City ENGINEER Check-out Copy

CITY ENG. COPY.

HYDROLOGIC ENGINEERING STUDY

of the

ROCKRIMMON NORTH

and

ROCKRIMMON SOUTH

DRAINAGE BASINS

FOR THE

DEPARTMENT OF PUBLIC WORKS

COLORADO SPRINGS, COLORADO

MARCH 1967

KARCICH & WEBER INC.
Engineers · Planners · Consultants
Colorado Springs, Colorado

Karcich & Weber, Inc.

ENGINEERS — PLANNERS — CONSULTANTS

P. O. BOX 4291 2630 AIRPORT ROAD
COLORADO SPRINGS, COLORADO

March, 1967

Director of Public Works
City of Colorado Springs
Colorado Springs, Colorado

Dear Sir:

Enclosed herewith is the Hydrologic Engineering Study of the Rockrimmon North and Rockrimmon South Basins, authorized by the City Council of the City of Colorado Springs.

This report includes a study of the rainfall runoff characteristics, and channel improvements for the entire basins. It also includes a study of storm sewer requirements, developed basin hydrographs, and recommendations for required streets and grading in the basin. If desired, the study may be used as a "Master Drainage Plan" for the basin as it is developed in the future.

We have enjoyed preparing this study for the City and are available to answer any questions you may have in regards to it.

Very truly yours,

KARCICH & WEBER, INC.

By: Matthew F. Karcich
Matthew F. Karcich P.E.
Secretary - Treasurer

MFK/dh

HYDROLOGIC ENGINEERING STUDY

OF THE

ROCKRIMMON NORTH AND ROCKRIMMON SOUTH

DRAINAGE BASINS

FOR THE

DEPARTMENT OF PUBLIC WORKS

COLORADO SPRINGS, COLORADO

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ENGINEERING

Karcich & Weber, Inc.
2630 Airport Road
Colorado Springs, Colorado

Consulting Engineers

MARCH, 1967

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I. DISCUSSION & RECOMMENDATIONS

A. SCOPE AND PURPOSE:

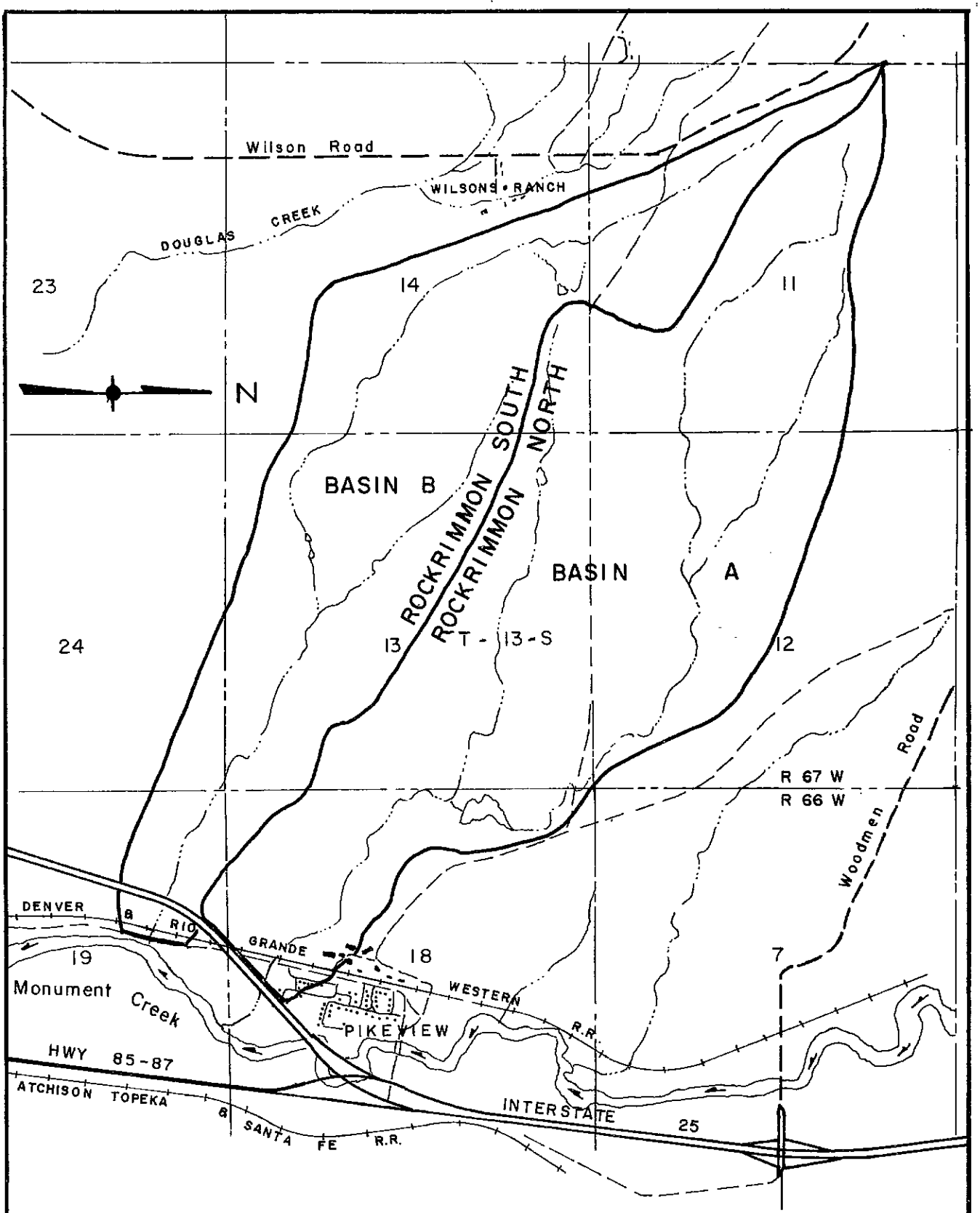
It is the intent of this report to furnish the basis for an overall plan for placing storm sewers, culverts, and drainage appurtenances in the ROCKRIMMON NORTH AND ROCKRIMMON SOUTH DRAINAGE BASINS, as subdivisions are developed. It should be a part of the overall plan for storm water control in the Metropolitan Area around Colorado Springs.

An unusual aspect of this study is the master planning that has already been developed for this area. This has enabled us to anticipate the locations of major drainage structures and to determine size and costs of the structures at the points in question.

This study does not establish the exact design details of a storm sewer or drainage channel in any definite area, but does establish the general location of required storm drainage structures and their required sizes in accordance with the planned development of the area.

Existing channels will be reserved for drainage purposes, and encroachments on them will not be allowed. According to the planned development these existing channels will be enhanced and utilized to some extent. No attempt will be made in this study to accomodate passageways of such design that the residents of the area using the bridle paths on horseback can traverse under planned major streets or roads. We have included sketches to show some pedestrian underpasses, provided the developer desires to sustain the cost. See Figures III - H-1 , 2 and 3.

Studies of undeveloped basins provide a basis for logical and relatively inexpensive overall storm drainage design. Thus, adequate storm drainage structures may be constructed as subdivisions are developed, thereby minimizing costs and avoiding potential storm damage.



LOCATION MAP

ROCKRIMMON DRAINAGE AREAS NORTH & SOUTH

FIG. I

B. BASIN DESCRIPTION:

Rockrimmon North and Rockrimmon South Drainage Basins lie adjacent to each other, northwest of Colorado Springs, east of Wilson Road, and south of Woodman Valley, being approximately 1.7 and 1.3 square miles in area respectively. Their terminal point is Monument Creek. The topography is varied being in the foothills of the Rampart Range, which is the Front Range of the Rocky Mountains. Erosion has created some precipitious slopes in the area. See Figure 1.

The Basins are drained individually by one major defined channel, which has many minor contributing branches and except after a storm, the entire stream beds are dry. They are both irregular in shape, having very narrow starting and outfall points, and being 0.9 mile and 0.6 mile respectively in width at their widest points. Drainage of the terrain is generally Southeasterly. Due to the steep slopes the water movement is fast. Existing grasses, trees and brush help to control erosion. Some soil conservation work has been accomplished in these areas. See Figures III-A, and III-B.

The soils in the basin areas are dark soils of the stream terraces with sandy subsoils, Eastonville Series, and some very shallow, common stony or gravelly soils. The Northern part has decomposed granites, and the Southern part consists of fine grained sands of the Laramie formation. Some clay will appear in the deeper strata. See Soil Classification Map III-C.

C. STUDY CRITERIA:

In the absence of measured data a synthetic hydrograph was adapted to the soil conditions of the Rockrimmon Basins.

This report is compiled from the procedures as outlined by the Soil Conservation Service and modified by the Bureau of Reclamation.

The following criteria forms the basis for the computation of the runoff hydrograph.

1. RAINFALL - 2" intensity, 1 hour duration, 50 year frequency.
2. SOIL TYPE - Soil Group C & D, Comprising Shallow Soils and common stoney or gravelly soils.
3. RUNOFF CURVE NO. - Weighted No. from the hydrologic soil cover complexes.
4. WATER SHED CONDITIONS II $I_a = 0.2S$

D. RAINFALL PATTERNS:

Average annual rainfall is low for the Basins, being about 14.49 inches per year. The major portions of this annual rainfall are in May, June, July, and August as indicated by the graph of Figure III-D. Both mountain type storms and plains type storms fall on this basin. The amount of actual moisture from snow fall is usually not high enough to lead to excessive runoff.

Storms of record in the basin fall into two categories.

1. Short, intense storms lasting up to two hours, and usually local in nature, and,

2. Long term storms lasting six hours or more, and being spread over a large area.

The long term storms last a relatively long period of time, allow high infiltration, produce a great volume of runoff, but have a relatively low flood peak. The short duration storm produces less runoff water, but being intense, has a very high flood peak.

It was found through study that the 2 inch intensity, 1 hour duration, 50 year frequency storm with soil condition II produced the highest reasonable design peak flow. This storm was used in all computations. The hydrographs in the latter sections of this report can be used to change the design storm if desired, but for the purposes of this report, all data is given for this design storm.

E. RUNOFF PATERNS:

Due to the unavailability of measured data, a synthetic hydrograph must be adapted to the soil conditions and topography of the Rockrimmon Basins. Synthetic hydrographs were produced with the method developed by the Soil Conservation Service and modified by the bureau of Reclamation, as previously outlined. See Figure III-E.

The Rockrimmon North Basin was divided into 12 drainage sub-basins and 23 minor basins, as shown in the drawings. An outfall point was assigned to each sub and minor basin and a synthetic hydrograph constructed for these points. The hydrographs of each minor basin were combined to form hydrographs for the outfall point of each of the sub-basins.

The Rockrimmon South Basin was divided into 13 drainage sub-basins and 8 minor sub-basins, as shown in the drawings. An outfall point was assigned to each sub and minor basin and a synthetic hydrograph constructed for these points. The hydrographs of each minor basin were combined to form hydrographs for the outfall point of each of the sub-basins.

All the hydrographs developed in this report are based on the assumption that the entire area has been developed according to the Master Development Plan. The area presently is hilly grasslands, forests, and rock outcroppings. Runoff peaks for this condition are lower than for the fully developed condition of the Development Plan.

Since there is no sure way to predict growth of the City of Colorado Springs, it is assumed that the entire basin would be developed according to Plan. The provided criteria for design of adequate drainage structures that will be large enough to handle the water produced if the entire basin becomes developed as noted on the drawings. See Tables III-F, and III-G, Pages 19, 20, and 21.

These hydrographs are all synthetic and some adjustments may be made when more accurate development conditions are known. Although the hydrographs are synthetic, the method is widely used and results have been favorable.

F. MAIN DRAINAGE CHANNELS:

The most economical method of removing flood runoff from a developed area is to improve and use existing ditches or drainage channels. Initial cost is lower, the ditches are easier to maintain and clean than are pipes or culverts.

In developed areas, ditches are impractical because sufficient space usually has not been provided by the development for proper sized ditches or control works.

Previous studies commissioned by the City of Colorado Springs have recommended a "Drainage Channel" drainage system in other areas. The Drainage Channel system consists of land reserved for drainage flow and for certain drainage structures. This land should be maintained as a ditch, should be planted in grass where possible and rip-rapped on all curved and other areas where necessary to prevent erosion. However, in these basins, development has considered keeping and maintaining existing channels in their present state, with only minor modifications to accomodate some planned phase.

Some erosion control may be desired in the natural channels, since channel erosion is basically a function of the specific weight of the fluid, slope of the channel and depth of flow. For seeding, the gully banks should be sloped using very flat slopes and leaving a wide bottom. Suitable grasses, would be blue grama, crested wheat, and side oats grama. The seeding should be accomplished in accordance with recommendations of the U.S. Soil Conservation Service. Yellow clover is a biannual and may need replacing as re-seeding by itself is questionable. Sand Hill type of alfalfa needs watering and care. The latter two types are not recommended because of the characteristics noted. Truck dumped rip-rap will undoubtedly control erosion better than seeding or sodding. Check

dams, unless they provide retention, will generally not reduce velocities to maintain control of erosion. Several existing retention dams in the basins may perform some erosion control until they are removed because of the planned development.

Retention Reservoirs in Area 2Bb and 5Aa1 are planned for use as future baseball areas. These small retention reservoirs can be utilized as they now exist, and flow through the dam provided by a culvert of adequate size to handle the design storm. This is what has been considered in our study. The other alternative is to completely remove the reservoirs and re-work the original channel for unrestricted flow.

A retention reservoir located in the planned golf course Area 2Ah is intended to be used as a water hazard, and flow through the dam provided by a spillway culvert of adequate size for the design storm. No additional retention is contemplated. However, several small ponds are being contemplated for additional water hazards in the planned golf course area.

The reservoir located in Area 8Aa is intended for use as recreational area. However, no additional retention is contemplated, and the reservoir will probably be utilized only as it now exists. We have planned for no additional retention in our study. In order to adequately protect the downstream areas, and to prevent any collapse of the existing reservoir, a spillway of a capacity of 1300 cfs should be constructed, to allow a design storm of at least 3 times the runoff as determined by our study to safely pass.

If any lakes or reservoirs being contemplated in the area are built, they should be excavated as depressions rather than dams.

Pedestrian underpasses are proposed in the sub-basin and minor basin Areas of 2Ab, 3Ac, 1Ad, and 6Aa. We have submitted sketches of how these underpasses can be designed for use by horseback riders using the bridle paths. See Figure III-H. Our study

does not include such designs in the cost analysis but considers only culverts of adequate size for the design storm.

The existing culverts in Area 10Aa, 11Aa, 12Aa, 11Ba, 12Ba and 13Ba are shown in Figures III-I and III-J together with pertinent data and capacities.

G. INDIVIDUAL RECOMMENDATIONS:

1. General:

Our study has considered the main existing drainage channels, and the more prominent sub-channels. Some existing physical cross sections were taken and are noted in Figure III-K with locations shown in Figure III-A and Figure III-B. Culvert sizes are shown in tables in the latter part of this report. Several alternates of asbestos bonded CMP, RCP and box culverts are noted in each case. The alternate to be used should be determined in the final design of structures depending on costs and actual field requirements.

2. Culverts:

In order to achieve maximum discharge when not flowing full, culverts should be laid on slopes at least equal to the critical slope or greater than the critical slope if this is more practical in a given installation. Slope consideration should also include velocity of the discharge, which affects erosion of the downstream side of the channel. See Figure III-L for typical Box Culverts.

3. Street Design:

Street design of some of the streets should consider street capacity for surface drainage. An example is the minor street through 1Aj, 2Aj, 3Aj, and 4Aj, and the major street through Areas 1Ak and 2Ak. The planned streets can carry the design storm runoff with vertical 8 inch curbs with an outfall structure into the main channel.

Final street design within the planned development may indicate a need or desire for some storm sewer in lieu of surface drainage in the street.

Our study has considered storm sewer in Area 1Ac and 6Aa, A concrete paved channel is considered for Area 2Aa in the median strip. This same concrete paved channel can be utilized for the culvert in 6Aa. See Figure III-M.

It has been suggested that the major street through Area 8Ba be a divided street and contain a drainage channel as a median dividing strip. (This is not shown on the Development Plan.) Our study has considered two crossings of the channel with the street on either side of the channel, and have therefore, included two additional 72 inch culverts in our cost summary. Street capacity at this point is insufficient to carry the surface drainage.

4. Road Cross Drainage:

In a few cases, existing roads are to be widened and probably regraded and paved. Area 11Aa is an example and the existing arch culvert should be extended to include the widened roadbed.

Area 10Ba will have a new frontage road West of the Highway and will require a new 96 inch culvert or its alternate and some fill.

Area 10Ba1 will need a culvert of 42 inch diameter crossing the frontage road. The present drainage is contained in a small channel to the West of the railroad embankment and traverses Southerly to Area 12Ba. A paved channel may also be needed to carry runoff Southerly under the freeway adjacent to the railroad. Our cost analysis does not reflect this item.

Area 13Ba will require a new 96 inch culvert, and realighment to better accomodate the flow. The existing 6 foot diameter CMP is mislocated, is in a state of collapse and is silted practically full at the upstream end. See Figure III-J, Page 26.

It is recommended that the existing stream channels be rip-rapped to control erosion. The tables on Pages 30 and 31 recommend minimum sizes of channels to be maintained and rip-rapped for the design storm.

H. SUMMARY AND CONCLUSIONS:

Because of the steep slopes, and the intensity of the storms in and around Colorado Springs, storm runoff peaks are large. Draining the area quickly, effectively, and as economically as possible necessitates the use of existing drainage channels. The size of the existing channel areas shown in Figure III-K are actual cross sections taken at the locations shown on Pages 14 and 15. Minimum channel sizes needed at various locations are shown in Tables N-1 and N-2, Pages 30 and 31. If space becomes critical concrete lined channels may be used.

The subdivision streets should be planned to provide maximum advantage for the drainage pattern. The street gutters should be designed by applying existing slopes and the recommended design peak flows.

The recommended storm drainage can be provided as each phase of the Master Plan is developed and thus eliminate expensive storm sewer installation after the area is developed.

It is recommended that the design features of this study be followed in general, making revisions as necessary and that the cost be pro-rated among the subdivisions involved.

Cost summaries for each basin are included in the back of this report.

SECTION II AND III

II BIBLIOGRAPHY

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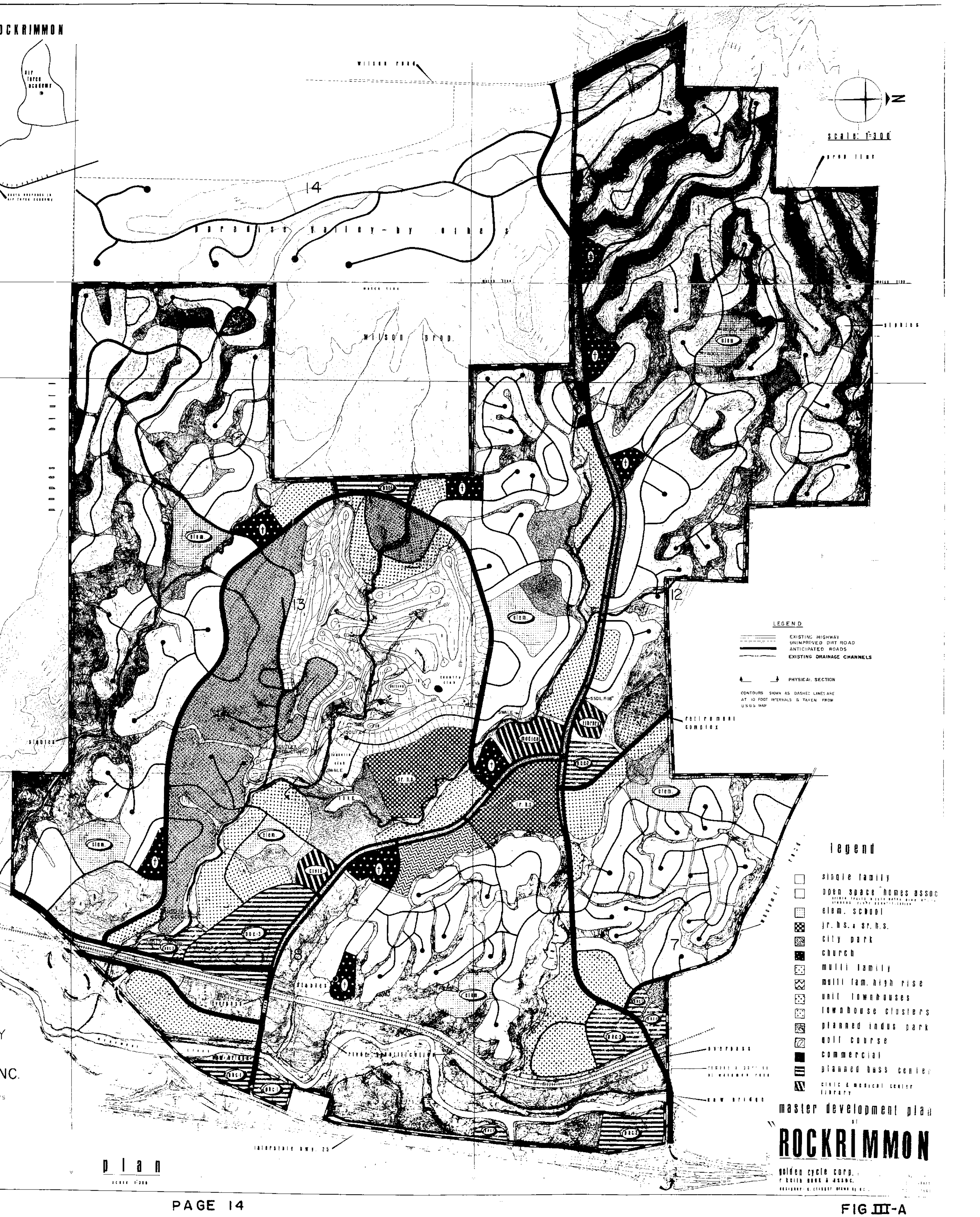
III TABLES & DRAWINGS



ROCKRIMMON
wilson road
scale: 1"=300'
prop. line
14
paradise valley-by others
wilson prop.
stables
elem.
13
12
country club
SWALE
OUTLET STRUCTURE
medical
library
retirement complex
civic
18
7
stables
overpass
new bridge
interstate hwy. 25
LEGEND
EXISTING HIGHWAY
UNIMPROVED DIRT ROAD
ANTICIPATED ROADS
EXISTING DRAINAGE CHANNELS
PHYSICAL SECTION
CONTOURS SHOWN AS DASHED LINES ARE AT 10 FOOT INTERVALS & TAKEN FROM U.S.G.S. MAP
legend
single family
open space "homes assoc
elem. school
jr. h.s. & sr. h.s.
city park
church
multi family
multi fam. high rise
unit townhouses
townhouse clusters
planned indus park
golf course
commercial
planned buss center
civic & medical center
library
master development plan
of
"ROCKRIMMON
golden cycle corp.
r. keith hook & assoc.
plan

FIG III-A

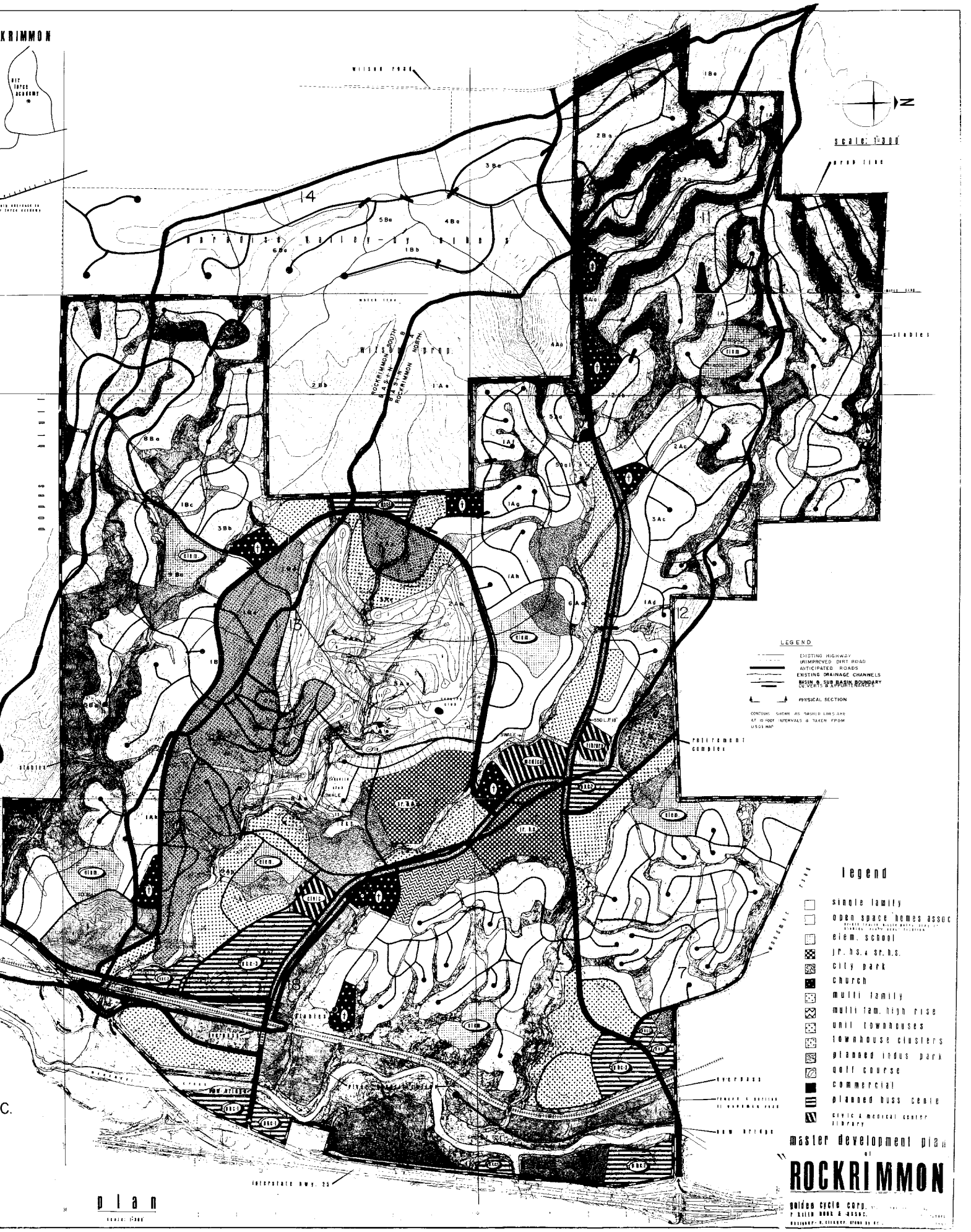
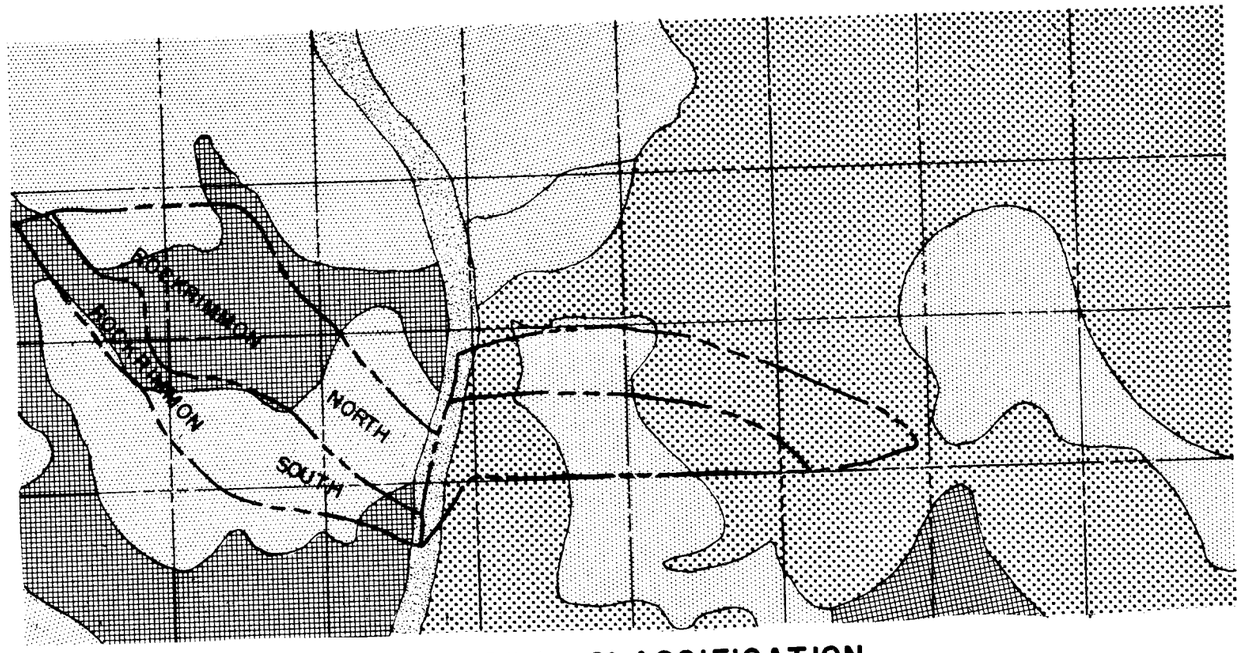
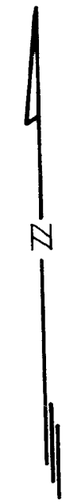

KRIMMON
scale: 1"=200'
LEGEND
EXISTING HIGHWAY
UNIMPROVED DIRT ROAD
ANTICIPATED ROADS
EXISTING DRAINAGE CHANNELS
PHYSICAL SECTION
CONTOURS SHOWN AS DASHED LINES ARE AT 10 FOOT INTERVALS & TAKEN FROM USGS MAP
legend
single family
open space homes assoc
elem. school
jr. h.s. & sr. h.s.
city park
church
multi family
multi fam. high rise
unit townhouses
townhouse clusters
planned indus park
golf course
commercial
planned buss centr
civic & medical center library
master development plan
of
ROCKRIMMON
golden cycle corp.
plan
scale: 1"=200'
stables
retirement complex
overpass
new bridge
interstate hwy. 25

FIG. III-B





SOIL CLASSIFICATION

0.5 0 1.0

SCALE OF MILES

SOIL CLASSIFICATION LEGEND

- LOOSE SANDS AND GRAVELS OF THE FIRST BOTTOMS, RIVERWASH
- DEEP, DARK UPLAND SOILS WITH SANDY SUBSOILS. EL PASO SERIES
- VERY SHALLOW, COMMON STONY OR GRAVELLY SOILS
- DEEP, DARK SOILS OF THE STREAM TERRACES WITH SANDY SUBSOILS. EASTONVILLE SERIES

CITY OF COLORADO SPRINGS

ROCKRIMMON NORTH & ROCKRIMMON SOUTH DRAINAGE BASINS

SOIL CLASSIFICATION

DESIGNED	KARCICH & WEBER, INC. ENGINEERS PLANNERS CONSULTANTS		
DRAWN Ron			
CHECKED	APPROVED		
COLORADO SPRINGS	SCALE As Noted	DATE 2-2-67	DRAWING NO. FIG III C

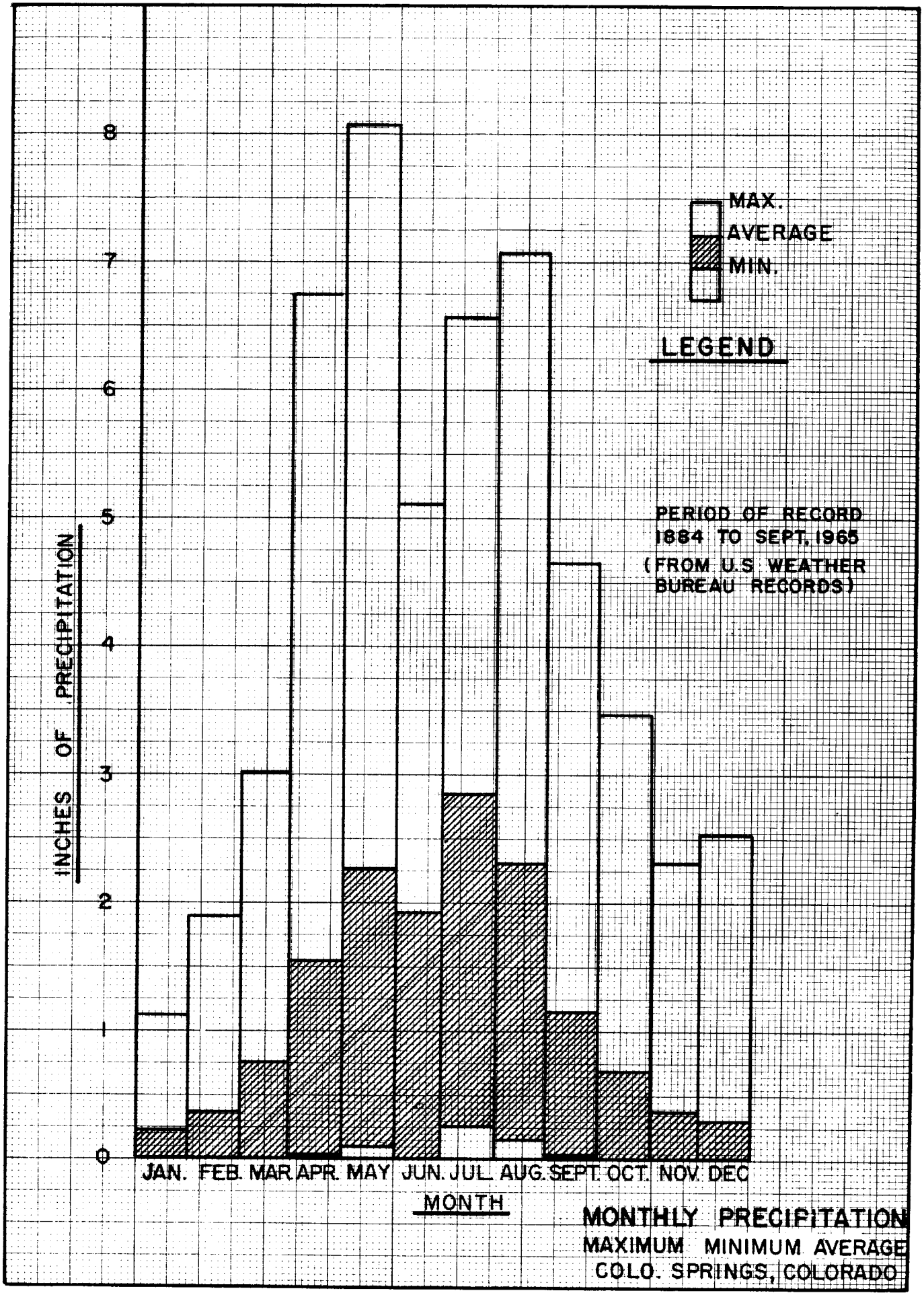
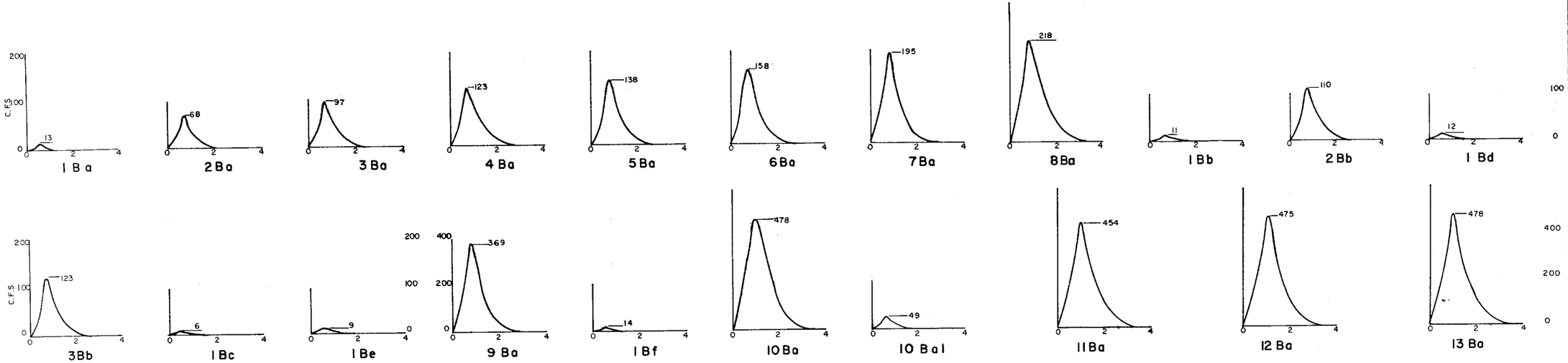
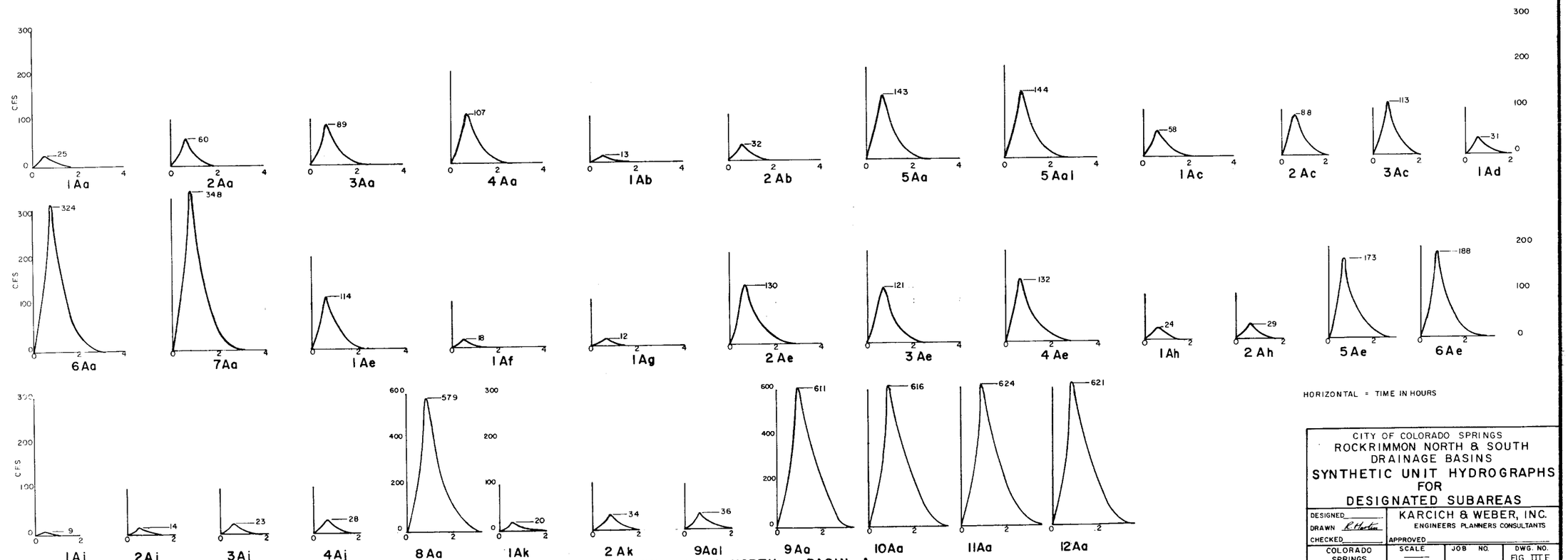

MAX.
AVERAGE
MIN.
LEGEND
PERIOD OF RECORD
1884 TO SEPT. 1965
(FROM U.S WEATHER
BUREAU RECORDS)
INCHES OF PRECIPITATION
0
1
2
3
4
5
6
7
8
JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEPT. OCT. NOV. DEC
MONTH
MONTHLY PRECIPITATION
MAXIMUM MINIMUM AVERAGE
COLO. SPRINGS, COLORADO

FIG. III D



ROCKRIMMON SOUTH - BASIN B



ROCKRIMMON NORTH — BASIN A

HORIZONTAL = TIME IN HOURS

CITY OF COLORADO SPRINGS
ROCKRIMMON NORTH & SOUTH
DRAINAGE BASINS
SYNTHETIC UNIT HYDROGRAPHS
FOR
DESIGNATED SUBAREAS

DESIGNED	KARCICH & WEBER, INC. ENGINEERS PLANNERS CONSULTANTS		
DRAWN R Hartin			
CHECKED	APPROVED		
COLORADO SPRINGS	SCALE	JOB NO.	DWG. NO. FIG III E

TABLE III-F

RUNOFF DISCHARGE - ROCKRIMMON NORTH

BASIN A

Area Designation	Area Sq. Miles	Area Sq. Miles (Accum.)	Peak Qp 50 Year Storm CFS
1Aa	.0416	.0416	25
2Aa	.0645	.1061	60
3Aa	.0565	.1626	89
4Aa	.0428	.2054	107
1Ab	.0204	.0204	13
2Ab	.0338	.0542	32
5Aa	.0147	.2743	143
5Aa1	.0150	.2893	144
1Ac	.0980	.0980	58
2Ac	.0577	.1557	88
3Ac	.0519	.2076	113
1Ad	.0501	.0501	31
6Aa	.2090	.7560	324
7Aa	.0758	.8318	348
1Af	.0292	.0292	18
1Ag	.0192	.0192	12
1Ae	.1634	.2118	114
2Ae	.0333	.2451	130
3Ae	.0442	.2893	121
4Ae	.0301	.3194	132
1Ah	.0384	.0384	24
2Ah	.0192	.0576	29
5Ae	.0465	.4235	173
6Ae	.0512	.4747	188

TABLE III-F

RUNOFF DISCHARGE - ROCKRIMMON NORTH

BASIN A

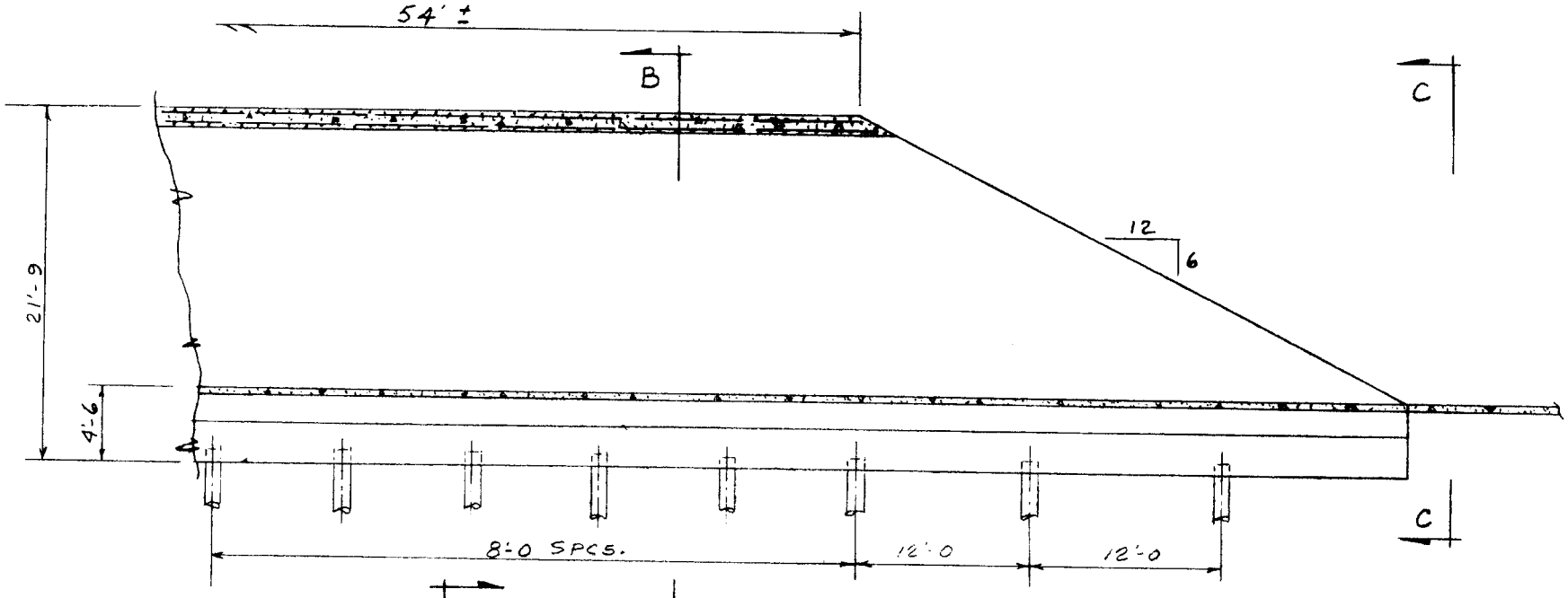
Area Designation	Area Sq. Miles	Area Sq. Miles (Accum.)	Peak Qp 50 Year Storm CFS
1Aj	.0143	.0143	9
2Aj	.0078	.0221	14
3Aj	.0233	.0454	23
4Aj	.0098	.0552	28
8Aa	.1091	1.4708	579
1Ak	.0266	.0266	20
2Ak	.0220	.0486	34
9Aa1	.0565	.0565	36
9Aa	.1194	1.6393	611
10Aa	.0131	1.6724	616
11Aa	.0081	1.6805	624
12Aa	.0040	1.6845	621

TABLE III-G

RUNOFF DISCHARGE - ROCKRIMMON SOUTH

BASIN B

Area Designation	Area Sq. Miles	Area Sq. Miles (Accum.)	Peak Qp 50 Year Storm CFS
1Ba	.0214	.0214	13
2Ba	.1002	.1216	68
3Ba	.0616	.1832	97
4Ba	.0523	.2355	123
5Ba	.0424	.2779	138
6Ba	.0621	.3440	158
7Ba	.0847	.4247	195
8Ba	.0910	.5157	218
1Bb	.0191	.0191	11
2Bb	.2085	.2276	110
1Bd	.0202	.170	12
3Bb	.0259	.2705	123
1Bc	.0101	.0101	6
1Be	.0152	.0189	9
9Ba	.0884	.9031	369
1Bf	.0219	.0219	14
10Ba	.2864	1.2119	478
10Ba1	.0692	.0692	49
11Ba	.0027	1.2141	454
12Ba	.0135	1.2968	475
13Ba	.0070	1.3038	478



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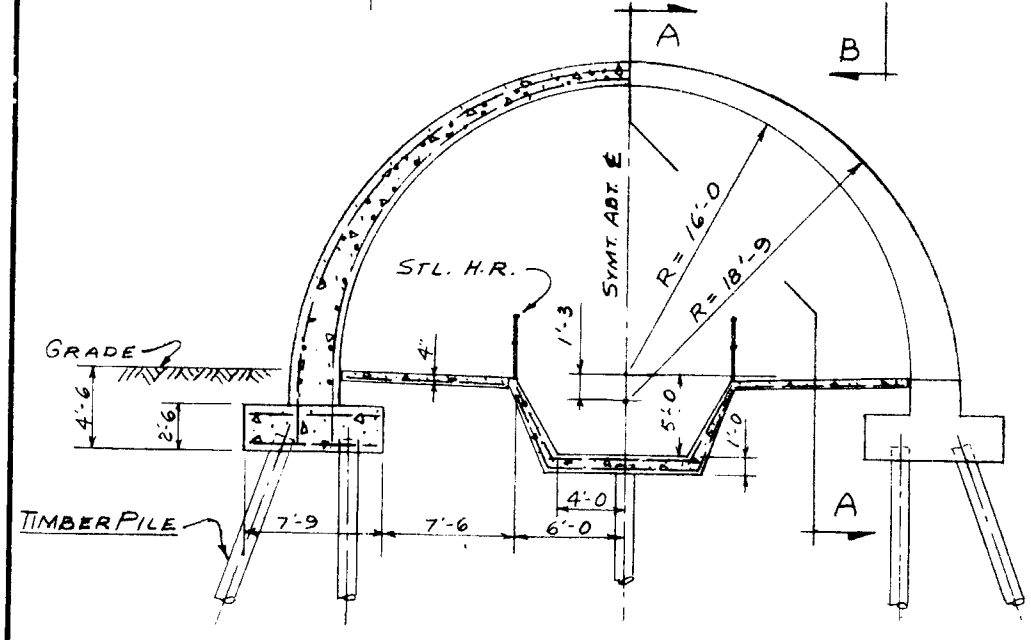


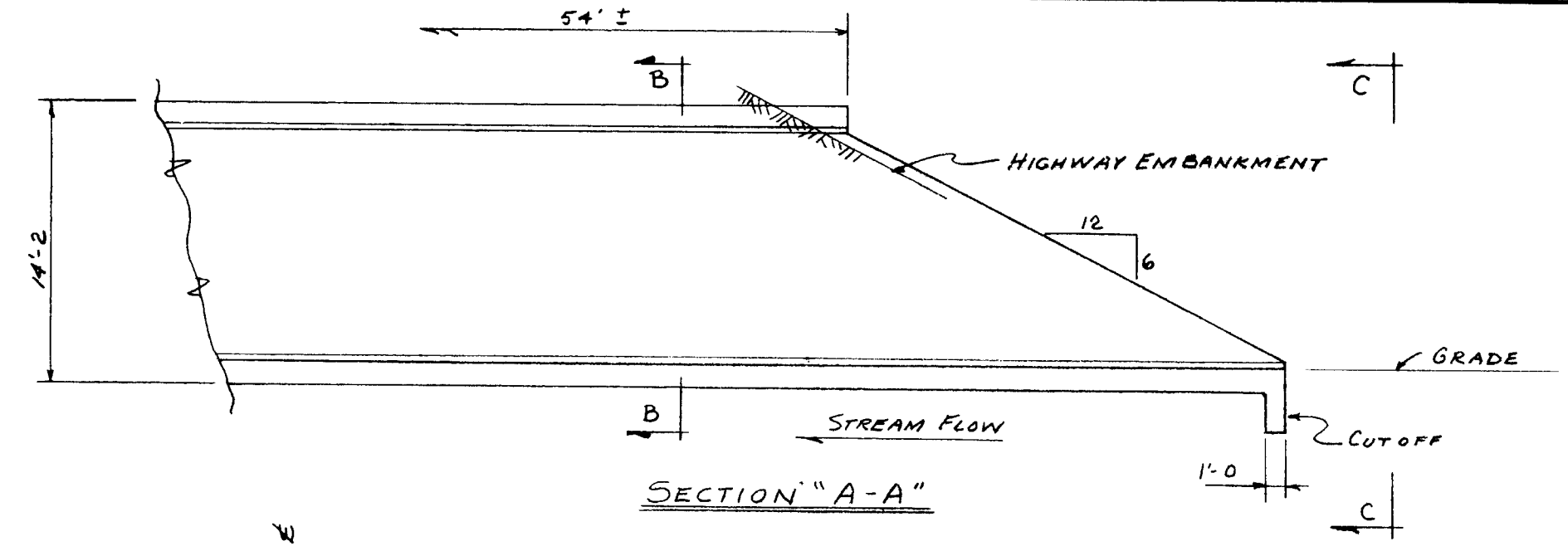
SECTION "B-B"

SECTION "C-C"

PEDESTRIAN UNDERPASS

SCALE : 3/32" = 1'-0

FIG. III - H 1



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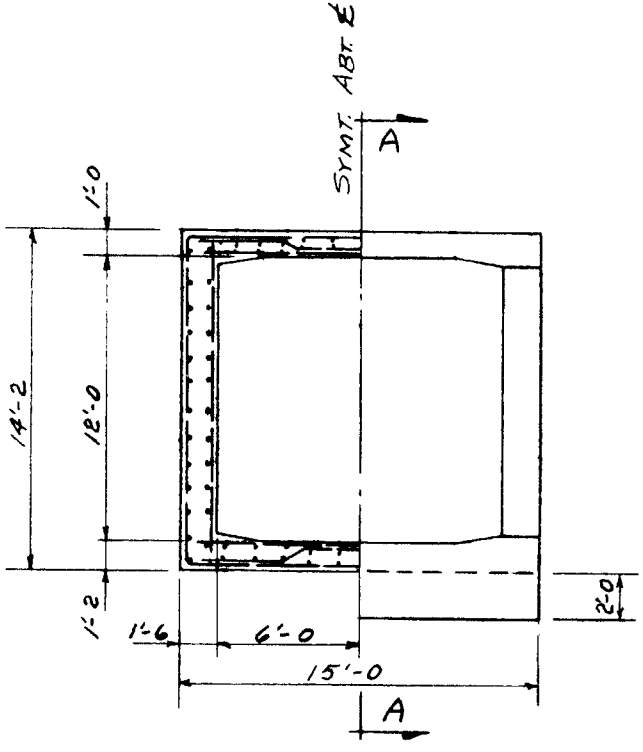


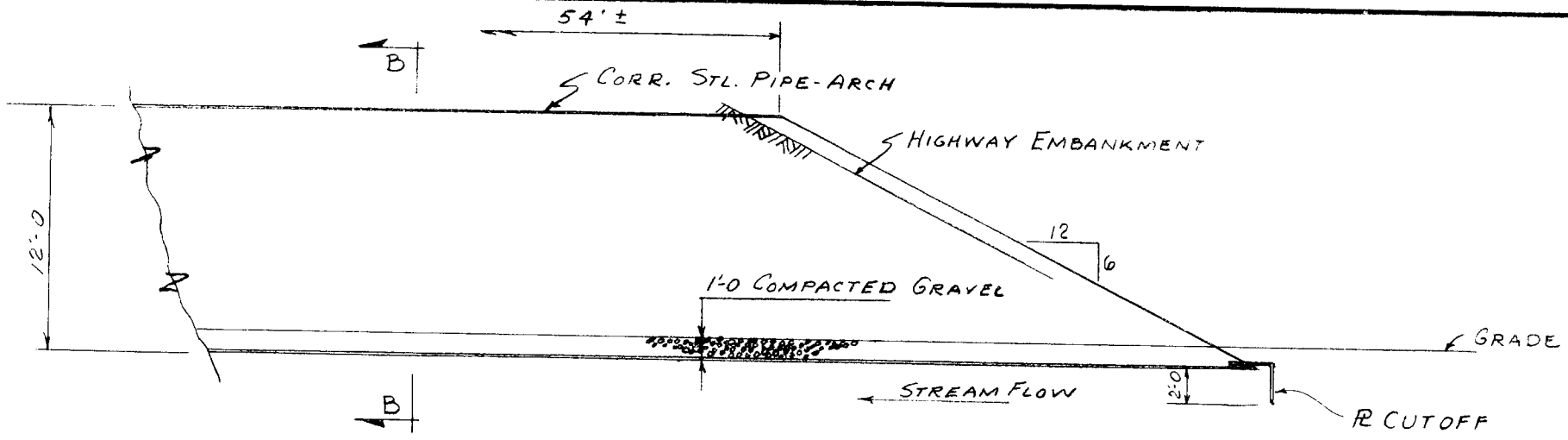
SECTION "B-B"

SECTION "C-C"

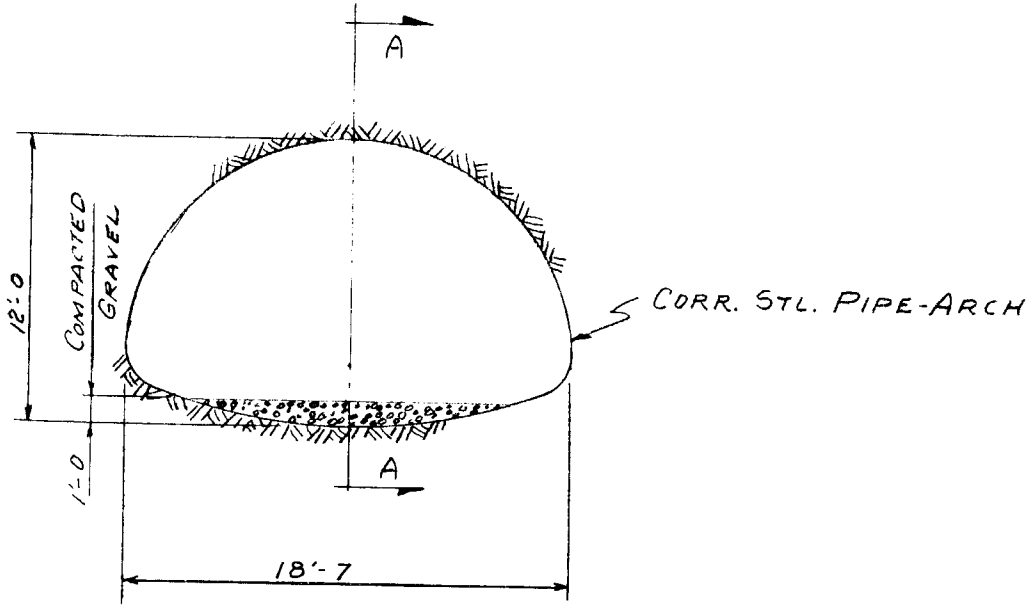
PEDESTRIAN UNDERPASS

SCALE 1/8" = 1'-0

FIG III-H2



SECTION "A-A"

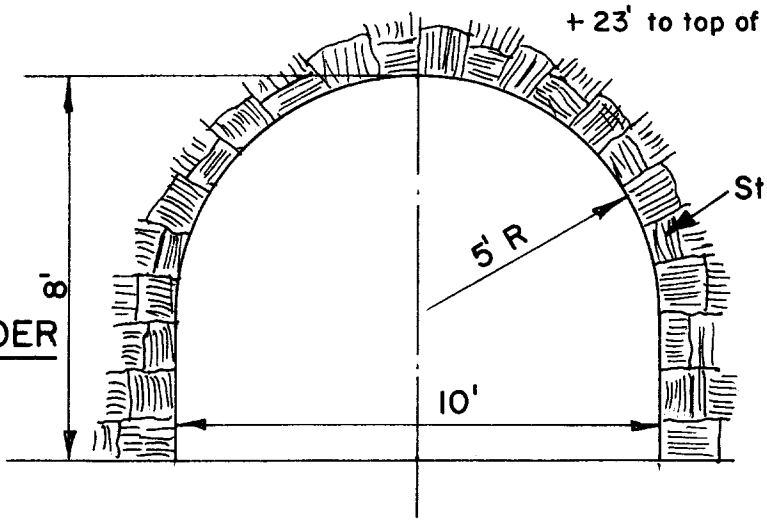


SECTION "B-B"

PEDESTRIAN UNDERPASS

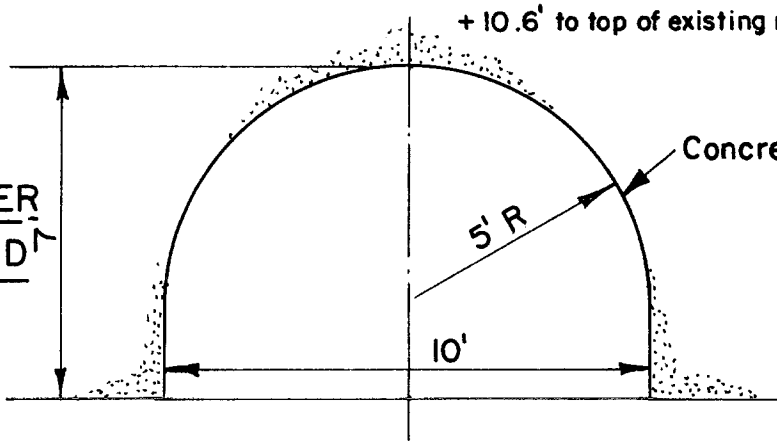
SCALE 1/8" = 1'-0

FIG III - H3



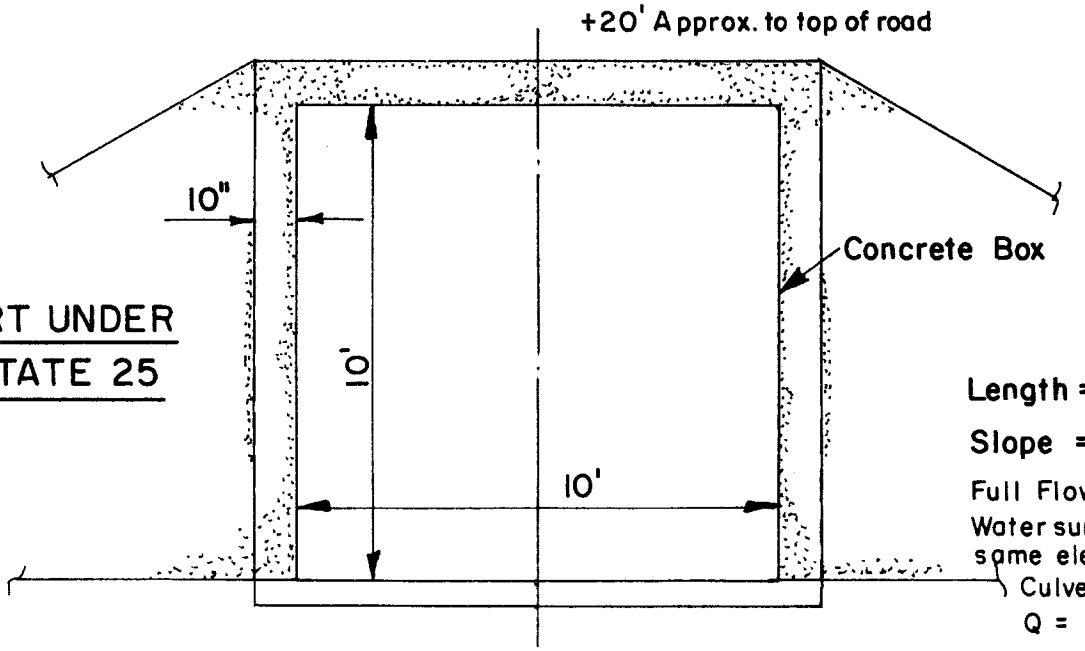
CULVERT UNDER RAILROAD

Length = 74 L.F.
Slope = 1.08%
Q = 616 C.F.S
Water surface 2.18 ft above top of Culvert



CULVERT UNDER FRONTAGE ROAD

Length = 50 L.F.
Slope = 0.80 %
Q = 619 C.F.S
Water surface 2.28 ft above top of Culvert

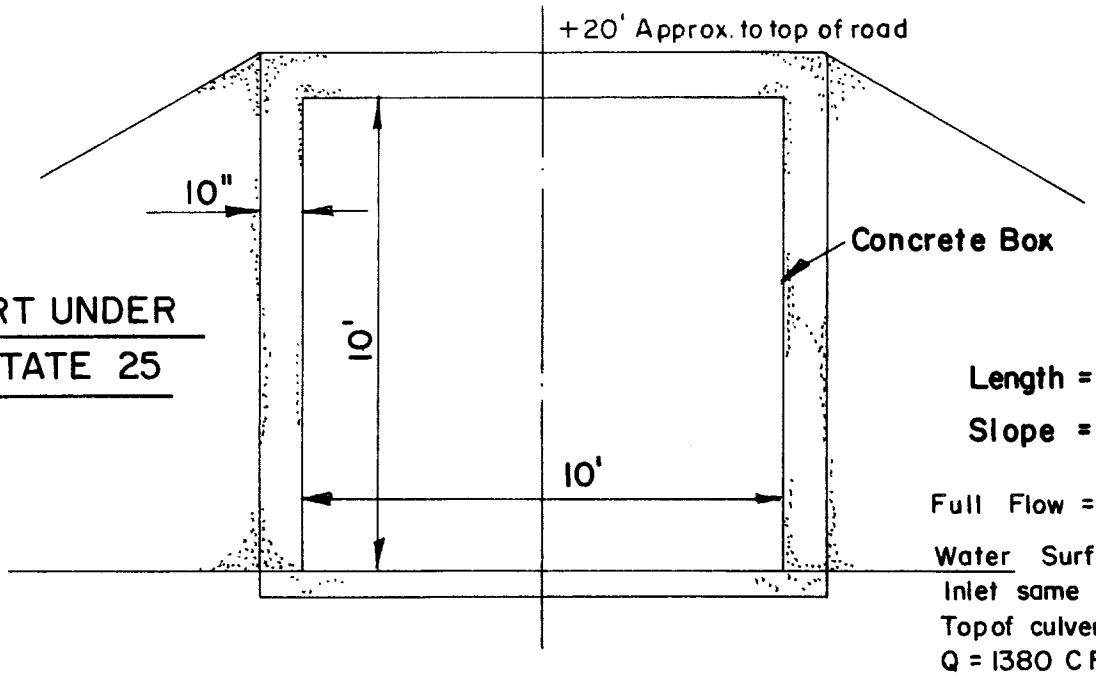


CULVERT UNDER INTERSTATE 25

Length = 308 L.F.
Slope = 1.46%
Full Flow = 2544CFS
Water surface at Inlet same elev. as top of Culvert
Q = 1390 C.F.S

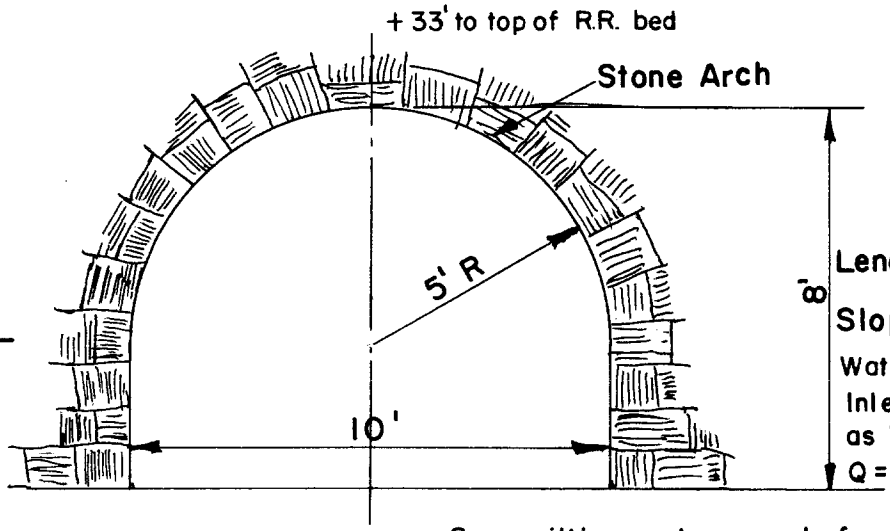
EXISTING CULVERTS OUT OF ROCKRIMMON NORTH-BASIN A

FIG III-1



CULVERT UNDER INTERSTATE 25

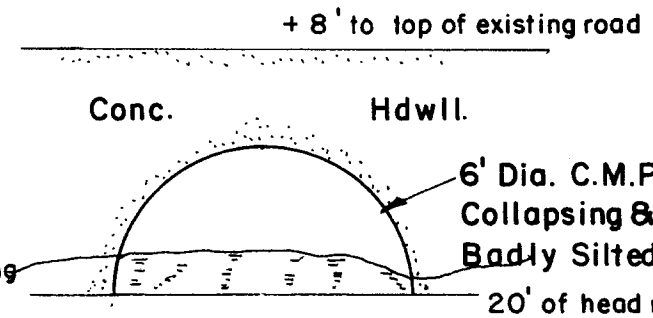
Length = 376 L.F.
Slope = 1.25%
Full Flow = 2354 CFS
Water Surface at Inlet same elev. as Top of culvert
Q = 1380 CFS



CULVERT UNDER RAILROAD

Length = 98' L.F.
Slope = 1.32%
Water Surface at Inlet same elev. as Top of culvert
Q = 480 CFS

Some silting upstream end of culvert

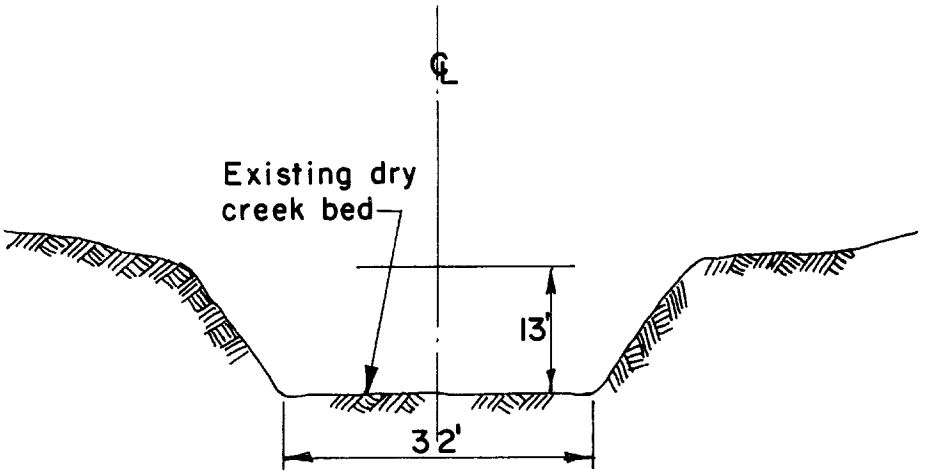


CULVERT UNDER FRONTAGE ROAD

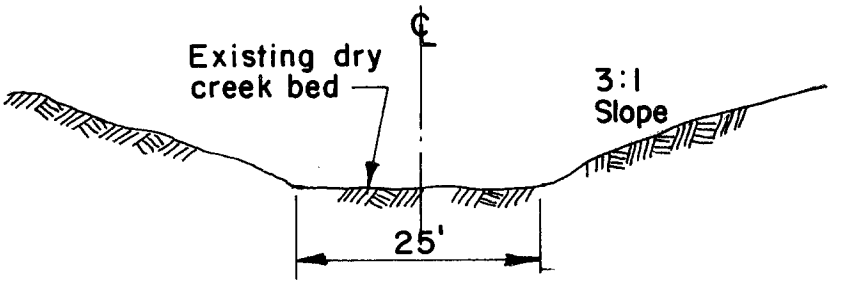
Length = 50 L.F.
Slope = 2.80%
20' of head needed to carry full flow of 480 CFS Remove, Replace and Realign with larger culvert upstream.

EXISTING CULVERTS OUT OF ROCKRIMMON SOUTH- BASIN B

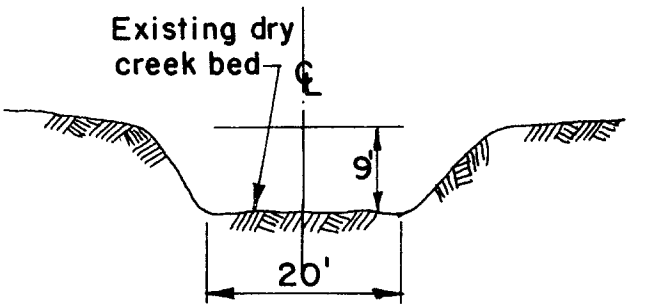
FIG. III-J



TYPICAL CHANNEL SECTION
IN SUB-BASIN 9Ba



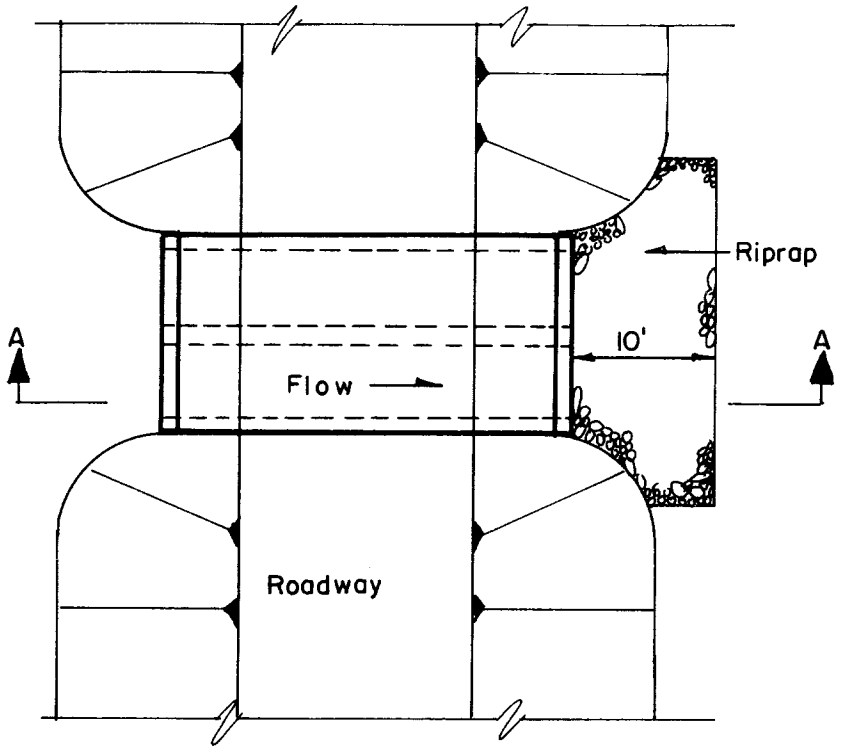
TYPICAL CHANNEL SECTION
IN SUB-BASIN 9Aa



TYPICAL CHANNEL SECTION
IN SUB-BASIN 8Aa

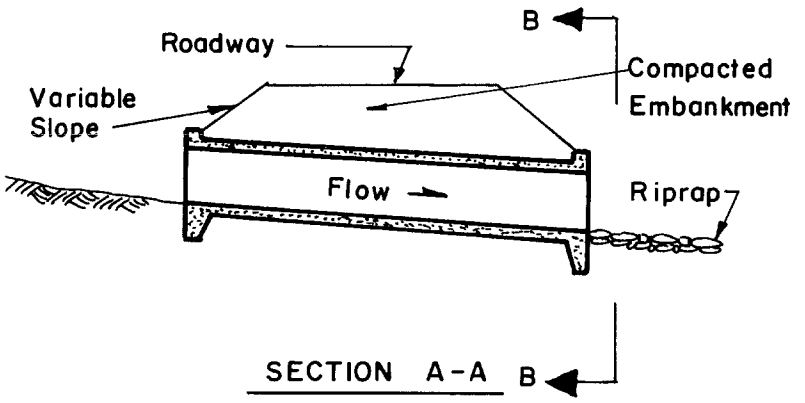
EXISTING PHYSICAL
SECTIONS

FIG III - K

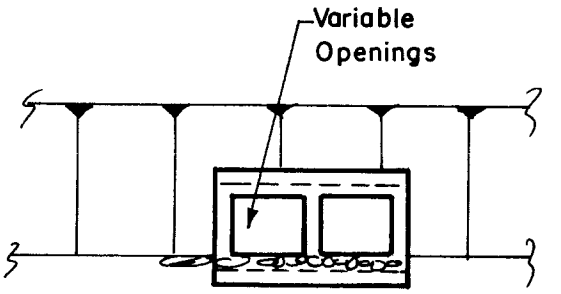


PLAN

No Scale



SECTION A-A



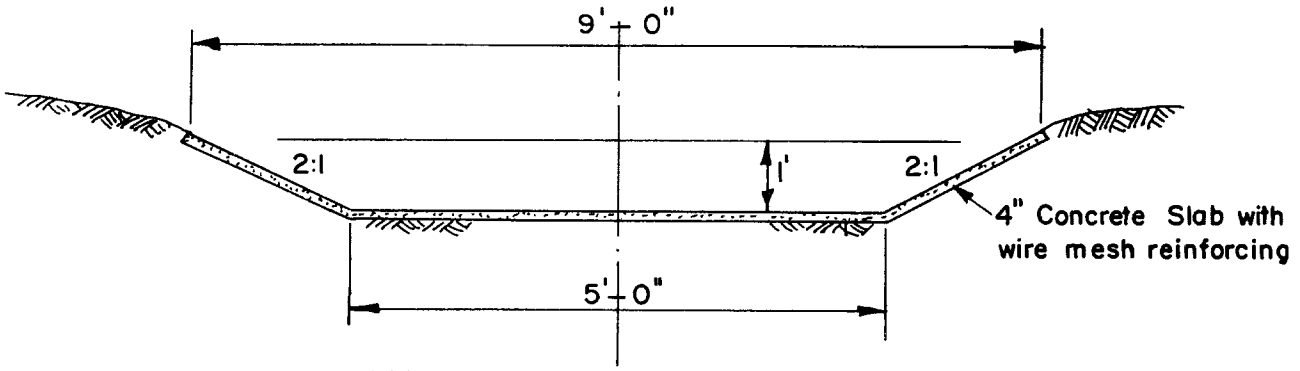
SECTION B - B

TYPICAL BOX CULVERT

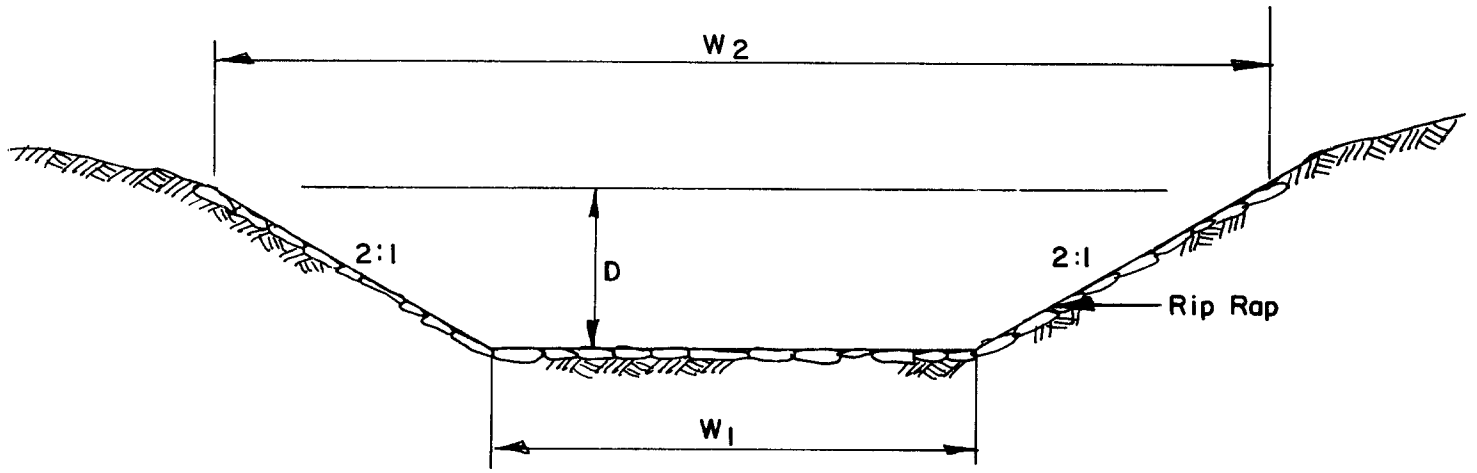
(SIZE VARIES)

BOX CULVERT DETAILS

FIG III-L



MEDIAN STRIP CHANNEL (1600 L.F. REQUIRED)
IN SUB-BASIN 2Aa



TYPICAL CHANNEL SECTION
For Definition of letters see tables
Page 30 and 31

TYPICAL CHANNEL
CROSS SECTIONS

FIG III-M

SUMMARY

ROCKRIMMON NORTH

III N-1 - DRAINAGE CHANNELS*

Area Designation	Area Sq. Miles	Q CFS	S	Avg. V FPS	Approx. L (ft)	Min. Channel Size W1	W2	D	Cost
1Aa	.0416	25	.1254	12	1200	4	8	1	$ 7,910.00
2Aa	.0645	60	.0500	9	1600	5	9	1	14,050.00**
3Aa	.0565	89	.0600	10	1000	7	11	1	8,925.00
4Aa	.0428	107	.0340	10	1000	4	12	2	10,066.00
5Aa	.0147	143	.0600	14	600	4	12	2	6,041.00
5Aa1	.0150	144	.0250	9	400	4	12	2	4,025.00
2Ac	.0577	88	.0474	12	1180	4	12	2	11,879.00
3Ac	.0519	113	.0500	13	600	4	12	2	6,041.00
1Ad	.0501	31	.1333	14	1200	4	8	1	7,910.00
6Aa	.2090	324	.0280	12	5580	4	16	3	75,600.00
7Aa	.0758	343	.0378	14	1800	4	16	3	24,388.00
1Ae	.1634	88	.0424	9	2400	8	12	1	23,275.00
2Ae	.0333	130	.0346	11	750	4	12	2	7,546.00
3Ae	.0442	121	.0333	10	600	4	12	2	6,041.00
4Ae	.0301	132	.0222	8	450	4	12	2	4,529.00
5Ae	.0465	173	.0133	8	1600	4	16	3	21,679.00
6Ae	.0512	188	.0207	9	675	7	15	2	8,372.00
8Ac	.1091	503	.0244	12	3200	9	21	3	55,804.00
9Ac	.1194	611	.0185	12	2700	9	25	4	56,469.00
								TOTAL	$360,550.00

*All Drainage Channels Rip-Rapped.

**Concrete Paved Median Strip Channel.

SUMMARY

ROCKRIMMON SOUTH

III N-2 - DRAINAGE CHANNELS*

Area Designation	Area Sq. Miles	Q CFS	S	Avg. V FPS	Approx. L (ft)	Min. Channel Size W1	W2	D	Cost
2Ba	.1002	68	.0457	9	1835	6	10	1	$ 14,959.00
3Ba	.0616	97	.0333	10	1200	4	12	2	12,078.00
4Ba	.0523	123	.0307	10	650	4	12	2	6,542.00
5Ba	.0424	138	.0254	9	550	4	12	2	5,536.00
6Ba	.0621	158	.0447	12	2325	4	12	2	23,400.00
7Ba	.0847	195	.0166	9	480	4	16	3	6,504.00
8Ba	.0910	218	.0251	10	2550	8	16	2	33,598.00
2Bb	.2085	110	.0415	12	3900	4	12	2	39,252.00
3Bb	.0259	123	.0567	13	600	4	12	2	6,039.00
9Ba	.0884	369	.0351	14	2950	5	17	3	42,264.00
10Ba	.2864	478	.0155	10	4500	5	21	4	80,080.00
11Ba	.0027	454	.1429	20	70	8	16	2	923.00
12Ba	.0315	475	.0240	13	250	8	16	2	3,294.00
13Ba	.0070	478	.0300	13	100	7	19	3	1,589.00
								TOTAL	$276,058.00

*All Drainage Channels Rip-Rapped.

SUMMARY

ROCKRIMMON NORTH

III N-3 - STORM SEWERS - DEVELOPED CONDITION

Area Designation	Approximate Length Ft.	Pipe (RCP or) Dia. (CMP) Inches	Remarks	Cost
1Ac	600	30	Along Proposed Road	$ 7,200.00
1Ac	400	36	Along Proposed Road	6,000.00
1Ac	400	42	Along Proposed Road	7,200.00
6Aa	650	18	In Median Strip	3,900.00
8Aa	150	24	Along Lot Line	1,500.00
9Aa	700	30	Along Frontage Road	8,400.00
			TOTAL	$ 34,200.00

SUMMARY

ROCKRIMMON NORTH

III N-4 - Culverts - Developed Condition

Area Designation	Qp CFS	S (Slope)	Approx. Length	Existing Culverts	Alternates for Additional Culverts			Remarks	Cost
					RCP Dia.	CMP* Dia.	Box Culverts W x H (ft)		
1Aa	25	.0750	80		1-27" 2-21"	1-30" 2-21"	2 x 2	Under Proposed Road	$ 800.00
2Aa	60	.0266	80		1-42" 2-30"	1-42" 2-30"	2'-8" x 2'-8"	Under Proposed Road	1,440.00
3Aa	89	.0533	150		1-48" 2-36"	1-48" 2-36"	3 x 3	Under Proposed Road with wingwalls & headwalls. Build up road.	5,625.00
4Aa	107	.0333	60		1-54" 2-42"	1-54" 2-42"	3½ x 3½	Under Proposed Road.	1,560.00
1Ab	13	.0333	60		1-21" 2-15"	1-21" 2-15"	2 x 2	Under Proposed Road.	420.00
2Ab	32	.0769	130		1-30" 2-21"	1-36" 2-24"	3 x 3	Under Proposed Road with wingwalls & headwalls. Build up road.	2,340.00
5Aa	143	.0166	60		1-60" 2-42"	1-60" 2-42"	4 x 5	Under Proposed Road	2,220.00
5Aa1	144	.1000	50		1-60" 2-42"	1-60" 2-42"	4½ x 4½	Through existing retention reservoir. Open channel spillway may be used.	1,850.00
1Ac	58	.0500	100		1-42" 2-30"	1-42" 2-30"	3½ x 3½	Under Proposed Road	1,800.00

ROCKRIMMON NORTH

III N-4 - Culverts - Developed Condition

Area Designation	Qp CFS	S (Slope)	Approx. Length	Existing Culverts	Alternates for Additional Culverts			Remarks	Cost
					RCP Dia.	CMP* Dia.	Box Culverts W x H (ft)		
2Ac	88	.0333	60		1-48" 2-36"	1-48" 2-36"	$3\frac{1}{2}$ x $3\frac{1}{2}$	Under Proposed Road	$ 1,260.00
3Ac	113	.0400	250		1-54" 2-42"	1-54" 2-42"	4 x 4	Under Proposed Road with wingwalls & headwalls. Build up road.	11,250.00
1Ad	31	.0400	140		1-30" 2-21"	1-36" 2-24"	3 x 3	Under Proposed Road with wingwalls & headwalls. Build up road.	2,520.00
6Aa	324	.0500	200		1-84" 2-60" 3-54"	1-84" 2-60" 3-54"	6 x 6	Under Proposed Road with wingwalls & headwalls. Build up road.	16,000.00
7Aa	348	.1000	100		1-84" 2-60" 3-54"	1-84" 2-60" 3-54"	6 x 6	Through existing retention reservoir. Existing open channel spillway may be used but improved to prevent erosion.	8,000.00
1Ae (See remarks)	32	.0333	60		1-30" 2-21"	1-36" 2-24"	3 x 3	Under access road to church site.	720.00
1Ae (As shown)	88	.0500	100		3-48"	3-48"		Ignore. See 1Ae below, but assume 3 road crossings of 3-48"-60' in length of UNPLATTED AREA FOR COST.	3,780.00
1Af	18	.0333	60		1-24" 2-18"	1-24" 2-18"	2 x 2	Under Proposed Road.	660.00

SUMMARY

ROCKRIMMON NORTH

III N-4 - Culverts - Developed Condition

Area Designation	Qp CFS	S (Slope)	Approx. Length	Existing Culverts	Alternates for Additional Culverts			Remarks	Cost
					RCP Dia.	CMP* Dia.	Box Culverts W x H (ft)		
1Ag	12	.0333	60		1-21"	1-21"	2 x 2	Under Proposed Road.	$ 420.00
1Ae (Includes 1Ae, 1Af & 1Ag)	114	.0500	100		1-54" 2-42" 3-36"	1-54" 2-42" 3-36"	4 x 4	Under Proposed Road with wingwalls & headwalls.	4,500.00
2Ae	130	.0333	60		1-54" 2-42" 3-36"	1-60" 2-42" 3-36"	4 x 4	Under Proposed Road.	1,560.00
3Ae	121	.0400	100		1-54" 2-42" 3-36"	1-54" 2-42" 3-36"	4 x 4	Through proposed water hazard golf course. No retention considered.	2,600.00
4Ae	132	.0300	100		1-54" 2-42" 3-36"	1-54" 2-42" 3-36"	4 x 4	Same as 3Ae above.	2,600.00
1Ah	24	.0600	100		1-30" 2-21"	1-30" 2-21"	2 x 2	Under Proposed Road with wingwalls & headwalls.	1,800.00
2Ah	29	.1500	60		1-30" 2-21"	1-30" 2-21"	$2\frac{1}{2}$ x $2\frac{1}{2}$	Through existing retention reservoir. Open channel spillway may be used.	720.00

SUMMARY

ROCKRIMMON NORTH

III N-4 - Culverts - Developed Condition

Area Designation	Qp CFS	S (Slope)	Approx. Length	Existing Culverts	Alternates for Additional Culverts			Remarks	Cost
					RCP Dia.	CMP* Dia.	Box Culverts W x H (ft)		
5Ae	173	.0200	100		1-60" 2-48" 3-42"	1-60' 2-48" 3-42"	5 x 5		$ 3,700.00
6Ae	188	.0700	100		1-66" 2-48" 3-42"	1-66" 2-48" 3-42"	5 x 5	See Note 3Ae above.	4,600.00
1Aj	9	--	--		--	--	--	Street Surface Drainage.	
2Aj	14	--	--		--	--	--	Street Surface Drainage.	
3Aj	23	--	--		--	--	--	Street Surface Drainage.	
4Aj	28	--	--		--	--	--	Street Outlet Structure.	800.00
8Aa	579	.0333	60		1-108" 2-78" 3-66"	1-108" 2-78" 3-66"	8 x 8	Under Proposed Road with wingwalls & headwalls.	6,600.00
1Ak	20	--	--		--	--	--	Street Surface Drainage.	
2Ak	34	--	--		--	--	--	Street Outlet Structure.	800.00
9Aa1	36	--	--		--	--	--	Proposed Storm Sewer	

SUMMARY

ROCKRIMMON NORTH

III N-4 - Culverts - Developed Condition

Area Designation	Qp CFS	S (Slope)	Approx. Length	Existing Culverts	Alternates for Additional Culverts			Remarks	Cost
					RCP Dia.	CMP* Dia.	Box Culverts W x H (ft)		
9Aa	611	.0200	100		1-108" 2-78" 3-66"	1-108" 2-78" 3-66"	8 x 8	Under Proposed Road. Build up road.	$ 11,000.00
10Aa	616			Stone Arch				See Fig. III-1 Existing stone arch culvert under R.R.	
11Aa	619			Conc. Arch				See Fig. III-1 Existing conc. arch culvert under Co. Road, increase width 50 L.F.	5,000.00
12Aa	621			10'x10' Box Culvert				See Fig. III-1 Existing box culvert under Interstate #25.	
								TOTAL	$108,945.00

*All proposed CMP culverts to be asbestos bonded.

SUMMARY

ROCKRIMMON SOUTH

III N-5 - Culverts - Developed Condition

Area Designation	Qp CFS	S (Slope)	Approx. Length	Existing Culverts	Alternates for Additional Culverts			Remarks	Cost
					RCP Dia.	CMP* Dia.	Box Culverts W x H (ft)		
1Ba	13	.0300	60		1-21" 4-12"	1-24" 2-18"	2 x 2	Under Proposed Road.	$ 420.00
2Ba	68	.0333	180		1-48" 2-30"	1-48" 2-30"	$3\frac{1}{2}$ x $3\frac{1}{2}$	Under Proposed Road with wingwalls & headwalls. Build up road.	6,960.00
3Ba	97	.0240	125		1-48" 2-36" 3-30"	1-54" 2-36" 3-30"	4 x 4	Under Proposed Road with wingwalls & headwalls.	5,620.00
4Ba	123	.0125	80		1-60" 2-42"	1-60" 2-42"	$4\frac{1}{2}$ x $4\frac{1}{2}$	Under Proposed Road with wingwalls & headwalls.	4,255.00
5Ba	139	.0296	135		1-60" 2-42"	1-60" 2-42"	$4\frac{1}{2}$ x $4\frac{1}{2}$	Under Proposed Road with wingwalls & headwalls.	6,215.00
6Ba	158	.0200	50		1-60" 2-48"	1-60" 2-48"	$4\frac{1}{2}$ x $4\frac{1}{2}$	Under Proposed Road with wingwalls & headwalls.	2,775.00
1Bb	12	.0800	50		1-18" 4-12"	1-21" 3-15"	2 x 2	Under Proposed Road with FES	286.00
2Bb	111	.1333	60		1-54" 2-42"	1-54" 2-42"	$4\frac{1}{4}$ x $4\frac{1}{4}$	Through Existing Retention Reservoir. Open channel spillway may be used. See Note.	2,160.00 3,780.00
3Bb	123	.0250	60		1-54" 3-36"	1-54" 3-36"	$4\frac{1}{2}$ x $4\frac{1}{2}$	Under Proposed Road with wingwalls & headwalls.	3,240.00

SUMMARY

ROCKRIMMON SOUTH

III N-5 - Culverts - Developed Condition

Area Designation	Qp CFS	S (Slope)	Approx. Length	Existing Culverts	Alternates for Additional Culverts					Remarks	Cost
					RCP Dia.	CMP* Dia.	Box Culverts W x H (ft)				
7Ba	195	.0200	50		1-66" 2-54"	1-66" 2-54"	5	x	5	Under Proposed Road with wingwalls & headwalls.	$ 3,450.00
8Ba	219	.0215	80		1-72" 3-42"	1-72" 3-42"	5½	x	5½	2 Additional 72" Culverts included for cost FINAL STREET LOCATION WILL DETERMINE NEED.	6,600.00 13,200.00 19,800.00
1Bc	7	.0666	60		1-18" 2-12"	1-18" 2-12"				Under Proposed Road.	600.00
1Bd	12	.0600	100		1-21" 2-15"	1-21" 2-15"	2	x	2	Under Proposed Road. Build up road.	1,350.00
1Be	10	.0625	80		1-18" 2-15"	1-21" 2-15"	2	x	2	Under Proposed Road. Build up road.	870.00
9Ba	369	.0100	50		1-84" 2-66"	1-90" 2-66"	6½	x	6½	Under Proposed Road with wingwalls & headwalls.	6,000.00
1Bf	14	.0800	50		1-21" 4-12"	1-24" 2-15"	2	x	2	Under Proposed Road.	350.00
10Ba	478	.0200	100		1-96" 2-72"	1-96" 2-72"	7	x	7	Under Proposed Road with wingwalls & headwalls.	15,000.00
10Ba1	49	.0200	100		1-42" 3-24"	1-42" 2-30"	3	x	3	Under Proposed Road with wingwalls & headwalls. Build up road.	3,300.00

SUMMARY

ROCKRIMMON SOUTH

III N-5 - Culverts - Developed Condition

Area Designation	Qp CFS	S (Slope)	Approx. Length	Existing Culverts	Alternates for Additional Culverts			Remarks	Cost
					RCP	CMP*	Box Culverts		
					Dia.	Dia.	W x H (ft)		
11Ba	455	.0200	100		1-90"	1-90"	$6\frac{1}{2}$ x $6\frac{1}{2}$	Under Proposed Road with wingwalls & headwalls . Build up road.	$ 13,400.00
11Ba	455			10x10' Box				See Fig. III-J Existing culvert under Interstate #25	
12Ba	476			Stone Arch				See Fig. III-J Existing stone arch culvert under R.R.	
13Ba	478	.0280	100	Replace 6' Dia. CMP	1-96" 2-72"	1-96" 2-72"	7 x 7	See Fig. III-J Replace & realign new culvert under County Road.	10,000.00
								TOTAL	$109,741.00

*All Proposed CMP Culverts to be Asbestos Bonded.

Note: 2Bb - Assume 3-48" culverts for road crossings through unplatted area 60' in length

III N-6 - SUMMARY OF COST ESTIMATES

Area Rockrimmon North Drainage Basin	1.69 Sq. Mi.
Area Rockrimmon South Drainage Basin	1.31 Sq. Mi.

COSTS

ROCKRIMMON NORTH

Rip-Rap Min. Channel as shown		$360,550.00
Culverts		108,945.00
Storm Sewers		34,200.00
	TOTAL	$503,695.00

ROCKRIMMON SOUTH

Rip-Rap Min. Channel as shown	$276,058.00
Culverts	109,741.00
	$385,799.00

UNIT COSTS

ROCKRIMMON NORTH

Cost/Sq. Mi.	$298,045.00
Cost/Acre	466.00

ROCKRIMMON SOUTH

Cost/Sq.Mi.	$294.503.00
Cost/Acre	460.00