400	320	.310	.686	.4	87.50
L2	209.92	.32	6400	260	.330	.698	.4	88.75
L3	122.81	.19	6000	180	.380	.728	.4	50.53
L4	443.06	.69	9000	280	.500	.800	.4	166.98
M	343.97	.54	5800	200	.360	.716	.4	146.01
N	390.50	.61	5600	160	.365	.719	.4	164.25
O	259.34	.42	5400	200	.325	.695	.4	116.99
P1	479.59	.80	10600	340	.580	.848	.4	182.64
P2	384.30	.60	7600	240	.420	.752	.4	154.47
P3	240.08	.38	6600	180	.420	.752	.4	97.83

Cottonwood Creek
Drainage Basin

<u>Basin</u>	<u>Acre</u>	<u>Sq. Mi.</u>	<u>L (ft)</u>	<u>H (ft)</u>	<u>Tc (hrs)</u>	<u>Tp (hrs)</u>	<u>Q (in)</u>	<u>Qp (CFS)</u>
P4	221.98	.35	5000	120	.360	.716	.4	94.64
P5	178.35	.28	5200	100	.400	.740	.4	73.24
P6	271.07	.42	4200	100	.320	.592	.4	137.35
P7	84.46	.13	3000	170	.117	.570	.4	44.15
P8	74.21	.12	3600	190	.220	.632	.4	36.76
P9	84.46	.13	2600	100	.180	.608	.4	41.39
Q	331.81	.52	7200	320	.380	.728	.4	138.28
R	380.08	.59	6000	220	.320	.692	.4	165.06
S	151.24	.24	4600	180	.260	.656	.4	70.83
T	370.25	.58	5800	240	.325	.595	.6	283.08
U	757.19	1.18	8200	340	.420	.752	.6	470.70
V	424.71	.66	7200	340	.380	.728	.6	263.27
W	744.71	1.16	13800	460	.680	.908	.4	247.00
X	316.36	.49	5800	320	.290	.674	.6	211.12
Y	301.98	.47	4400	140	.290	.674	.6	202.50
Z	312.56	.49	4800	90	.380	.728	.6	195.46
A11	485.78	.759	11800	390	.860	.860	.4	170.86

Cottonwood Creek
Drainage Basin

<u>Basin</u>	<u>Acre</u>	<u>Sq. Mi.</u>	<u>L (ft)</u>	<u>H (ft)</u>	<u>Tc (hrs)</u>	<u>Tp (hrs)</u>	<u>Q (in)</u>	<u>Qp (CFS)</u>
A ₁ 2	299.42	.467	7400	410	.35	.710	.4	127.34
A ₁ 3	201.90	.315	4200	110	.30	.680	.4	89.68
B ₁	399.34	.623	10700	460	.50	.800	.4	150.77
C ₁	343.80	.537	8800	360	.44	.764	.4	136.08
D ₁	341.57	.533	3500	80	.28	.668	.6	231.71

Cottonwood Creek
Drainage Basin

ACCUMULATIVE HYDROGRAPH SYSTEM

NOTE: Numbers designate sub-basins; letter "H" designates Hydrograph Point, and/or basins.

<u>LINE</u>	<u>BASE QP</u>	<u>BASE Tp</u>	<u>LENGTH</u>	<u>S %</u>	<u>TIME/Hrs.</u>	<u>PT TP/Hrs.</u>	<u>Qp</u>	<u>VEL. FPS</u>
H-I to H-II (Accumulation of basins A-B-C & D)	839.32	0.81	4800	3.33	.085	.90	1069.62	15.75
ACCUMULATIVE TO H-III								
H-II to H-III	1069.62	0.90	4000	2.0	.087	.99	1237.37	12.83
ACCUMULATIVE TO H-IV								
H-III to H-IV	1237.37	0.99	3000	2.0	.065	1.06	1237.37	12.83
BASIN F to H-IV	193.6	0.95	15600	3.33	.275	1.23	193.6	15.75
I to H-IV	81.9	0.61	2800	3.57	.049	.66	81.9	15.75
E 1/2 G2 to 3	71.7	0.72	7200	5.55	.107	.83	71.7	18.56
G-1 to 3	211.10	0.75	8600	4.18	.141	.89	211.10	17.0
3 to H-IV	282.80	0.89	6800	2.95	.139	1.03	398.62	13.5

Cottonwood Creek
Drainage Basin

ACCUMULATIVE TO H-V								
<u>LINE</u>	<u>BASE QP</u>	<u>BASE Tp</u>	<u>LENGTH</u>	<u>S %</u>	<u>TIME/Hrs.</u>	<u>PT TP/Hrs.</u>	<u>Qp</u>	<u>VEL. FPS</u>
J to Greenbelt	41.81	.602	3600	4.44	.058	.660	41.81	17.25
E 1/2 to H-IV	37.36	.569	2900	6.2	.046	.642	37.36	17.25
G4 to Greenbelt	70.2	.800	8200	3.0	.151	.951	70.2	15.00
W 1/2 G-2 to G-5	75.7	.716	7200	5.55	.116	.832	75.7	17.25
G-5 to H-V	75.7	.704	8600	3.25	.155	.859	203.46	15.35
H-IV to H-V	1859.97	1.06	3800	2.62	.080	1.14	1971.98	13.17
ACCUMULATIVE TO H-VI								
L-3 to Greenbelt	50.53	.728	6000	3.0	.152	.980	50.53	11.0
L-1 to Greenbelt	87.50	.686	6400	5.0	.096	.782	87.50	18.56
L-1 to H-VI	87.50	.782	3600	3.33	.063	.845	129.25	15.75
L-2 to H-VI	88.75	.698	6400	4.0	.111	.809	88.75	16.0
L-3 to H-VII	50.53	.728	6000	3.0	.152	.880	50.53	11.0
H-VI to H-VII	214.25	.845	2200	2.80	.045	.890	242.05	13.50
H-VII to H-VIII	292.58	.890	3400	2.94	.067	.957	348.27	14.00
H-V to H-VIII Pickup W 1/2 of K	2098.38	1.14	1800	1.10	.049	1.19	2135.74	10.24

Cottonwood Creek
Drainage Basin

ACCUMULATIVE TO H-IX

<u>LINE</u>	<u>BASE QP</u>	<u>BASE Tp</u>	<u>LENGTH</u>	<u>S %</u>	<u>TIME/Hrs.</u>	<u>PT TP/Hrs.</u>	<u>Qp</u>	<u>VEL. FPS</u>
M to N	146.01	.716	5800	3.4	.102	.828	146.01	15.70
N 1/6 to H-IX	146.01	.828	5600	2.85	.124	.952	282.88	12.5
O to Greenbelt	116.99	.695	5400	3.70	.086	.781	116.99	17.25
H-VIII to H-IX	2455.74	1.19	4000	2.50	.087	1.28	2497.49	12.83

ACCUMULATIVE TO H-X

P3 to H-X	97.83	.752	6600	2.70	.137	.889	97.83	13.38
P4 to H-X	94.64	.716	5000	2.40	.106	.822	94.64	13.00
P5 to H-X	73.24	.740	5200	1.90	.114	.854	73.24	12.60
P6 to H-X	137.35	.592	4200	2.40	.090	.682	137.35	13.00

ACCUMULATIVE TO H-XI

P1 to H-XI	182.64	.848	10600	3.20	.196	1.04	182.64	15.00
P2 to H-XI	154.47	.752	7600	3.15	.141	.893	154.47	15.00
P7 to H-XI	44.15	.570	3000	5.67	.045	.625	44.15	18.56
H-X to H-XI	395.82	.682	3000	2.0	.076	.758	395.82	11.0

Cottonwood Creek
Drainage Basin

ACCUMULATIVE TO H-XII								
<u>LINE</u>	<u>BASE QP</u>	<u>BASE Tp</u>	<u>LENGTH</u>	<u>S %</u>	<u>TIME/Hrs.</u>	<u>Pt TP/Hrs.</u>	<u>Qp</u>	<u>VEL. FPS</u>
S to H-XII	70.83	.656	4600	3.90	.073	.729	70.83	17.50
R to H-XII	165.06	.692	6000	3.66	.098	.790	165.06	17.00
Q to H-XII	138.28	.728	7200	4.44	.110	.838	138.28	18.25
P8 to H-XII	36.76	.632	3600	5.25	.053	.689	36.76	18.60
P9 to H-XII	41.39	.608	2600	3.90	.041	.649	41.39	17.50
H-IX to H-XII + N 1/6	2737.33	1.28	5800	1.72	.140	1.42	2764.71	11.50
H-XI to H-XII	850.82	.758	3150	1.26	.087	.845	850.82	10.1
ACCUMULATIVE TO H-XIII								
T to H-XIII	283.08	.595	5800	4.10	.090	.685	283.08	17.75
U to H-XIII	470.70	.728	8200	4.10	.128	.856	470.70	17.75
H-XII to H-XIII	3350	1.42	2800	1.40	.071	1.49	3350	11.0
ACCUMULATIVE TO H-XIV								
H-XIII to H-XIV Pickup X	3675.5	1.49	8250	1.69	.191	1.68	3886.12	12.0
E 3/4 V to H-XIV	197.45	.674	5800	5.5	.087	.761	197.45	18.5
Y to H-XIV	202.50	.674	4400	3.2	.081	.755	202.50	15.0

Cottonwood Creek
Drainage Basin

ACCUMULATIVE TO H-XV								
<u>LINE</u>	<u>BASE QP</u>	<u>BASE Tp</u>	<u>LENGTH</u>	<u>S %</u>	<u>TIME/Hrs.</u>	<u>PT TP/Hrs.</u>	<u>Qp</u>	<u>VEL. FPS</u>
H-XIV to H-XV Pickup W1/4V	3982.11	1.68	3300	2.73	.068	1.75	4047.93	13.50
W to H-XV	650	See: Pulpit Rock Report				.860	650	Part II Pulpit Rock
Z to H-XV	195.46	.728	4800	1.88	.103	.831	195.46	13.0
XV to XVI END OF MAJOR BASIN DRAINAGE	4308.93	1.75	3000	2.0	.066	1.82	4482.31	12.60
S 3/4 D1 to XVI	173.78	.668	4800	2.50	.102	.770	173.78	13.00
A1-1 to XVII	170.86	.860	11800	3.3	.219	.979	170.86	15.0
A1-2 to XVII	127.34	.680	4200	2.61	.090	.770	127.34	13.0
XVII to XVIII	282.86	.979	4400	2.72	.094	1.07	372.54	13.0
B1-1 to XVIII	150.77	.800	10,700	4.29	.165	.965	150.77	18.0
XVIII to XIX	520.29	1.07	2400	3.33	.044	1.11	520.29	15.0
C1 to XIX	136.08	.764	10800	3.70	.176	.940	194.01	17.0
XIX to XX END MINOR BASIN--	698.78	1.11	2200	2.73	.041	1.15	698.78	13.38
TOTAL FLOW 698.78								
from portion basin B1 173.78								
TOTAL FLOW FROM Major Basin 4482.31								
TOTAL---5,354.87 CFS								

Cottonwood Creek
Drainage Basin

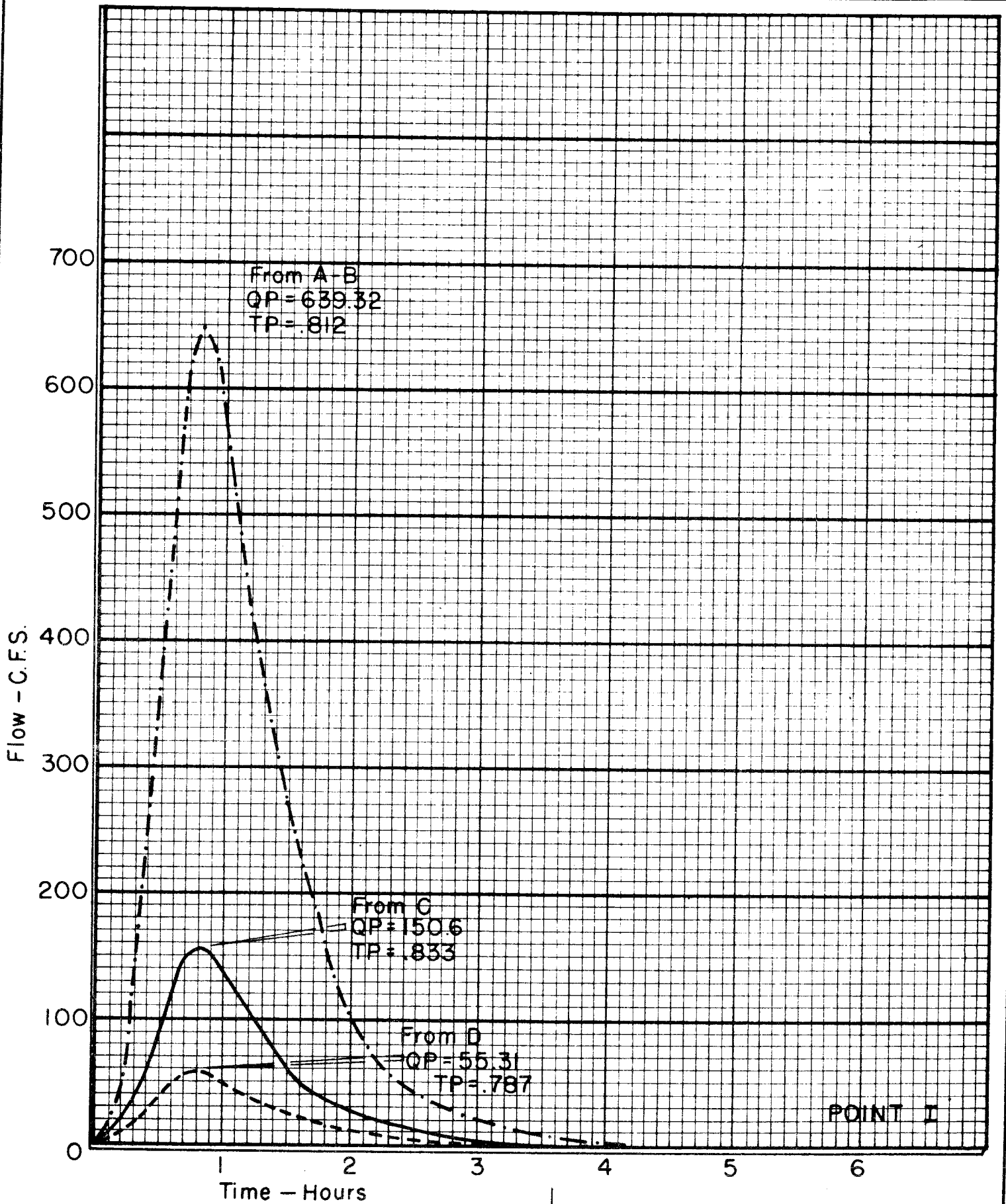
MAJOR DRAINAGE STRUCTURES
TABLE NO. 1

<u>LOCATION</u>	<u>EXISTING STRUCTURE</u>	<u>REQUIRED STRUCTURE</u>
Basin A & B @ Academy Boulevard	24" CMP	45 Square feet
Basin E	None	120 Square Feet
Basin G-3	None	35 Square Feet
Basin G- B & I	Wood Bridge	240 Square Feet
Basin K & G- 5	None	270 Square Feet
Basin N and O Northeast corner Section 11	None	320 Square Feet
Basin P-8 and 9	None	120 Square Feet
Basin Q and S	None	360 Square Feet
Basin U	None	35 Square Feet
Basin T and U	None	405 Square Feet
Basin V and X (East line Section 9)	3-148" CMP	420 Square Feet
Academy Boulevard--Cottonwood Creek	2-60" CMP	480 Square Feet

STORM SEWER PIPING
TABLE NO. 2

<u>BASIN</u>	<u>PIPE SIZE</u>	<u>CATCH BASINS</u>	<u>LENGTH</u>
E	42"-9.5 SF		100 feet
F	36"-7 SF		100 feet
	42"-9.5 SF		100 feet
	30"-5 SF	1	300 feet
	54"-16 SF		200 feet
G	42"-9.5 SF		100 feet
	60"-19.5 SF	1	1000 feet
	30"-5 SF	3	1000 feet
	60"-19.5 SF		100 feet
	36"-7 SF	1	700 feet
	48"-12.5 SF		100 feet
	78"-33 SF		100 feet
	66"-24 SF		300 feet
K	36"-7 SF	1	350 feet
	30"-5 SF	1	600 feet
L	30"-5 SF	2	700 feet
	36"-7 SF	3	1250 feet
	48"-12.5 SF		200 feet
	78"-33 SF		100 feet
N	30"-5 SF	1	800 feet
	36"-7 SF	2	600 feet
	66"-24 SF		100 feet
P	30"-5 SF	2	800 feet
	36"-7 SF	2	1300 feet
	42"-9.5 SF	2	1300 feet
	54"-16 SF		100 feet
	60"-19.5 SF		100 feet
	66"-24 SF		100 feet
Q	36"-7 SF	2	1100 feet
R	30"-5 SF	2	1100 feet
	66"-24 SF		100 feet

<u>BASIN</u>	<u>PIPE SIZE</u>	<u>CATCH BASINS</u>	<u>LENGTH</u>
S	30"-5 SF	1	400 feet
	36"-7 SF	1	1000 feet
	48"-12.5 SF		100 feet
T	42"-9.5 SF	1	500 feet
	60"-19.5 SF		100 feet
U	60"-19.5	1	450 feet
V	42"-9.5 SF	1	400 feet

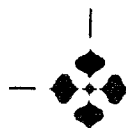
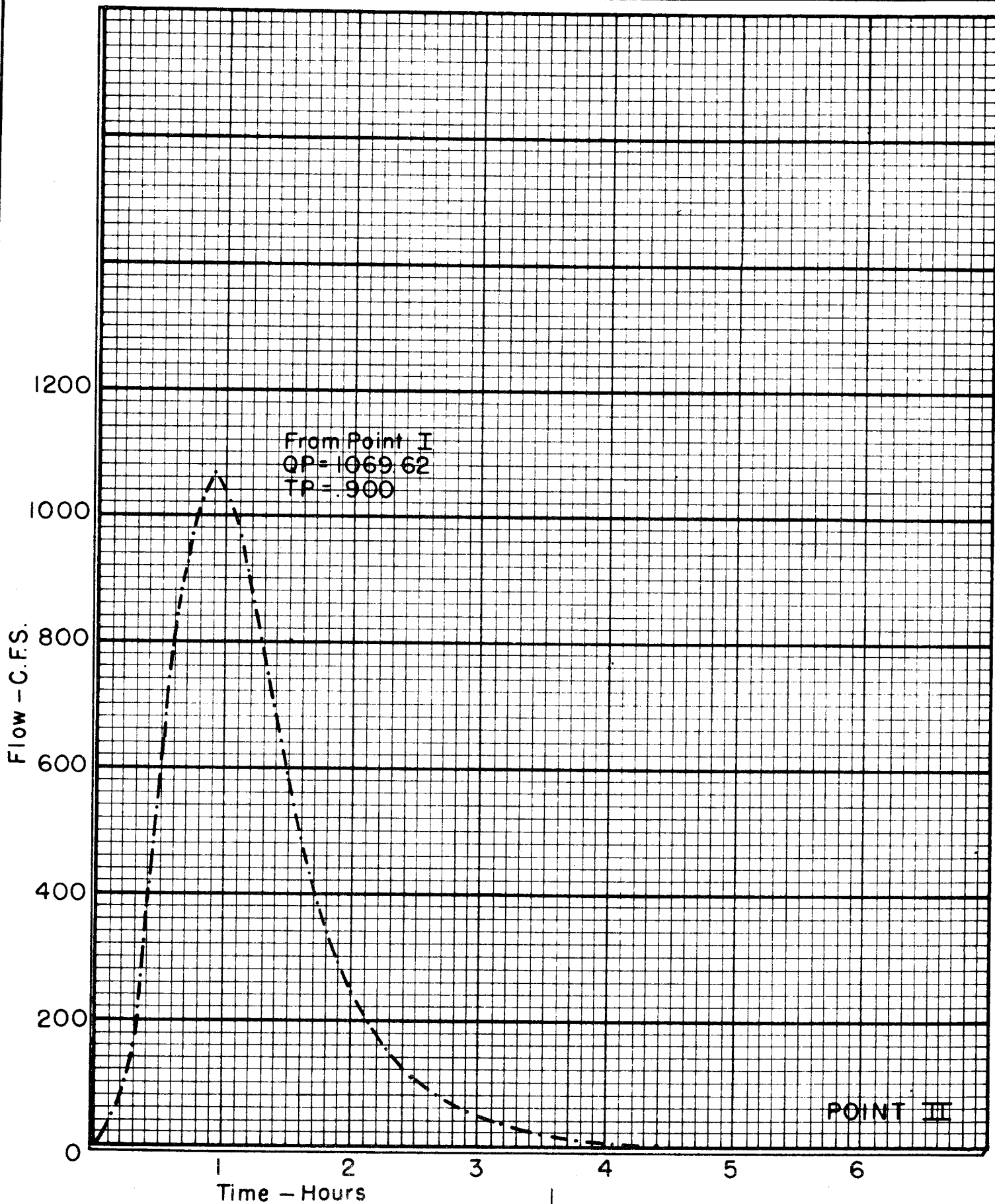


r. keith hook & associates, inc.

PHONE 473 5657

1585 E. PLATTE AVE

COLORADO SPRINGS COLORADO 80909

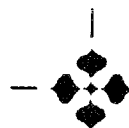
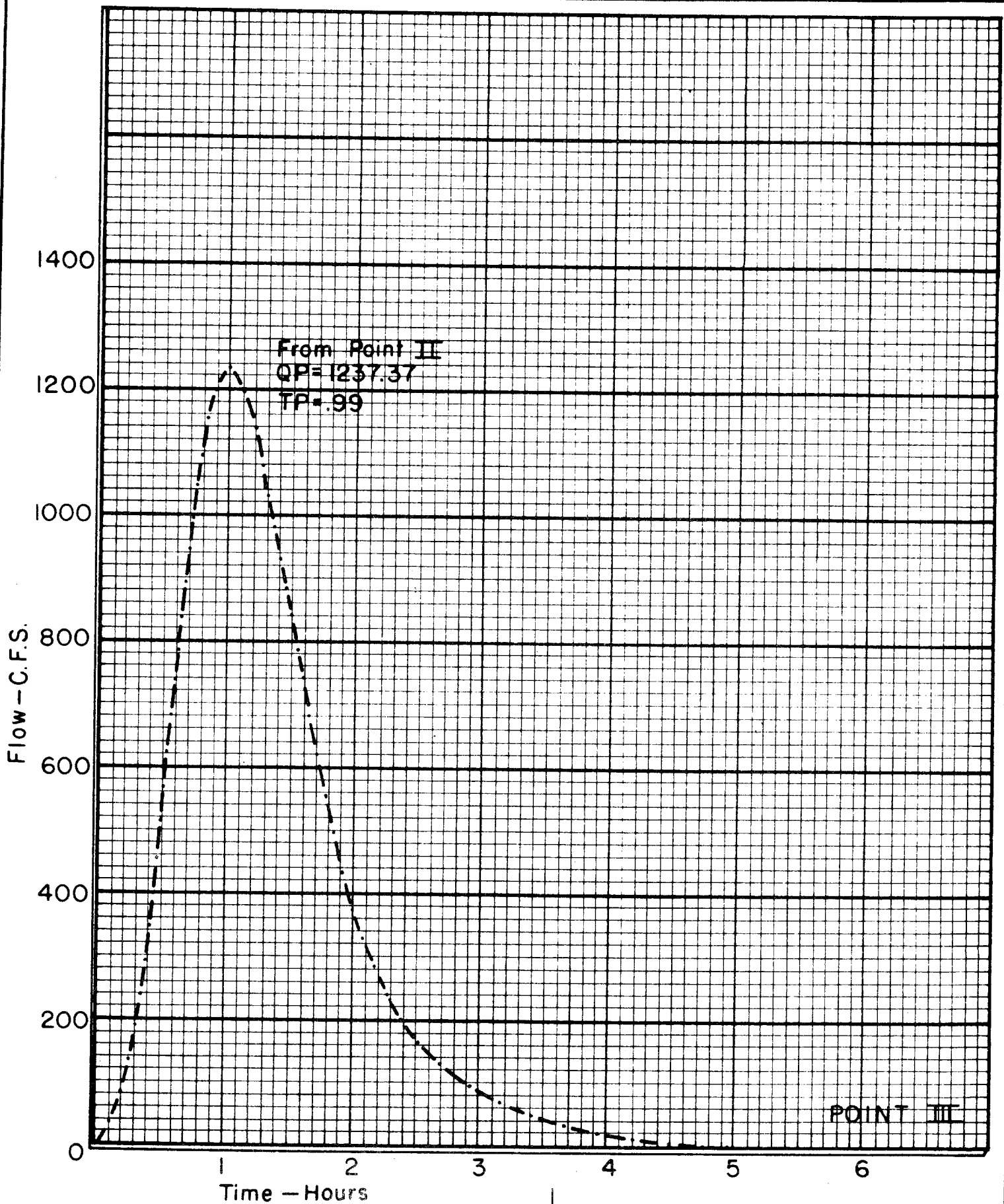


r. keith hook & associates, inc.

PHONE 473-5653

2545 E. PLATTE AVE

COLORADO SPRINGS, COLORADO 80909

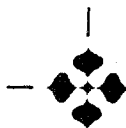
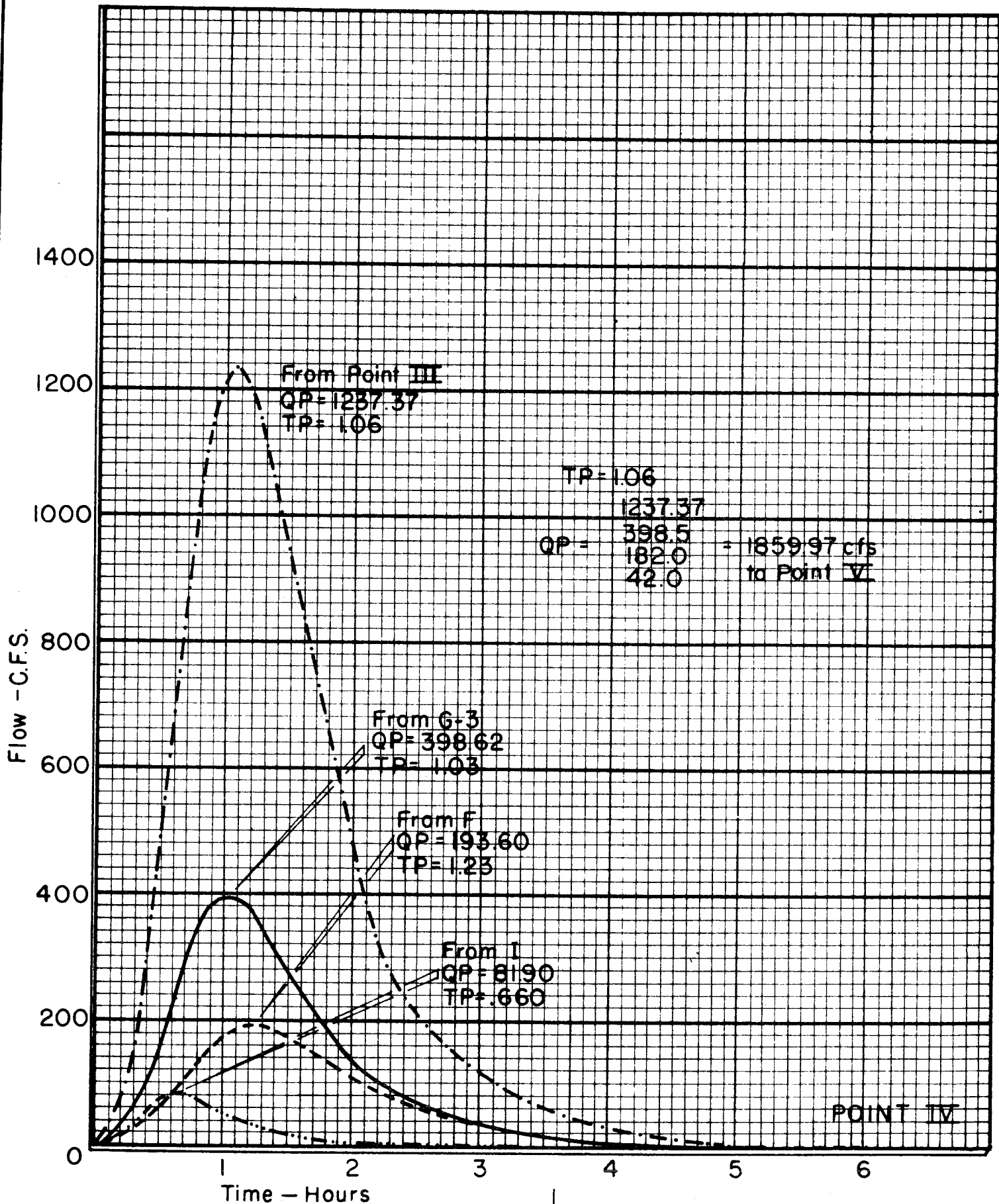


r. keith hook & associates, inc.

PHONE 473-5653

2545 E. PLATTE AVE

COLORADO SPRINGS, COLORADO 80904

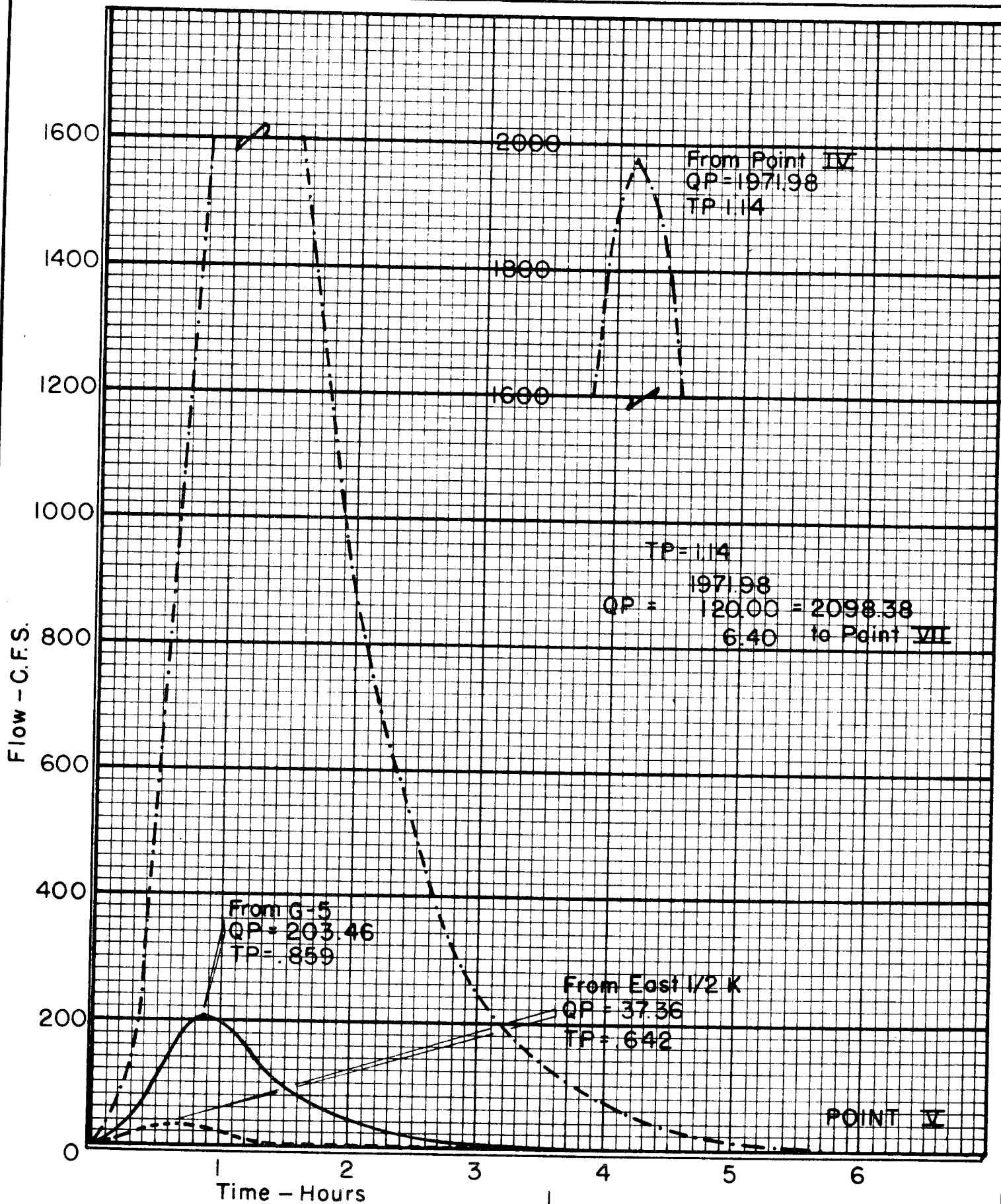


R. Keith Hook & Associates, Inc.

PHONE 473-5657

2545 E. PLATTE AVE

COLORADO SPRINGS, COLORADO 80909



r. keith hook & associates, inc.

PHONE 472 5652

2545 E. PLATTE AVE

COLORADO SPRINGS COLORADO 80909

Flow - C.F.S.

200
150
100
50
0

Time - Hours

1

2

3

4

5

6

From L-1
QP = 129.25
TP = .845

From L-2
QP = 88.75
TP = .809

TP = .845

QP = $\frac{129.25}{85.00} = 214.25$
to Point VII

POINT VII

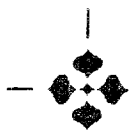
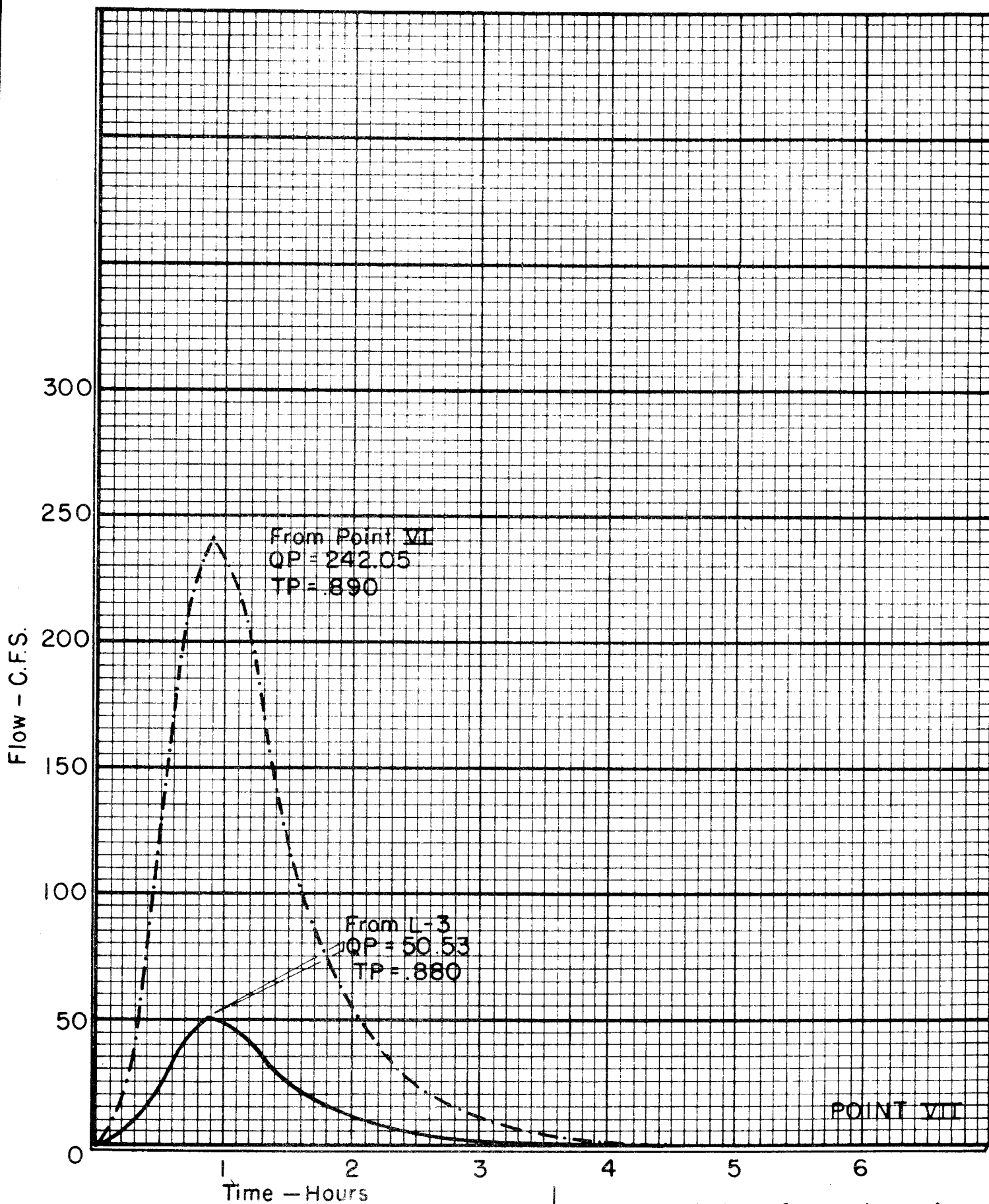


r. keith hook & associates, inc.

PHONE 473-5657

2545 E. PLATTE AVE

COLORADO SPRINGS, COLORADO 80909

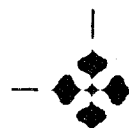
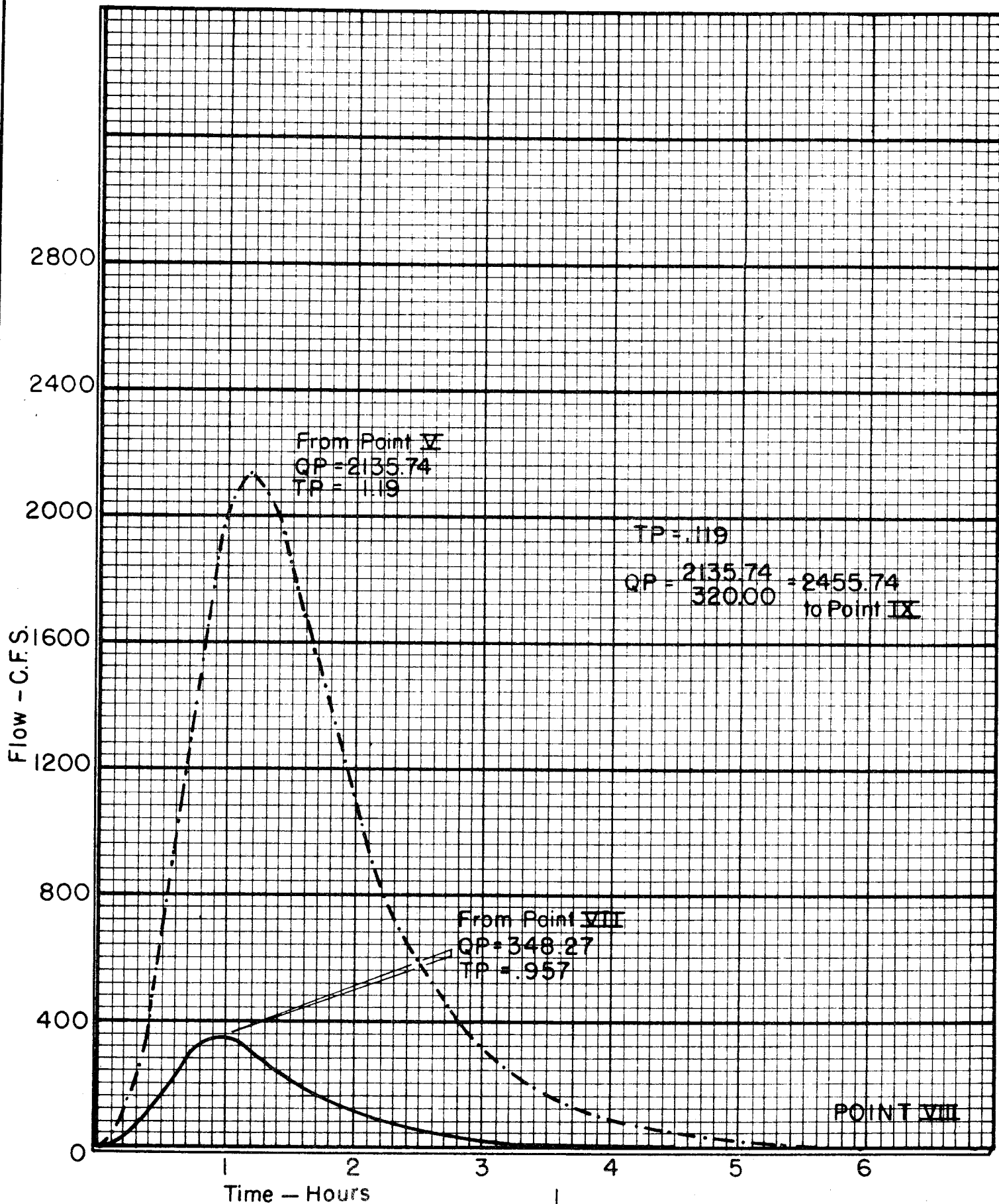


r. keith hook & associates, inc.

PHONE 477-5651

2545 E. PLATTE AVE.

COLORADO SPRINGS, COLORADO 80909

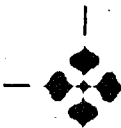
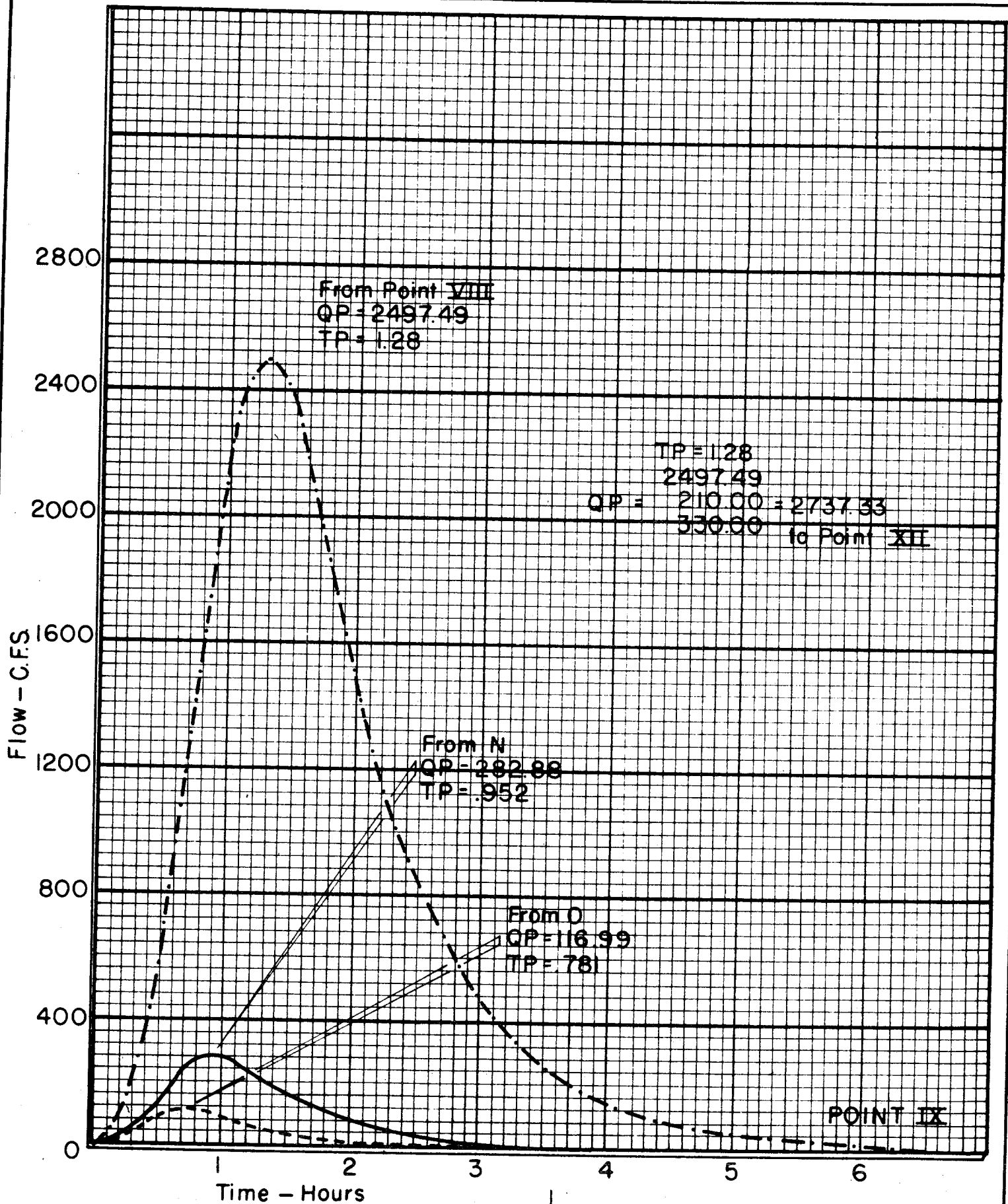


r. keith hook & associates, inc.

PHONE 473-5652

2545 E. PLATTE AVE

COLORADO SPRINGS COLORADO 80909



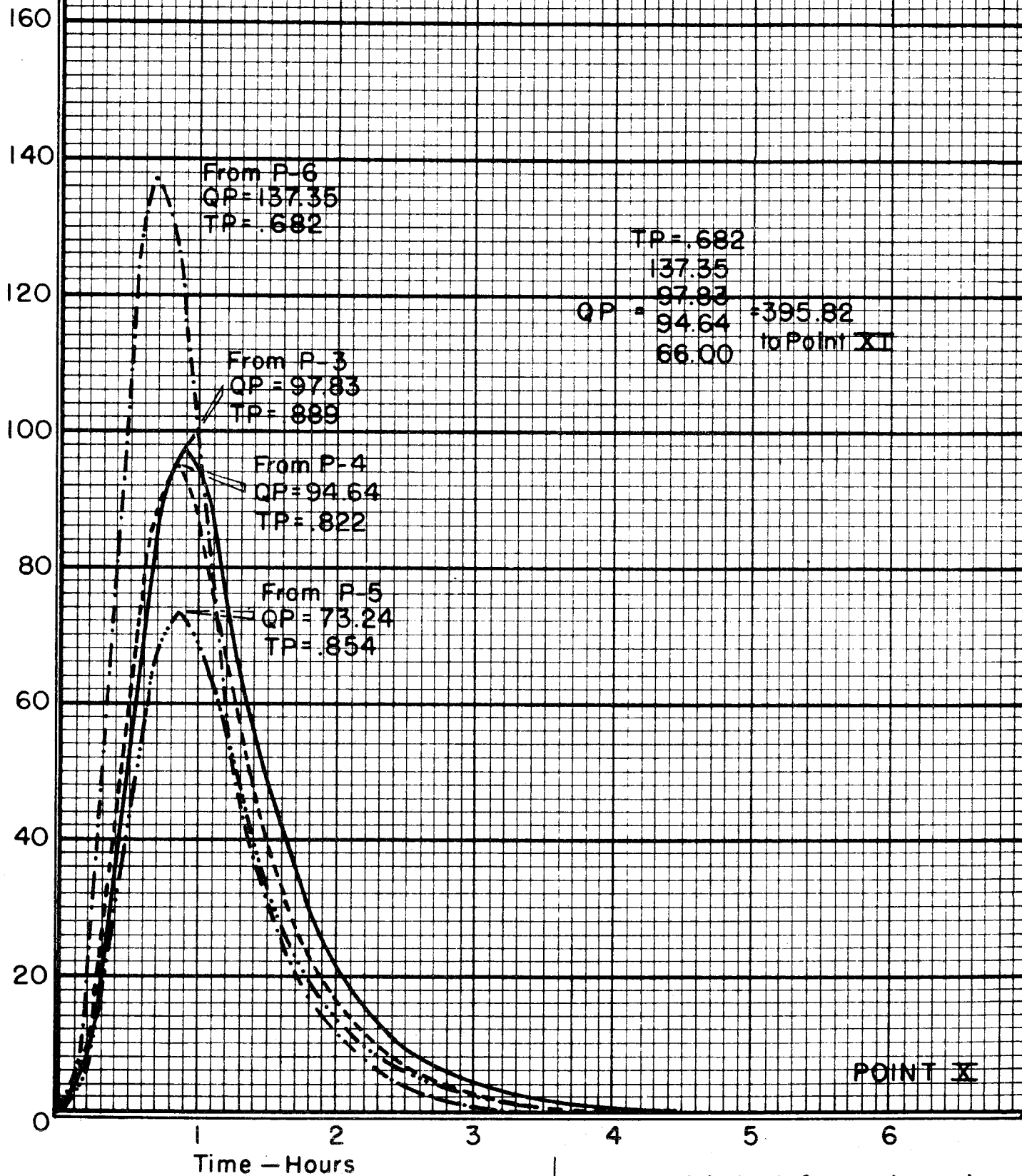
r. keith hook & associates, inc.

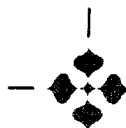
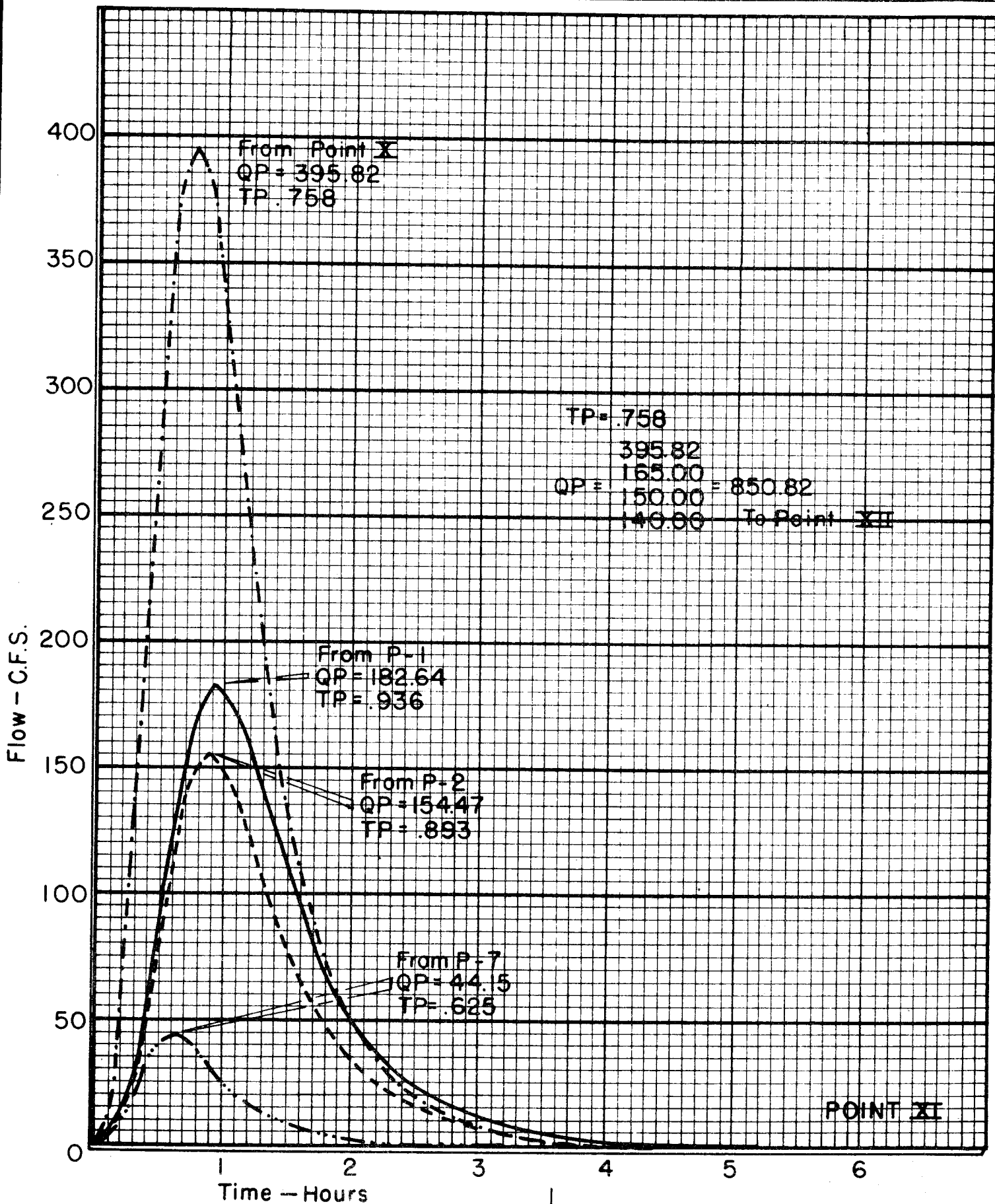
PHONE 473 5653

2545 E PLATTE AVE

COLORADO SPRINGS COLORADO 80909

Flow - C.F.S.





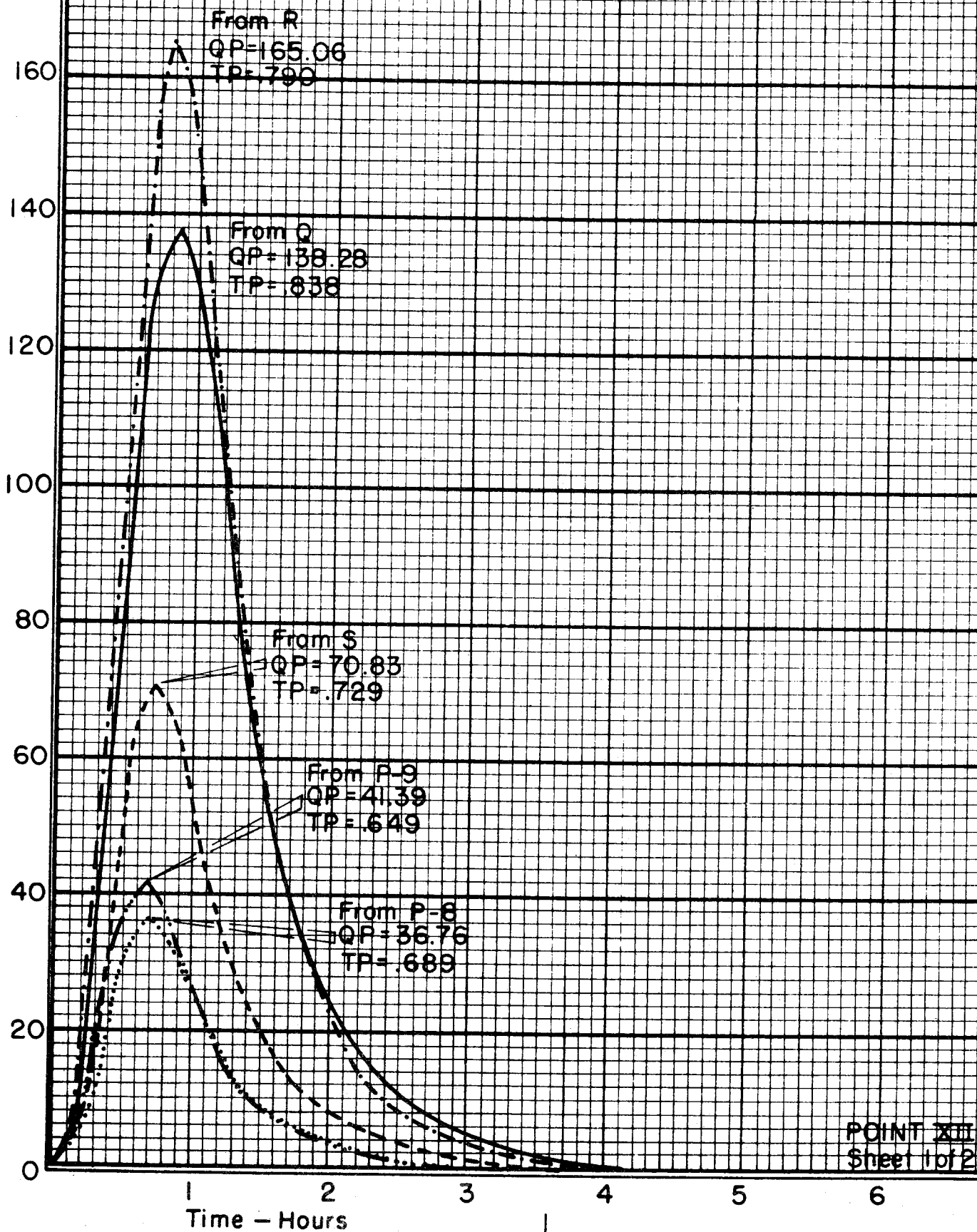
r. keith hook & associates, inc.

PHONE 473-5653

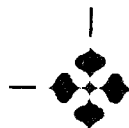
2545 E. PLATTE AVE

COLORADO SPRINGS, COLORADO, 80909

Flow - C.F.S.



POINT XII
Sheet 1 of 2



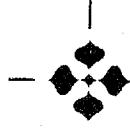
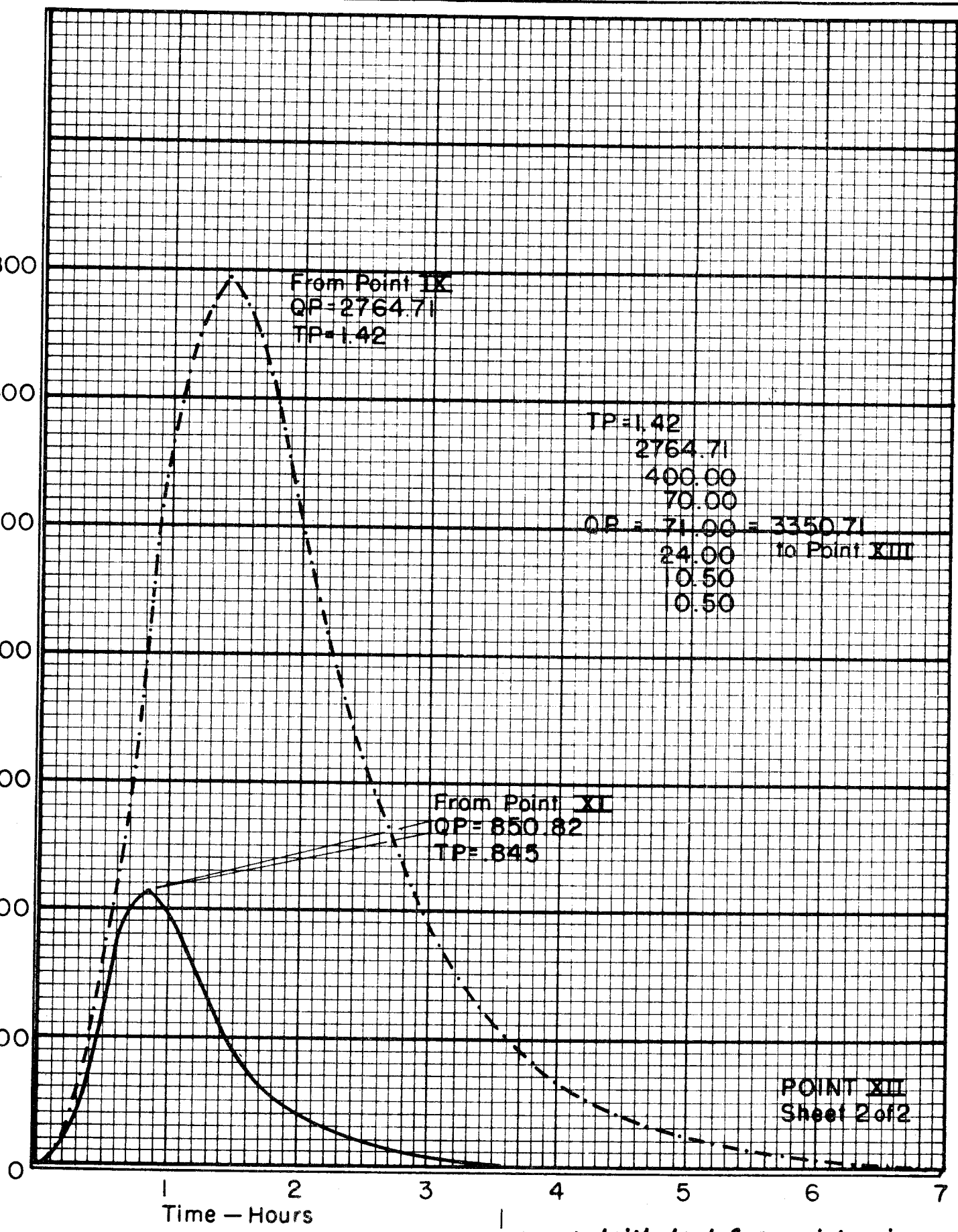
r. keith hook & associates, inc.

PHONE 473-5653

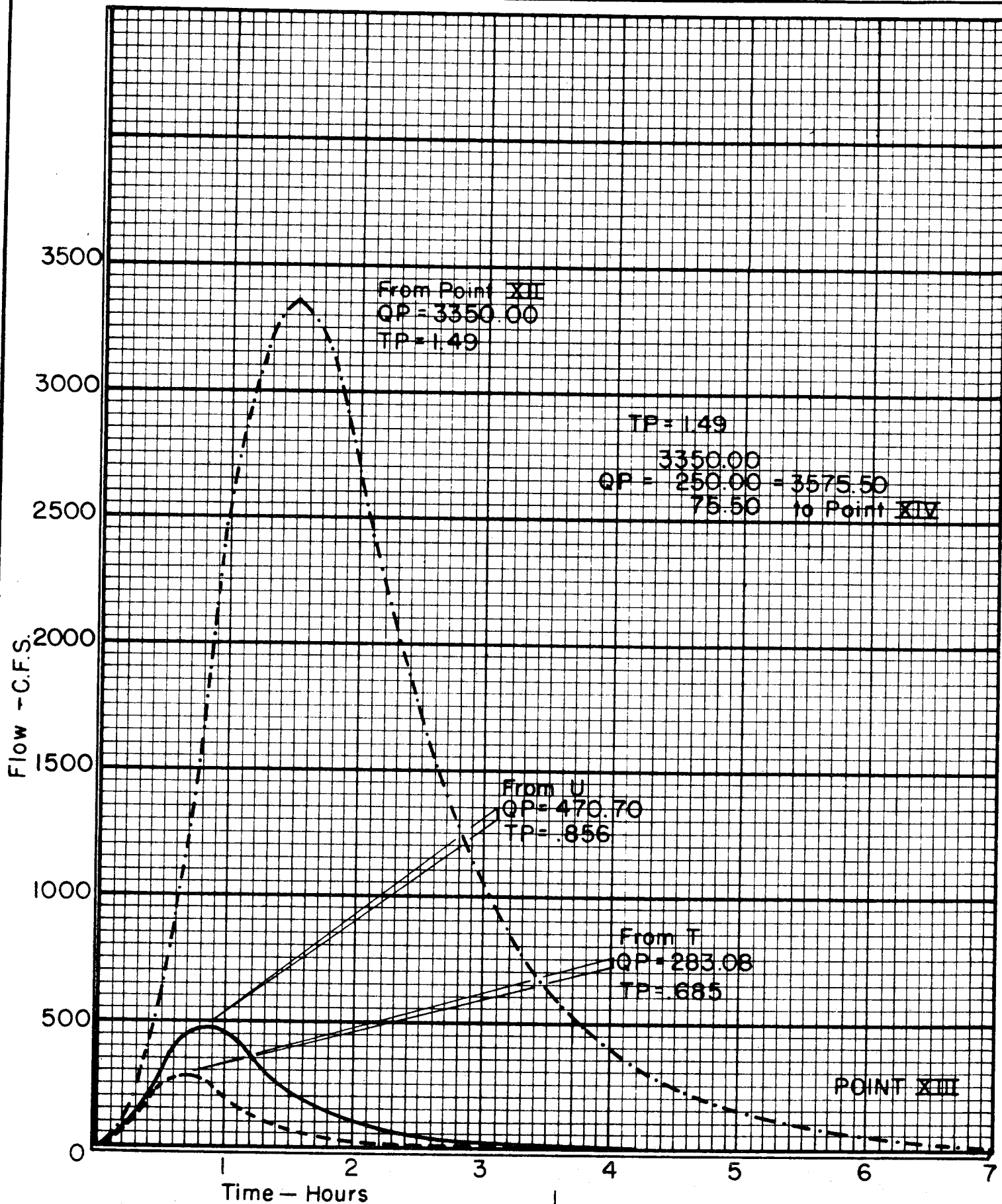
2545 E. PLATTE AVE

COLORADO SPRINGS, COLORADO 80909

Flow - C.F.S.



r. keith hook & associates, inc.

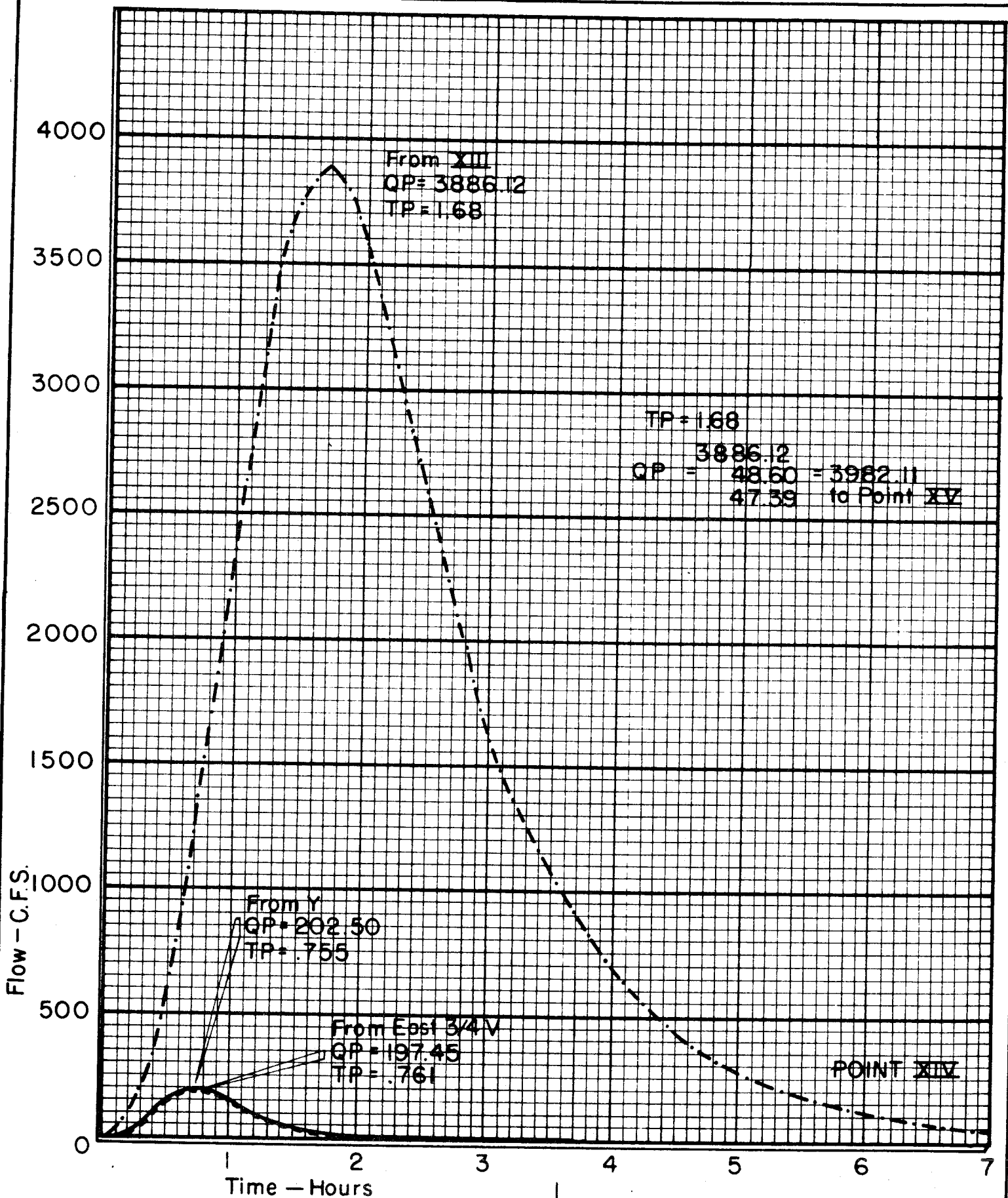


r. keith hook & associates, inc.

PHONE 473-5653

2545 E. PLATTE AVE

COLORADO SPRINGS COLORADO 80909

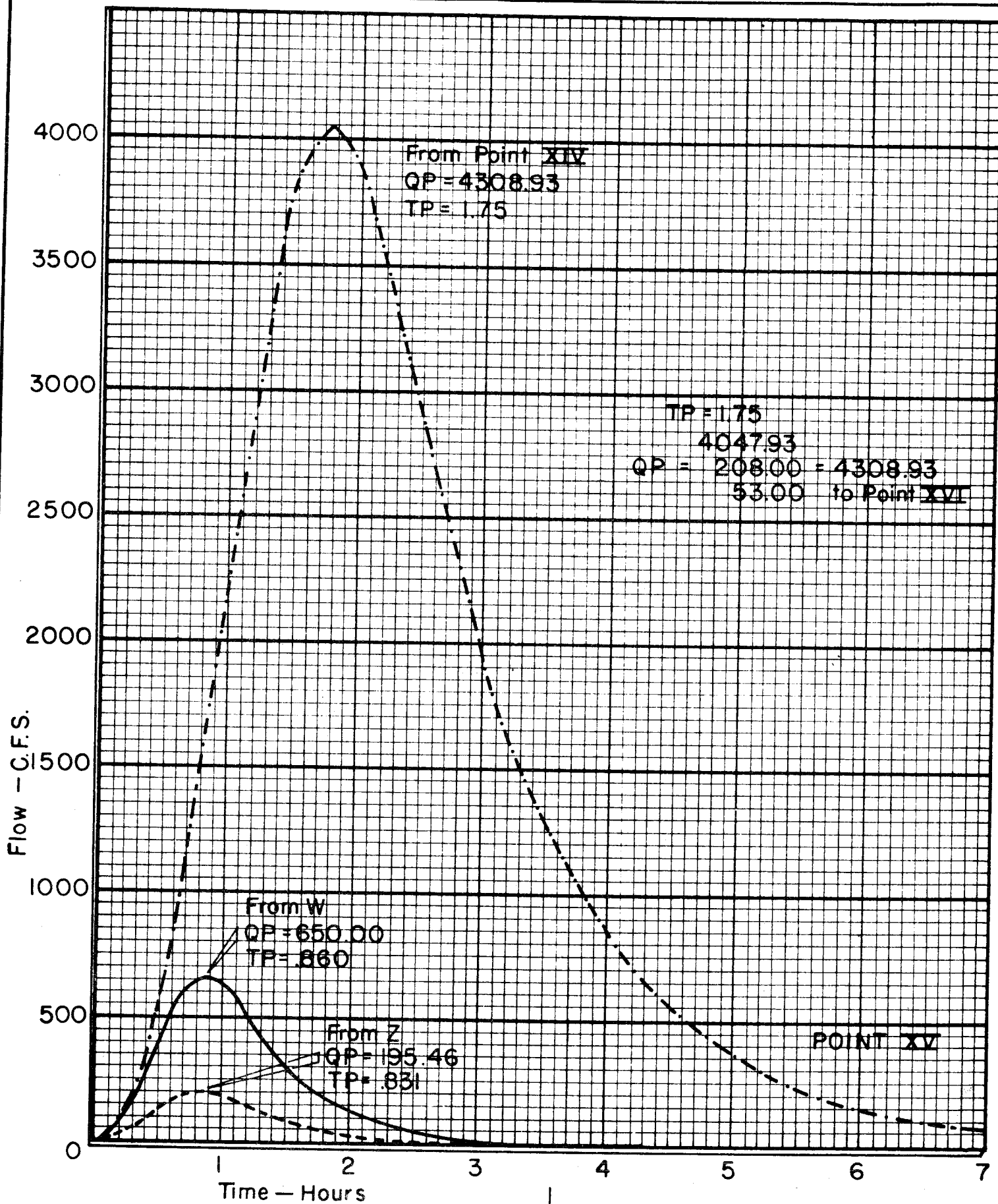


r. keith hook & associates, inc.

PHONE 473-5653

2545 E PLATTE AVE

COLORADO SPRINGS COLORADO 80909

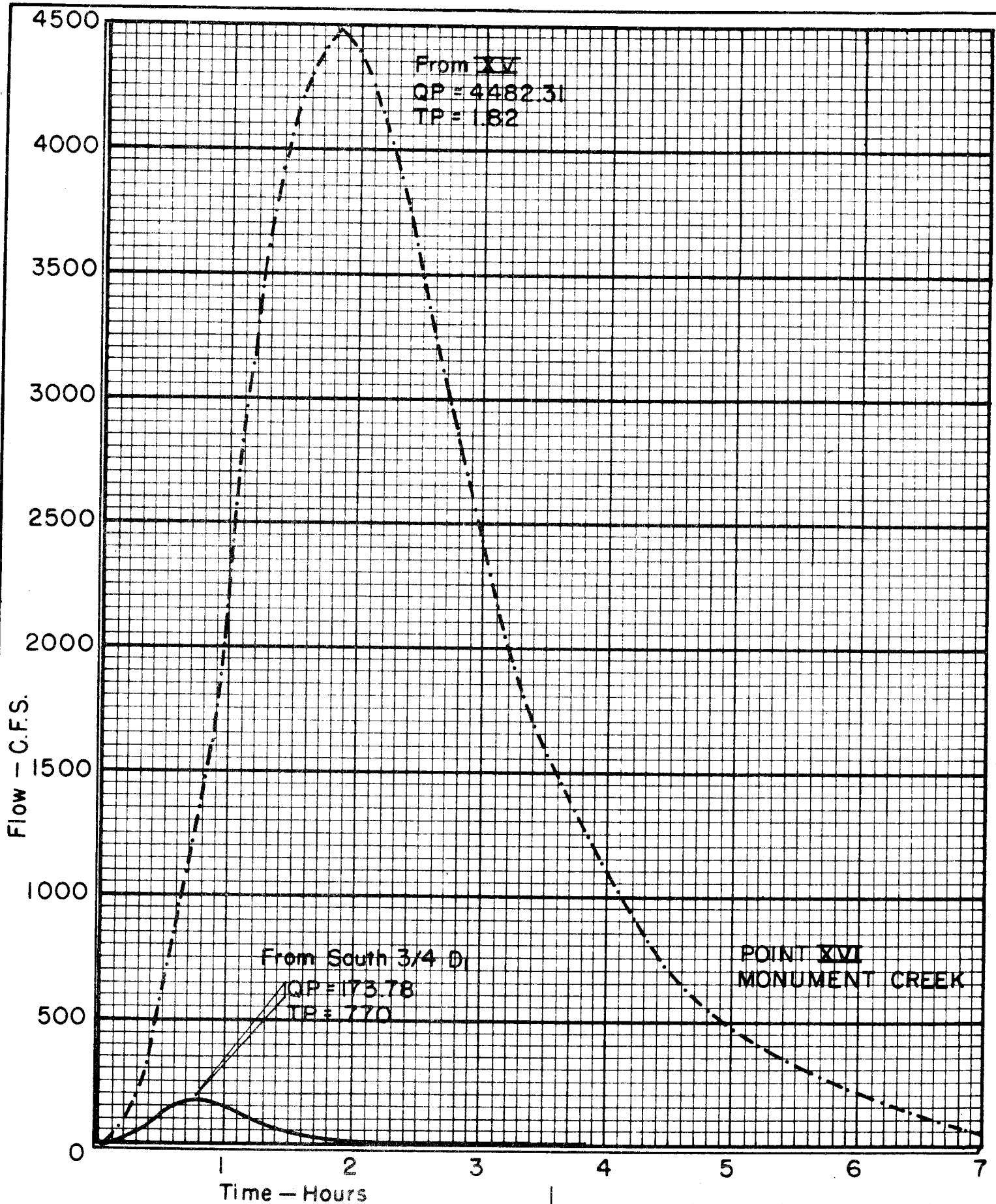


r. keith hook & associates, inc.

PHONE 473-5653

2545 E PLATTE AVE

COLORADO SPRINGS COLORADO 80905

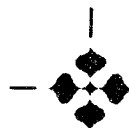
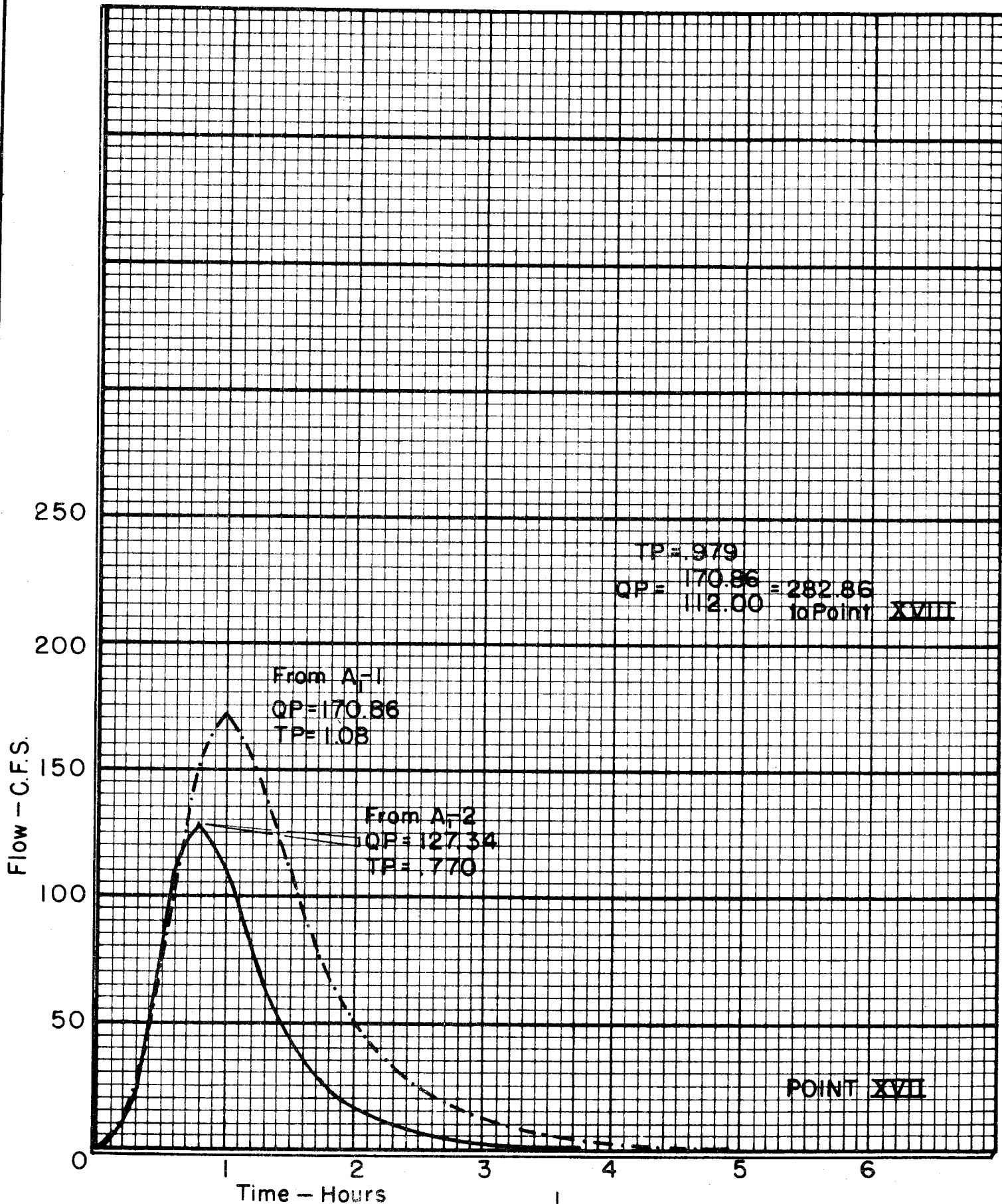


r. keith hook & associates, inc.

PHONE 473-5653

2545 E PLATTE AVE

COLORADO SPRINGS COLORADO 80909

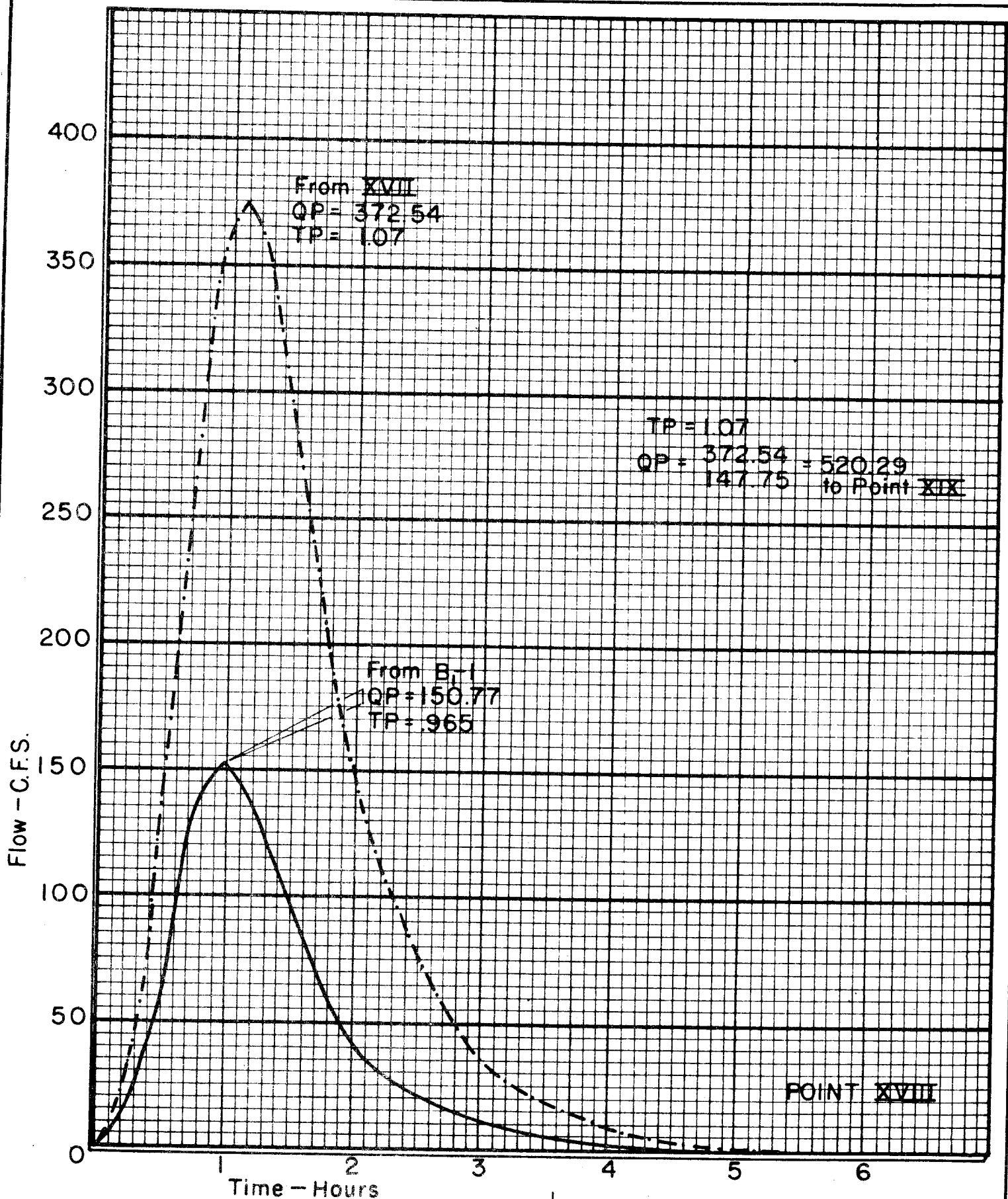


r. keith hook & associates, inc.

PHONE 473-5653

2545 E PLATTE AVE

COLORADO SPRINGS COLORADO 80909

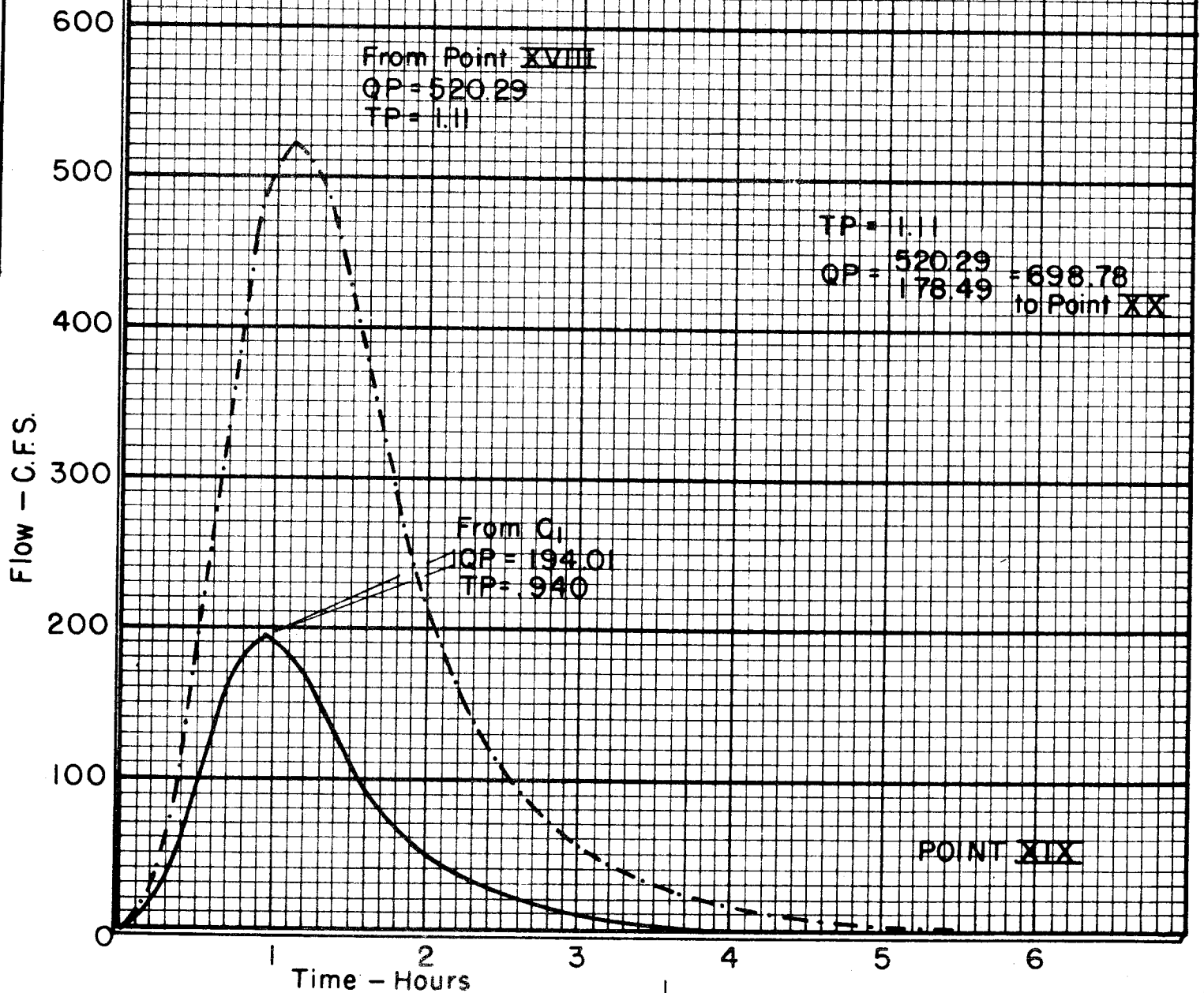


r. keith hook & associates, inc.

PHONE 473-5653

2545 E. PLATTE AVE

COLORADO SPRINGS, COLORADO 80909

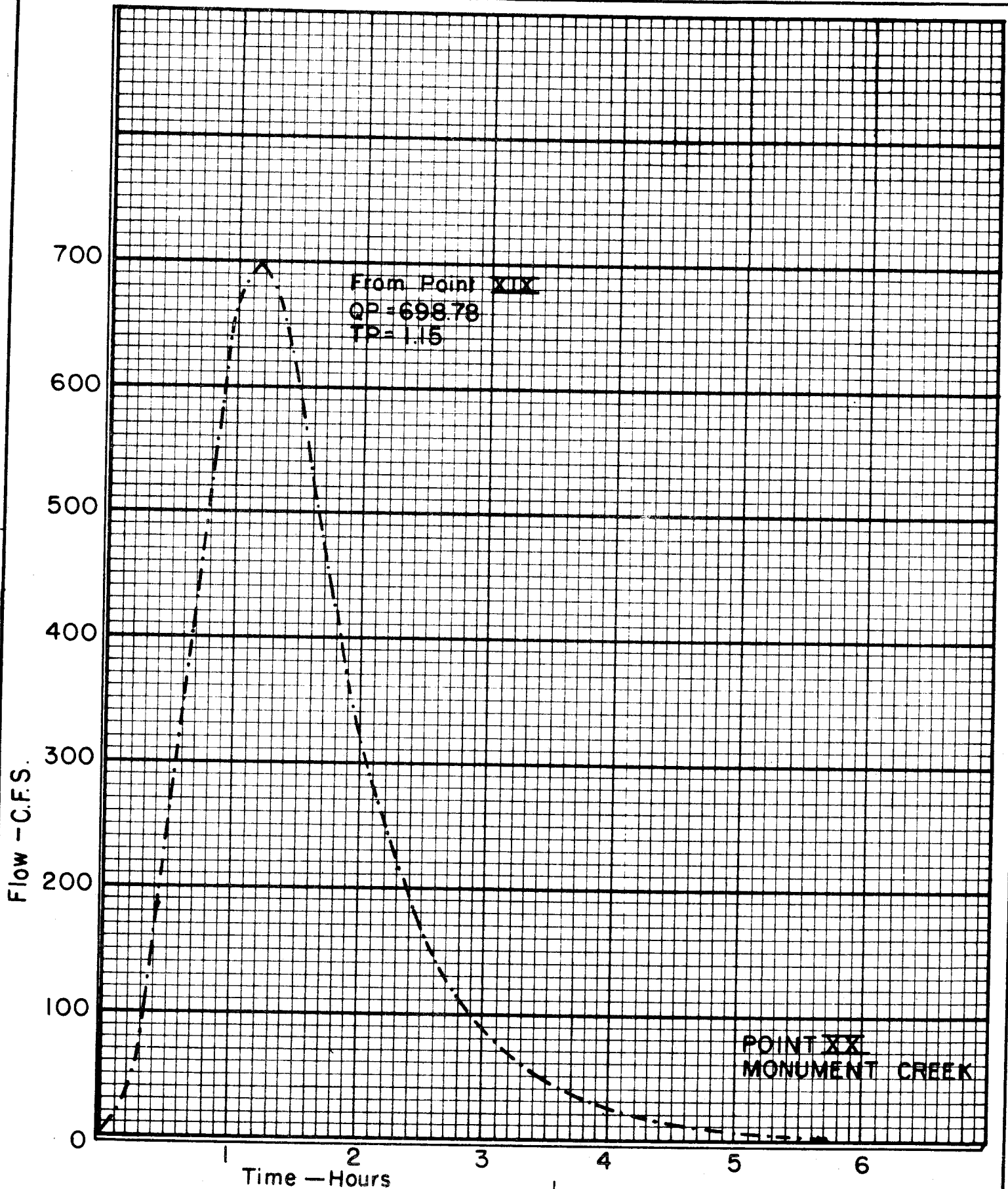


r. keith hook & associates, inc.

PHONE 473 5653

2545 E. PLATTE AVE

COLORADO SPRINGS COLORADO 80909

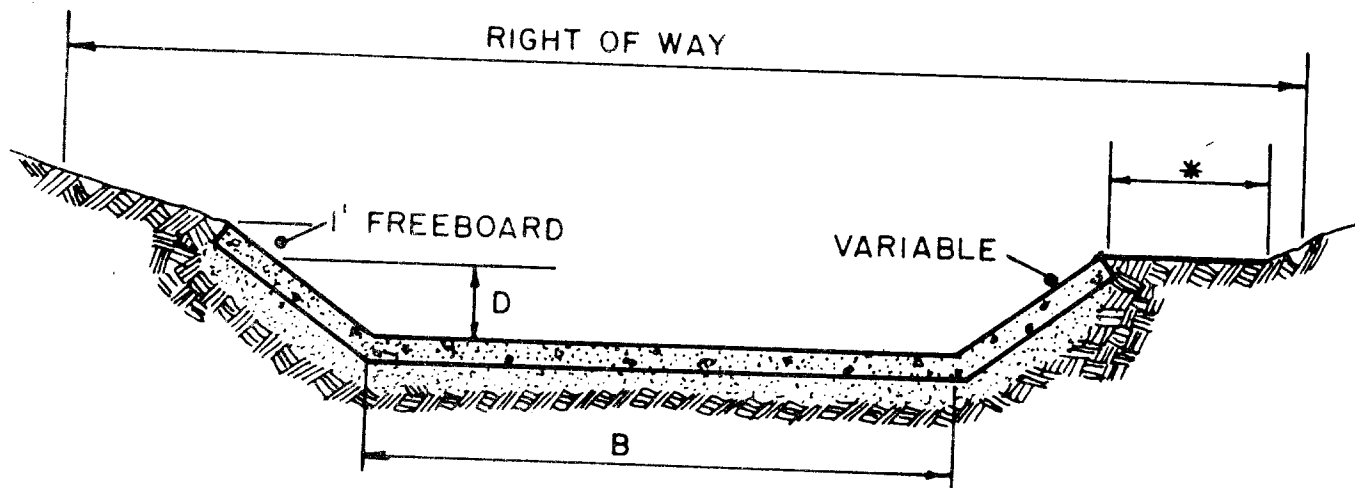


r. keith hook & associates, inc.

PHONE 473-5653

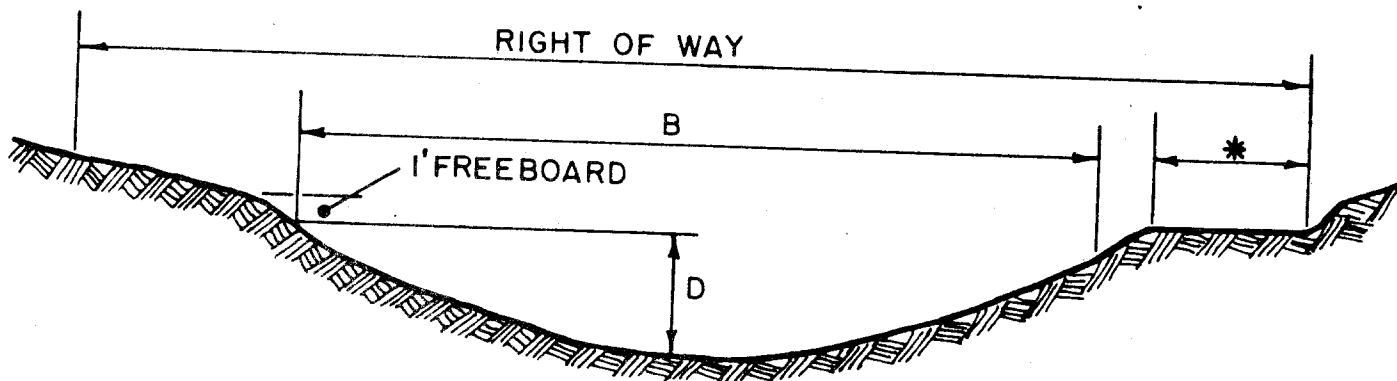
2545 E. PLATTE AVE

COLORADO SPRINGS COLORADO 80909



CONCRETE LINED SECTION

* 16' ROADWAY FOR MAINTENANCE



SWALED SECTION



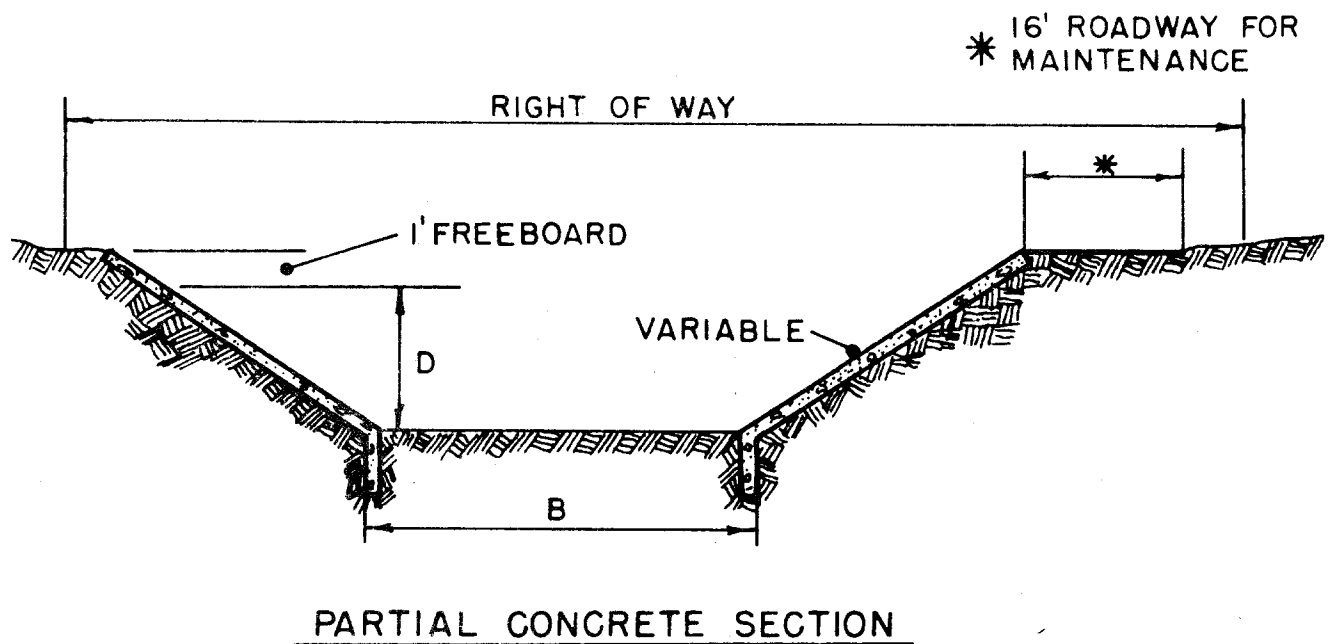
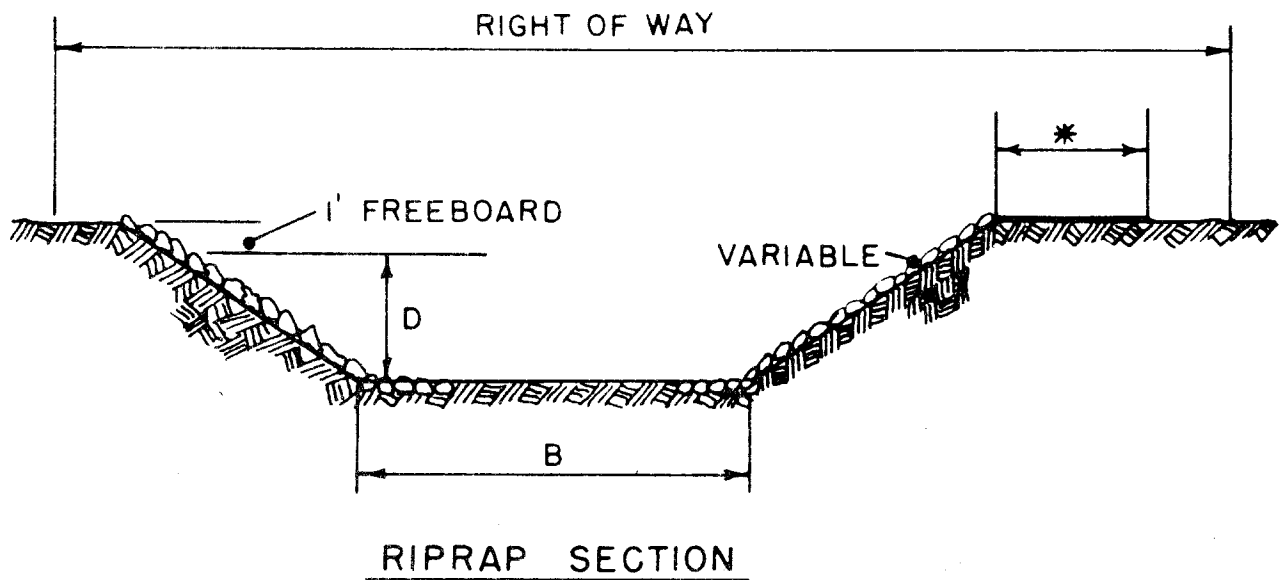
r. keith hook & associates, inc.

PHONE 473-5653

2545 E. PLATTE AVE

COLORADO SPRINGS, COLORADO 80909

TYPICAL DITCH SECTIONS



r. keith hook & associates, inc.

TYPICAL DITCH SECTIONS

PHONE 473-5653

2545 E. PLATTE AVE.

COLORADO SPRINGS, COLORADO 80909

Cottonwood Creek
Drainage Basin

ESTIMATE OF COST
(in place)

<u>ITEM</u>	<u>DESCRIPTION</u>	<u>QUANTITY</u>	<u>UNIT</u>	<u>UNIT COST</u>	<u>AMOUNT</u>
1.	Main greenbelt channel shaping & slope treatment	66,600	LF	\$15.00	\$ 999,000.00
2.	Minor drainage channels	165,650	LF	\$8.00	\$1,325,200.00
3.	Piping CMP				
	(a) 30"	5700	LF	\$14.00	\$ 79,800.00
	(b) 36"	6400	LF	\$18.00	\$115,200.00
	(c) 42"	2500	LF	\$21.00	\$ 52,500.00
	(d) 48"	400	LF	\$24.00	\$ 9,600.00
	(e) 54"	300	LF	\$29.00	\$ 8,700.00
	(f) 60"	1750	LF	\$43.00	\$ 75,250.00
	(g) 66"	600	LF	\$47.00	\$ 28,200.00
	(h) 78"	200	LF	\$87.00	\$ 17,400.00
4.	Drainage outlets catch basins or curb openings	31	EA.	\$1500.00	\$ 46,500.00
5.	Reinforced concrete culverts	60	EA.	\$30,000.00	\$1,800,000.00
6.	Rip-rapp (bank protection) 25 Areas, 1000 SY per area	25,000	SY	\$8.00	\$200,000.00
TOTAL COST---10,575 Acres					\$4,757,350.00
Cost Per acre: $\frac{\$4,757,350}{10,575}$ = \$449.86/Acre					

The estimated per acre cost excludes all areas within the major and minor basins that have been subdivided or developed. NOTE: A large portion of the sub-basins A1, B1, and C1 fall within the Chapel Hills water and sanitation district (2,077 acres) though proposed improvements are shown in these areas, their cost and the acreage of the District are not included in this cost estimate.

Cottonwood Creek
Drainage Basin

(Cost Estimate, Continued)

Reference is made to Item No. 5 of the Cost Estimate:

To provide sufficient funds for projected developments in the Cottonwood Creek Basin, roadway systems, an allowance of 60 major drainage structures at \$30,000 each has been made. This amount will equal approximately four (4) drainage structures per square mile.

A portion of these drainage structures are shown to show size requirements.