CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

OTTAWA

MINES BRANCH INVESTIGATION REPORT IR 63-117

SURFACE WATER QUALITY IN THE MARMOT CREEK PROJECT BASIN - A PROGRESS REPORT FOR THE PERIOD MAY - SEPTEMBER, 1963

by

J. F. J. THOMAS

MINERAL PROCESSING DIVISION

COPY NO. 10

DECEMBER 6, 1963

Restricted-Government Use Only

Mines Branch Investigation Report IR 63-117

SURFACE WATER QUALITY IN THE MARMOT CREEK PROJECT BASIN - A PROGRESS REPORT FOR THE PERIOD MAY-SEPTEMBER, 1963.

by

J. F. J. Thomas*

SUMMARY OF RESULTS

The chemical analyses of waters collected from mid-May to the end of September, 1963 from Marmot Creek at the boundary of the 4-square-mile Marmot Creek Project are tabulated; these data cover daily sampling until about mid-July and weekly sampling thereafter. The analyses of several stream waters tributary to Marmot Creek within the Project Basin, collected late in September, are also included.

All stream waters contain appreciable mineral content, mainly alkaline earth bicarbonates (carbonate hardness). Graphical presentations show that the dissolved mineral content and therefore total hardness of Marmot Creek water increased steadily from mid-June to the end of September during which period creek discharge decreased. Water quality was, however, not significantly affected by increased discharge of short duration due to heavy rainfall.

Some of the tributary stream waters show significant differences in quality from Marmot Creek water, especially in non-carbonate hardness (sulphate) but definite co-relations are not possible with the limited data available. A continuation of the sampling programme is recommended on both Marmot Creek and the tributary streams, with daily sampling at least during the period of high discharge (spring run-off).

---

* Head, Industrial Waters Section, Mineral Processing Division, Mines Branch, Department of Mines and Technical Surveys, Ottawa, Canada.

INTRODUCTION

At the request of the Technical Coordinating Committee for the East Slopes (Alberta) Watershed Research Program a survey of surface water quality in the 4-square-mile Marmot Creek Project basin was started in late May, 1963. In the latter part of September when the writer visited the area to review the survey program, additional samples of stream waters were collected for chemical analysis. This report details the findings of this water quality survey up to the end of September, 1963.

SAMPLING PROCEDURE

Samples of Marmot Creek water have been collected at the outlet of the discharge-measuring flume, located at the lower boundary of the Project, by officers of the Water Resources Branch, Department of Northern Affairs and National Resources, Calgary, Alberta.

Daily sampling (12 fl oz samples) was initially requested for a period of several months with submission of the samples in lots of about 12 directly to the Industrial Waters Section's laboratory at Ottawa, Ontario. The frequency of sampling was decreased by the collector after about 1 1/2 months' operation, samples then being collected at intervals of from 4 to 10 days until about August 30; since then, weekly sampling has been carried out. The sampling interval was somewhat erratic during much of July and August (see Table 1).

During the visit to the Project on September 30, the writer requested weekly sampling be carried out and personally collected samples of the several small creeks which combine to form Marmot Creek, namely Middle (Fork), Twin, and Cabin Creeks. These samples were collected directly from the streams; either near their mouths or at the discharge-measuring flumes recently installed on these streams.

Discharge records on these tributary streams were not available at the time this report was prepared.

ANALYSIS OF CREEK WATERS

The daily samples, received in lots of 12, were combined in proportion to the stream discharge, that is, the volume of each sample in the final composite (usually a 2 liter volume) is directly proportional to the discharge of that day. The number of samples that were combined varied with the discharge and with the specific conductance of each sample. In no case did the specific conductance of any sample in the composite deviate more than 15 per cent from the mean conductance of all the samples included; similarly the discharge of any one day during the composite period did not deviate 15 per cent from the mean discharge for the period.

A relatively complete chemical analysis was made of the composite sample, but such an analysis was not possible on later samples because insufficient water was received. Only major constituents, with some variation in the ones selected for test, were determined on these samples.

COMMENT

The limited amount of analytical data available at this time prevents drawing definite conclusions on water quality and on quality-quantity relationships.

However, Table 1 shows that Marmot Creek water is appreciably mineralized, most of which is hardness salts. The water increases in hardness from medium-hard in early June to very hard (over 180 ppm as $CaCO_3$) late in August and September. Some non-carbonate hardness (calcium sulphate) is present but most of the mineral content is calcium and magnesium bicarbonates. This type of water is to be expected in the calcareous Rocky Mountain area.

Alkali salts are very low and heavy metals are almost absent in these waters.

Figure 2 further illustrates the preponderance of hardness salts. As the specific conductance of Marmot Creek water increases steadily after about June 1, the total hardness increases in an almost parallel relationship. Non-carbonate hardness (sulphate) shows only a slight increase over this period, again confirming that the increase in mineral content is primarily due to solution of carbonates.

The limited data on the tributary streams show that these are also hard, bicarbonate waters, similar in character to Marmot Creek water. There is some difference in the quality of these waters, Cabin Creek water containing more minerals and harder on September 30 than either Middle (Fork) or Twin Creek waters. The average hardness and specific conductance of Cabin and Middle-Twin Creeks is 193 and 351, respectively; these values are quite close to those found for Marmot Creek water on September 25, namely 189 and 347.

Ribbon Creek, another stream of the same character in the general area of the Project, is somewhat softer and has a greater proportion of sulphate ion.

Water from the Kananaskis River, into which both Marmot Creek and Ribbon Creek eventually flow, is also a hard bicarbonate water and has a higher sulphate to bicarbonate ratio than Marmot Creek. On the basis of one day sampling, this river water is very similiar in quality to Middle (Fork) Creek water.

Although insufficient data are available, turbidity in these waters is evidently not appreciable. The heavy rainfall about July 1, shown in the discharge curves of Figures 1 and 2, only resulted in a turbidity of 2 units.

Figure 1 is a plot of the discharge of Marmot Creek versus the mineral content (specific conductance) of the water over the period of daily sampling. The mineral content parallels the discharge during most of June. Heavy rainfall about July 1 resulted in a considerable increase in discharge. This increase was not reflected in the mineral-content curve, which continued its steady rise up to mid-July. After a high about July 1, discharge decreased rapidly. These curves indicate that the increased discharge in July is due not only to rainfall but probably includes increased discharge from mineralized swamps and springs. Since the water of Cabin Creek is harder and more mineralized than the other tributary streams, information on the discharges of all tributaries, as well as such parameters as rainfall, must be considered when interpreting the steady rise in mineral content with decreasing flow up to the middle of July. Normally this type of relationship indicates a greater percentage of ground water in the stream flow. The average discharge and the specific-conductance values for the composite samples over the period of daily sampling are also shown in Figure 1.

Figure 2 which is a plot of discharge, total hardness, specific conductance and non-carbonate hardness over the entire sampling period, further illustrates the negligible effect the rapid run-off of July 1 had on Marmot Creek water quality. The increase in specific conductance with corresponding decrease in discharge following this storm, already shown in Figure 1, continued until the end of September.

RECOMMENDATIONS

Sampling of Marmot Creek at weekly intervals should be continued at least until freeze-up. Prior to the spring break-up a quality-survey programme for 1964 will be submitted. It is probable that daily sampling will be requested at least for the period of the spring break-up with twice monthly (fortnightly) sampling thereafter on Marmot Creek, a sufficient quantity of sample being obtained to permit a more complete analysis to be made.

A somewhat similiar programme is contemplated for the tributary streams and if at all possible monthly sampling of these and Marmot Creek should be considered for the winter periods.

ACKNOWLEDGMENT

The assistance of the Water Resources Branch, Department of Northern Affairs and National Resources, Calgary, in collecting and shipping samples and supplying discharge data in this survey is greatly appreciated.

TABLE 1

Chemical Analyses of Surface Waters in the Marmot Creek Project

No.	Date of sampling	Storage period (Days)	Stream discharge (Second-feet): On sampling date	Stream discharge: Monthly mean	Water temperature (°F.)	Oxygen consumed by $KMnO_4$	Carbon dioxide (calculated) (CO_2)	pH	Colour (Hazen) (Units)	Turbidity (Units)	Redox potential (mV)	Suspended matter: Dried at 105°C.	Suspended matter: Ignited at 550°C.	Residue on evaporation dried at 105°C. (Dissolved solids): P.P.M.	Tons per acre-foot	Tons per day	Loss on ignition at 550°C.	Specific conductance $K \times 10^6$ at 25°C.	Calcium (Ca)	Magnesium (Mg)
RIBBON CREEK* near MOUTH																				
1	Sept. 30/63	16:21			49.5	...	1	8.2	0	0.3	−459							253	35.3	10.4
MARMOT CREEK* at lower boundary of PROJECT AREA																				
2	May 21/63	:72	12.2		41.0	...	3	7.9	10	...	−446							252	33.8	12.5
3	May 28 - June 9†	9 av.	12.7 av.		...	2.3	1.5	8.1	10	0	−443	...	...	120	0.163	4.1 av.	42.8	202	26.6	9.4
4	June 10 - June 21†	27 av.	13.6 av.		...	...	2	8.1	10	0	−444	...	...	...			...	207	27.0	10.0
5	June 22 - June 29†	47 av.	13.5 av.		...	...	2	8.1	15	0.1	−438	...	...	...			...	241	32.9	11.9
6	June 30 - July 4†	45 av.	16.3 av.		...	3.3	2	8.2	15	2	−396	...	...	...			...	254	34.2	12.0
7	July 5 - July 10†	39 av.	13.8 av.		...	...	2	8.1	10	0.5	−397	...	...	...			...	262	35.8	13.3
8	July 15	28:	11.4		...	...	...	8.0	10	...	−407	...	...	...			...	281	39.9	14.5
9	July 18	110:	11.9		42.5	...	3	7.9	...	...	...	...	...	...			...	278	35.4	15.8
10	July 23	105:	11.2		42	...	3	7.9	...	...	...	...	...	...			...	280	38.5	14.9
11	July 29	99:	11.7		42	...	3.5	7.9	...	...	...	...	...	...			...	309	39.5	16.5
12	Aug. 6	91:	10.8		44	...	2.5	8.1	...	...	...	...	...	...			...	306	39.9	16.7
13	Aug. 12	89:	10.0		43	...	3	8.0	...	...	...	...	...	...			...	321	43.9	16.0
14	Aug. 16††	81:	10.0		46.5	...	3	8.0	...	...	...	...	...	...			...	303	45.6	17.3
15	Aug. 16†††	81:	9.75		46	...	5	7.8	...	...	...	...	...	...			...	342	46.2	15.9
16	Aug. 26	71:	9.25		44	...	2.5	8.1	...	...	...	...	...	...			...	347	47.2	17.5
17	Aug. 27	70:	9.20		47	...	6.5	7.7	...	...	...	...	...	...			...	353	45.8	18.3
18	Aug. 29	70:	9.30		45	...	4	7.9	...	...	...	...	...	...			...	352	50.1	16.7
19	Sept. 4	63:	9.05		44	...	2	8.2	...	...	...	...	...	...			...	347	47.8	16.7
20	Sept. 11	56:	9.70		46.5	...	6	7.7	...	...	...	...	...	...			...	351	49.9	16.9
21	Sept. 19	48	9.35		45	...	6	7.7	...	...	...	...	...	...			...	321	47.1	16.2
22	Sept. 25	42:	9.05		43	...	1	8.4	...	...	...	...	...	...			...	347	46.0	18.1
CABIN CREEK*, TRIBUTARY to MARMOT CREEK																				
23	Sept. 30/63	16:21			...	...	3	8.1	0	0	−477	...	...	...			...	399	53.1	19.7
MIDDLE (Fork) and TWIN CREEKS* TRIBUTARY to MARMOT CREEK																				
24	Sept. 30/63	16:21			43.0	...	0.8	8.5	5	0	−460	...	...	...			...	303	42.2	13.7
MIDDLE (Fork) CREEK* TRIBUTARY to MARMOT CREEK																				
25	Sept. 30/63	16:22			43.2	...	2	8.1	5	0	−467	...	...	...			...	320	42.0	15.4
KANANASKIS RIVER, near MOUTH																				
26	Oct. 2/63	19:21			54.5	...	1.5	8.2	0	0	−448	...	...	...			...	322	47.4	12.5

No.	Iron (Fe): Total	Iron (Fe): Dissolved	Manganese (Mn): Total	Manganese (Mn): Dissolved	Aluminum (Al)	Copper (Cu)	Zinc (Zn)	Alkalis: Sodium (Na)	Alkalis: Potassium (K)	Ammonia (NH_4)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulphate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4): Total	Phosphate (PO_4): Dissolved	Silica (colorimetric) (SiO_2)	Boron (B)	Hardness as $CaCO_3$: Non-carbonate	Hardness as $CaCO_3$: Total	Sum of constituents	Per cent sodium	Sodium absorption ratio	Saturation index	Stability index	No.
1	...	...	...	...	...	...	...	0.5	0.3	...	0.0	128	22.9	0.3	0.23	0.2	...	...	2.7	...	25.5	131	135	0.8	0.017	+0.4	7.4	1
2	...	...	...	...	...	...	...	...	...	...	0.0	147	...	0.0	...	...	...	...	...	...	15.0	136	...	...	...	...	...	2
3	...	Trace	...	0.00	0.02	0.00	0.00	0.6	0.4	0.0	0.0	116	9.2	0.3	0.11	0.3	<0.1	...	4.4	...	9.9	105	108	1.2	0.025	+0.1	7.9	3
4	...	Trace	...	0.00	...	...	...	0.6	0.4	...	0.0	120	10.3	0.0	0.09	0.1	...	...	4.2	...	10.4	108.5	112	1.2	0.025	+0.1	7.9	4
5	...	0.00	...	0.00	...	...	...	0.6	0.4	...	0.0	145	11.6	0.3	0.08	0.1	...	...	4.8	...	14.5	131	133	1.0	0.023	+0.3	7.5	5
6	...	Trace	...	0.00	0.05	...	0.00	0.6	0.5	0.0	0.0	152	10.9	0.3	0.15	0.1	<0.1	...	5.3	...	10.4	135	139	0.9	0.022	+0.3	7.5	6
7	...	0.00	...	0.00	0.01			0.6	0.4	...	0.0	155	12.3	0.1	0.11	0.1	<0.1	...	5.4	...	12.5	140	144	0.9	0.022	+0.3	7.5	7
8	...	...	...	...	...	...	...	...	...	...	0.0	173	...	0.0	...	...	...	...	...	...	17.2	159	...	...	...	...	...	8
9	...	...	...	...	...	0.001	0.000	...	...	...	0.0	168	...	<0.05	...	...	...	...	...	...	16.0	153.5	...	...	...	...	...	9
10	...	...	...	...	...	...	...	0.7	0.5	...	0.0	173	...	<0.05	...	...	...	...	...	...	15.8	158	...	...	...	...	...	10
11	...	...	...	...	...	...	...	...	...	...	0.0	181	15.7	0.1	...	...	...	...	...	...	18.8	166.5	...	...	...	...	...	11
12	...	...	...	...	...	0.000	0.075	...	...	...	0.0	183	...	<0.05	...	...	...	...	...	...	18.5	168.5	...	...	...	...	...	12
13	...	...	...	...	...	...	...	0.8	0.5	...	0.0	195	...	0.1	...	...	...	...	...	...	18.7	179	...	...	...	...	...	13
14	...	...	...	...	...	...	...	...	...	...	0.0	202	15.7	<0.05	...	...	...	...	...	...	19.0	195	...	...	...	...	...	14
15	...	...	...	...	...	...	...	...	...	...	0.0	205	15.7	0.2	...	...	...	...	...	...	17.8	185	...	...	...	...	...	15
16	...	...	...	...	...	0.000	0.000	...	...	...	0.0	207	...	<0.5	...	...	...	...	...	...	20.5	190	...	...	...	...	...	16
17	...	...	...	...	...	...	...	1.1	0.7	...	0.0	210	...	0.4	...	...	...	...	...	...	17.5	199.5	...	...	...	...	...	17
18	...	...	...	...	...	0.000	0.003	...	...	...	0.0	211	...	<0.05	...	...	...	...	...	...	20.9	194	...	...	...	...	...	18
19	...	...	...	...	...	...	...	1.0	0.5	...	0.0	208	...	<0.05	...	...	...	...	...	...	17.5	198	...	...	...	...	...	19
20	...	...	...	...	...	...	...	...	...	...	0.0	213	16.0	0.2	...	...	...	...	...	...	19.1	194	...	...	...	...	...	20
21	...	...	...	...	...	0.000	0.002	...	...	...	0.0	198	...	0.3	...	...	...	...	...	...	21.9	184.5	...	...	...	...	...	21
22	...	...	...	...	...	...	...	1.9	0.5	...	1.4	195	...	0.5	...	...	...	...	...	...	27.1	189.5	...	...	...	...	...	22
23	...	...	...	...	...	0.000	0.000	1.5	0.6	...	0.0	243	16.5	0.3	0.12	0.2	...	...	6.6	...	14.4	214	218	1.5	0.045	+0.7	6.7	23
24	...	...	...	...	...	...	...	0.8	0.3	...	2.3	162	23.8	0.1	0.12	0.2	...	...	4.4	...	24.6	162	168	1.1	0.028	+0.8	6.9	24
25	...	...	...	...	...	0.000	0.000	0.7	0.6	...	0.0	158	37.1	0.05	0.14	0.1	...	...	4.2	...	38.5	168	178	0.9	0.023	+0.4	7.3	25
26	...	...	...	...	...	...	...	0.9	0.3	...	0.0	167	30.9	0.3	0.22	Trace	...	...	3.3	...	32.8	178	176	1.1	0.030	+0.6	7.8	26

Ribbon Creek: * Sampled from shore

Marmot Creek:
* Sampled at gauge usually between 0900 and 1000 hr
† Composite of daily samples according to discharge
†† 1020 hr
††† 0900 hr

Cabin Creek: * Sampled near mouth

Middle (Fork) and Twin Creeks: * Sampled near mouth

Middle (Fork) Creek: * Sampled near mouth

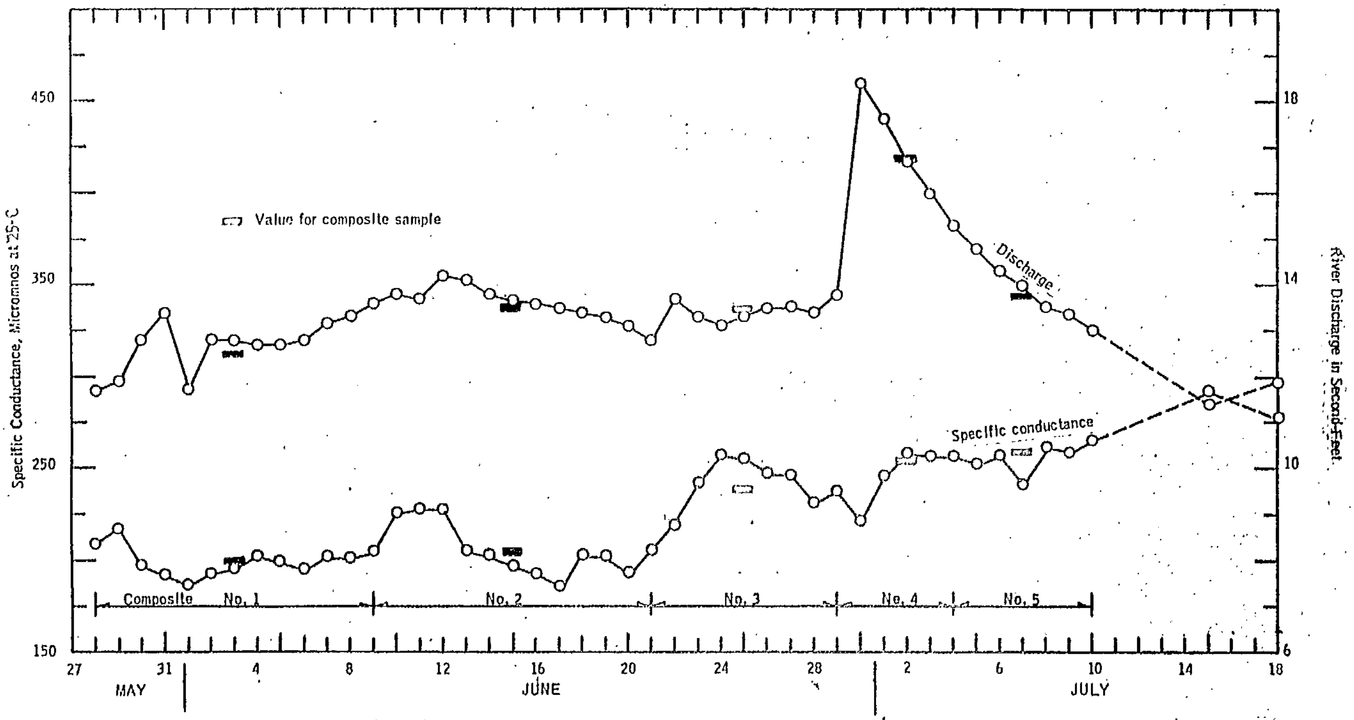

Figure 1 Daily Relationship between Specific Conductance and Creek Discharge, Marmot Creek at Gauge, May 28, 1963 – July 18, 1963

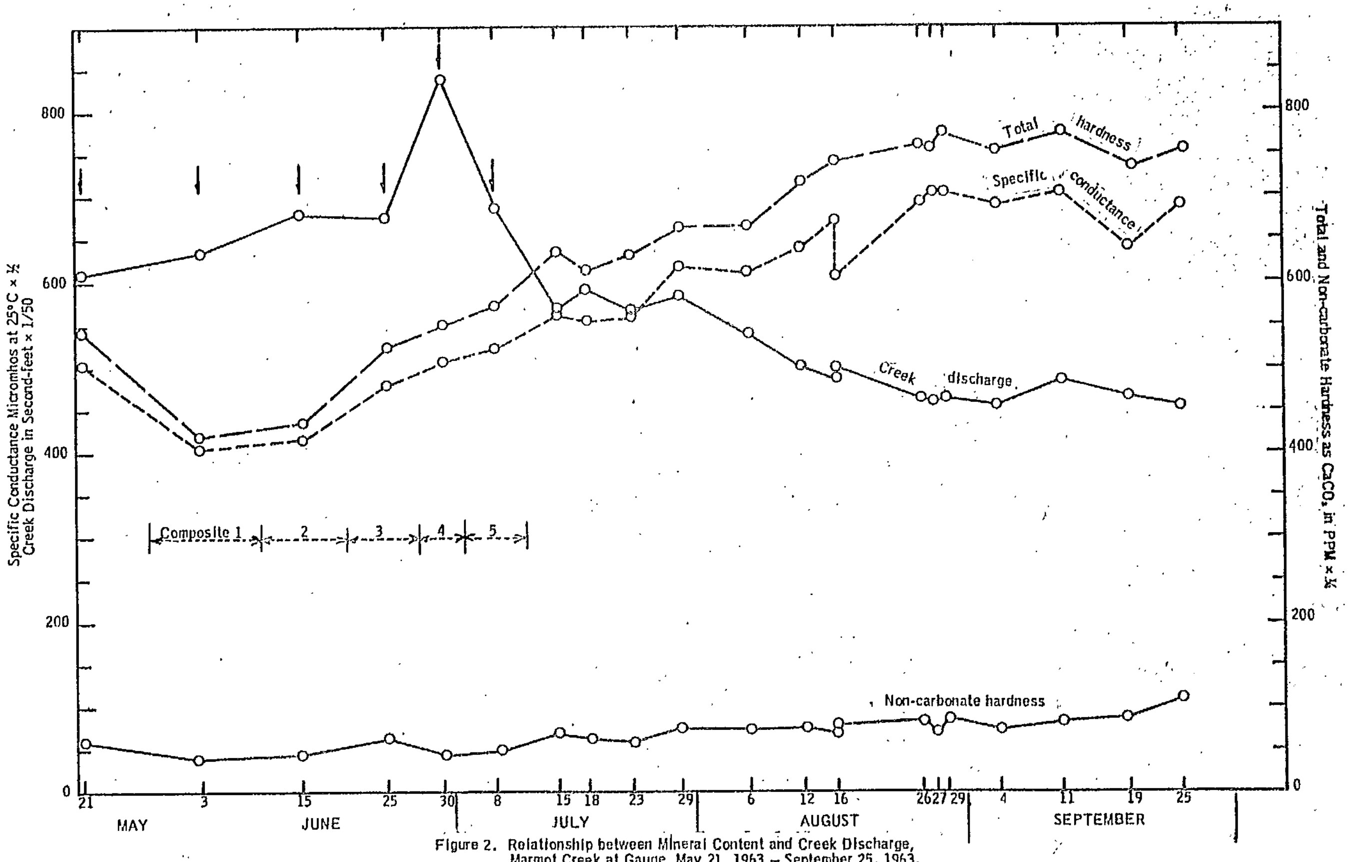

Figure 2. Relationship between Mineral Content and Creek Discharge, Marmot Creek at Gauge, May 21, 1963 – September 25, 1963.
Composite daily samples (*see also* Figure 1); values thereafter are for spot samples.