HYDROLOGY M23/D6 7 PLANS 1 of 2

M23/D6

7 Plans

City of Albuquerque
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

April 5, 1978

Base Commander
Dept. of the Air Force
Headquaters 1606th Air Base Wing (MAC)
K.A.F.B., New Mexico 87117

Gentlemen:

The development of the Four Hills Project has experienced flooding from an unnamed arroyo originating within the confines of the K.A.F.B. The City of Albuquerque has attempted to provide protection to the residents in the area through channelization and lining of the arroyo within the confines of the subdivision. This effort has required the expending of large sums of money (over $400,000.00) and the results of this effort are uncertain given the large discharges and high velocities anticipated.

It is the opinion of the writer that an effort should be undertaken to minimize the presently existing exposure of the residents of the subdivision by diverting the flow from the above mentioned arroyo to another water course within the confines of the base where damage to life and property would be minimal. Enclosed is a sketch of the suggested diversion.

I would, therefore, like to explore this possibility in a meeting with your staff and with the Engineer for the Developer at your earliest convenience.

Very truly yours,

Bruno Conegliano
Asst. City Engineer-Hydrology

cc; John Andrews
Jim Smith
Rip Orr
V.M. Kimmick
Drainage file

RECEIVED
NOV 02 1977
CITY ENGINEERS

PAUL'S HOMES INC.

Custom Homes

November 1, 1977

City of Albuquerque
P. O. Box 1293
Albuquerque, N. M. 87103

ATTENTION: Mr. V. M. Kimmick, P. E.
City Engineer

Re: Four Hills Village
17th and 19th Installments

Gentlemen:

This letter is to confirm our conversation October 28, 1977 wherein the City of Albuquerque agreed to pay the full cost of improving the channel north of Lots 1 and 2 Block 51 and one-half of the cost of improving the channel for the balance north of and adjacent to Four Hills Village 17th Installment.

It was further agreed that Four Hills Estates will stabilize the existing channel that transverses Four Hills Village 19th Installment.

Sincerely,

FOUR HILLS ESTATES, a Ltd. Partnership,
BY: PAUL'S HOMES, INC., Gen. Ptr.

BY: Paul W. Smith

PWS:cam

P. O. Box 14066 Station G Albuquerque, New Mexico 87111 Phone (505) 296-5494

CITY OF ALBUQUERQUE, NEW MEXICO
CITY ENGINEER'S OFFICE

MEMORANDUM - August 18, 1977

TO: Mr. H. R. Orr, Jr., Acting Public Works Director
FROM: V. M. Kimmick, City Engineer
SUBJECT: STORM DRAINAGE PROBLEMS NORTH OF FOUR HILLS
INSTALLMENT NO. 17

On Wednesday, August 17 at 10:00 A.M. a meeting was held at AMAFCA with the persons in attendance on the enclosed list. The 20 residents of Four Hills who attended the meeting expressed a number of concerns regarding the arroyo to the north of Installment 17. Several existing problems were discussed with the chain link fence newly installed which was partially knocked down by storm waters, and several residents expressed concern about the danger to their yards from storm waters. The drainage plan for Installment 17 calls for this arroyo to remain in its natural condition. Unfortunately the three recent rains have eroded the arroyo to such an extent that it is very obvious that the arroyo cannot function properly in a natural condition. All of the residents were unanimous in agreeing that concrete lining of this arroyo is the total answer to the problem.

We discussed the present design of the same arroyo to the west of Bernalillo Place and indicated that we were designing the lining of the arroyo at the present time and expected to have a work order issued within the next two to three weeks. We also indicated that funds were insufficient to accomplish the lining of the entire arroyo but that AMAFCA had indicated that there was a possibility they would contribute toward the completion of the project. In the area east of Bernalillo Place, the problem is further complicated by the fact that the private lots to the north of the arroyo are in the County and that no specific easements have been granted for the passage of flood waters.

The following matters were agreed upon by the persons at the meeting:

1. Paul Smith has agreed to pay for the salvage of the fence from the arroyo and the removal of such amount of the cyclone fencing as is necessary to provide access for equipment to perform earth moving for temporary relief in the channel. He also agreed to do some temporary grading and lining of the north side of the arroyo with some large boulders available on his construction site

in order to protect those properties to the north of Unit 17. In addition, he agreed that he would place some of these boulders on the north side of the arroyo where a small drainage easement comes in from Unit 17.

2. Paul Smith's engineer, Mr. Stites, will design an earth lined channel sufficient to carry the 2000 cubic feet per second of storm waters which traverse this arroyo. After this plan has been prepared, a second meeting will be held with the residents primarily aimed at showing them where the proposed earth lined channel will be and requesting that these residents to the north dedicate sufficient easement to allow construction of this channel. It was further agreed that an attempt would be made to balance the placement of this arroyo so that about an equal amount fell on Unit 17 and on the properties to the north.

3. The ultimate phase of this problem will be the concrete lining of this channel. The residents were told that the funds which were originally intended to line the lower arroyo would be used to line this arroyo should the bond issue pass in October.

I felt that the meeting was extremely successful, the residents expressed the fact that a lot of the problem was caused by communications. When they understood the total problem, they were very satisfied with our suggested solutions. Some of the residents remain concerned with the danger to their properties and Mr. Kielich has spoken with Mr. George Paul, the Street Maintenance Engineer who is providing some immediate protection for those properties involved. It is hoped that the meeting involved with the placement of the temporary earth channel will happen some time next week, however, we must wait for the design to be prepared by Paul Smith's engineer.

VMK/fs
Enclosure

cc - Bruno Conegliano
Bob Kielich
Dwayne Sheppard
George Paul

FOUR HILLS DRAINAGE PROBLEMS
17 August 1977

Mrs Gary W Wilson 1224 Cuatro Cerros Ln SE

Mr & Mrs L. Kisner 1008 Bragas Ct. SE.
Mr & Mrs Jerry L. Stegman 1019 Bernalillo Pl. SE
Clair Miller 1216 Cuatro Cerros S.E.
MR + MRS. TOM TINKLE 1632 SAGEBRUSH TR. SE
MRS. FRED GREYBAR 1308 CUATRO CERROS SE
MR ARDEL FRANK 1300 CUATRO CERROS SE
Major & Mrs Richard A. Wisler 1040 Bernalillo Pl. SE 299-1188
Mrs. D. C. Langman 1304 Cuatro Cerros S.E
Mrs. Hiber Hudson 1634 Sagebrush Tr. S.E.
MRS. EDMUND B. KASNER - 1011 SOLEDAD CT. SE
Jack Tischhauser 1018 Bernalillo Pl. S.E.
Edmund B. Kasner, 1011 Soledad Ct, SE
Paul Smith, Developer
Wilbur D. Stites, ENGINEER 8000 E. GIRARD #306 DENVER, COLO 80231

Mrs Jerry D Hurst 1312 Cuatro Cerros SE 294-1157
Martha J. Selzer 1220 Cuatro Cerros SE

City
V.M. Kimmick, City Engineer
Q.R. Krelich, Assistant City Engineer
Bruno Conelgiaro, Assistant City Engineer

AMAFCA
Jim Smith

City of Albuquerque
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

MAYOR
Harry E. Kinney

CHIEF
ADMINISTRATIVE OFFICER
Frank A. Kleinhenz

November 9, 1976

Paul's Homes Inc.
729 Four Hills Rd. S.E.
Albuquerque, New Mexico 87123

RE: DRAINAGE DIVERSION DITCH
EAST OF FOUR HILLS VILLAGE
13TH. INSTALLMENT

Dear Mr. Smith:

On October 4, 1976, plans for the subject project were returned to your engineer with comments by the City Engineering staff. The construction of the diversion needs to be completed by February 1, 1977. Many homes and people are subject to the risk of flooding which was to be eliminated by this facility. Your early action on this matter will be most appreciated, and a specific construction schedule is requested.

Very truly yours,

V. M. Kimmick
City Engineer

VMK/fs
cc: Ron Brown
E. F. Hensch
Bob Kielich
Kleston Laws
Dwayne Sheppard

Public Works Department
Director — Erwin F. Hensch, P. E. 766-7467
Engineering 766-7441 — V. M. Kimmick, P. E.
Street Maint. 766-7755 — G. E. Paul, P. E.
Asst. Director — Harold R. Orr, Jr. P. E.
Liquid Waste 766-7535 — R. P. Lowe, P. E.
Water 766-7437 — W. H. Otto, P. E.

October 4, 1976

Stites & Associates, Inc.
8000 E. Girard Ave., Suite 306
Denver, Colorado 80231

RE: FOUR HILLS VILLAGE DIVERSION CHANNEL

Dear Mr. Stites:

The plans for the subject diversion have been reviewed. The following questions and comments are presented for your consideration:

1. The plans mention dedicating existing arroyos with a replat. The dedication of an easement for the diversion is not mentioned. Presumably all dedication will occur at the same time. When is replat proposed? Until such time the channel will be on private property and not maintained by the City.

2. The drop structures should show in plan view.

3. What about rip rap at the junction of the diversion and the Sandia Military Reservation?

4. Is the rip rap to be wire bound, grouted or have a filter cloth? We have had a great amount of problems with water eroding fines from beneath the rip rap and causing failures.

5. Grade breaks in the dirt channel will not be held. Perhaps it would be desirable to make the grade changes at culverts and drop structures.

6. Depths do not increase where arroyos flow into the diversion. Also, depths sometimes increase with slope increase or decrease with a slope decrease. Perhaps a chart showing station, flow, water depth, velocity and channel bottom width would be helpful.

7. The "W" dimension shown on the plan is not reflected in the typical section. Also is the typical section for the channel parallel to the Sandia Military Reservation? If so, which side is the low side?

8. The drop structure and the typical section do not have the same shape. In section B the note "3 X 1'6" Grout Solid in Cell" does not mean anything.

Changes need to be made by you or you can authorize the changes to be made by the City.

Very truly yours,

Kleston H. Laws
Assistant City Engineer-Hydrology

KHL/fs

cc: Dwayne Sheppard
Paul's Homes Inc.
Ralph Hicks

WILBUR D. STITES & ASSOCIATES
8000 E. Girard
Suite 306
Denver 80231
AREA CODE (303) 751-1237

LETTER OF TRANSMITTAL

DATE 9-7-76	JOB NO. P8-6
ATTENTION ~~Paul Smith~~	
RE: Four Hills Village - Extension 17th Installment	

TO Paul's Homes, Inc
729 Four Hills Rd S.E.
Albuquerque, N.M. 87123

GENTLEMEN:

WE ARE SENDING YOU ☒ Attached ☐ Under separate cover via _____ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications

☐ Copy of letter ☐ Change order ☐ _____

COPIES	DATE	NO.	DESCRIPTION
1 ea			Sepias: Sheets 1,2,3 & 4 Diversion Channel
1 ea			Prints: " " " "

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit _____ copies for approval

☒ For your use ☐ Approved as noted ☐ Submit _____ copies for distribution

☐ As requested ☐ Returned for corrections ☐ Return _____ corrected prints

☐ For review and comment ☐ _____

☐ FOR BIDS DUE _____ 19_____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS _____

COPY TO _____

SIGNED: W. D. Stites

If enclosures are not as noted, kindly notify us at once.

City of Albuquerque
P.O. BOX 1293 ALBUQUERQUE, NEW MEXICO 87103

MAYOR
Harry E. Kinney

CHIEF
ADMINISTRATIVE OFFICER
Frank A. Kleinhenz

April 22, 1976

Mr. Wilbur D. Stites
Stites & Billingsley
8000 East Girard Ave., Suite 306
Denver, Colorado 80231

RE: FOUR HILLS VILLAGE

Dear Mr. Stites:

I have reviewed the drainage report dated April 8, 1976, previous reports, aerial photographs, street grades, as builts and other data and have concluded the proposal is unacceptable.

My conclusion is based on the following:

1. It appears the 62 acres (your Area 2) will contribute flow to La Cabra Drive. The flattest slope on this street is 2.44% with a carrying capacity of about 200cfs. You show 345cfs reaching this point. The energy gradient on this street in the steeper stretches could be as much as 5 feet above the street.

2. It appears another 60 to 70 acres will drain to the new proposed street south of La Cabra Drive with the same results in flow and energy.

3. A water block in the drainage report shown on Stagecoach Road was constructed on Pedregoso Place, thus Camino Cerrito will have about one third more flow than shown in the drainage report. This will exceed the capacity of this street. Part of this flow was to be diverted by the temporary ditch.

Public Works Department

Director – Erwin F. Hensch, P. E. 766-7467
Engineering 766-7441 – V. M. Kimmick, P. E.
Street Maint. 766-7755 – G. E. Paul, P. E.
Ass't. Director – Harold R. Orr, Jr. P. E.
Liquid Waste 766-7535 – R. P. Lowe, P. E.
Water 766-7437 – W. H. Otto, P. E.

4. I question the feasibility of removing two and three hundred cubic feet per second at velocities of 9 to 15 feet per second from streets with inlets and 90 degree direction changes.

I recommend a different solution be proposed.

Very truly yours,

Kleston H Laws

Kleston H. Laws
Assistant City Engineer-Hydrology

KHL/fs

cc: V. M. Kimmick
Ralph Hicks
Paul Smith

December 22, 1975

M23-D6

Mr. Bo K. Johnson
Murray-McCormick Inc.
2601 Wyoming Blvd. N.E. Suite F
Albuquerque, New Mexico 87110

RE: Drainage Report, Four Hills Village, Seventeenth Installment

Dear Mr. Johnson:

The concept of the subject drainage study is approved. Detailed design plans for the subdivision including all drainage improvements shall be approved by the City Engineer. All improvements shall be constructed with approved permits, contracts and City inspection.

Very Truly Yours,

Kleston H. Laws
Asst. City Engineer-Hydrology

KHL/tl

cc: John Robert

MURRAY-McCORMICK, INC.
ENVIRONMENTAL DESIGN
ARCHITECTURE · ENGINEERING · PLANNING · SURVEYING

December 9, 1975

City of Albuquerque
P. O. Box 1293
Albuquerque, New Mexico 87103

Attention: Mr. Kleston H. Laws, Drainage Engineer

Subject: Addendum to the Four Hills Village, Seventeenth Installment, Drainage Report

Dear Mr. Laws:

This addendum is in reply to questions raised by the City Hydrology Engineer, Mr. Kleston H. Laws.

a) Query - What will define the limits of construction in the drainage channel along the north boundary of the site?

- On the subdivision plat to be filed, a drainage and utility easement line is designated along the north boundary of the site. This line was determined by overlay of the existing channel. While ownership of the channel remains in the hands of the individual lot owners, no construction can take place in the easement. The intent is to leave the channel in its natural shape so that flow patterns will not be altered from the present condition.

The subdivision bordering the north side of the channel is shown on the enclosed plat, titled 4 Hills Village, Fifth Installment. Here again, ownership of the channel is in the hands of the individual lot owners, but any construction in or alterations of the channel is prohibited.

b) Query - What will become of the pond in the channel which is formed by a road corssing?

- The road crossing will be breached and the channel returned to its natural shape. The pond serves no useful purpose, and after development of the site, it could become a problem if allowed to remain.

c) Query - How will the water in the channel be forced into the easement west of the site?

- The width of the drainage easement west of the site is 65'. The channel adjacent to the site varies in width from 60' to 150'. It narrows down to 60' in width approximately 200' east of the northwest corner of the

2601 WYOMING BLVD., N.E. SUITE F/ALBUQUERQUE, NEW MEXICO 87110/505-292-1936
CALIFORNIA ALASKA OREGON WASHINGTON TEXAS GEORGIA FLORIDA COLORADO

site. The narrow sections of the channel have the capacity to handle all flows, plus the wider sections will help slow the runoff velocity down. The natural shape of the channel works, so no alterations should be needed in the area adjacent to the site and immediately west of the site.

d) Query - What will happen to the offsite flows from the east when that area is developed?

- Because of the topography, development of Area O-S-1 and O-S-2 (Figure 2) would most likely result in some flows being turned into the 17th site via the road at the east boundary. A conservative estimate of 30 c.f.s. being diverted onto the site would not pose any problem for the streets or drainage way. The remaining area from O-S-1 and O-S-2 could be diverted directly into the channel.

3) Query - The drainage channel approximately 2,000' downstream of the site lacks definition. Will this area of the channel be able to handle the additional flows added to it by the 17th site?

- The cross-section of the channel, as determined by actual field survey, in its narrowest section, will handle 1163 c.f.s. (Area = 72 ft^2, P = 32.5, slope = 5%, n = 0.035) The channel should be re-defined by grading in the areas shown on Plat M-22-Z. A typical cross-section of a channel base of 25', 4' depth of flow, 2:1 side slope, minimum slope of 4.5%, will handle 2500 c.f.s. Please refer to the accompanying plat of the channel regrading for details.

Very truly yours,

MURRAY-McCORMICK, INC.

Bo K. Johnson, P.E.
Vice President

MURRAY-McCORMICK, INC.
ENVIRONMENTAL DESIGN
ARCHITECTURE · ENGINEERING · PLANNING · SURVEYING

October 22, 1975

RECEIVED
OCT 29 1975
CITY ENGINEERS

City of Albuquerque
P.O. Box 1293
Albuquerque, New Mexico 87103

Attention: Mr. Kleston H. Laws, Drainage Engineer

Subject: Addendum to the Four Hills Village, Seventeenth Installment, Drainage Report.

Dear Mr. Laws:

This addendum is in reply to questions raised by the City Hydrology Engineer, Mr. Kleston H. Laws.

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The subdivision bordering the north side of the channel is shown on the enclosed plat, titled 4 Hills Village, Fifth Installment. Here again, ownership of the channel is in the hands of the individual lot owners, but any construction in or alterations of the channel is prohibited.

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c) Query - How will the water in the channel be forced into the easement west of the site?

- The width of the drainage easement west of the site is 65'. The channel adjacent to the site varies in width from 60' to 150'. It narrows down to 60' in width approximately 200' east of the northwest corner of the

2601 WYOMING BLVD., NE. SUITE F/ALBUQUERQUE, NEW MEXICO 87110/505-292-1936
CALIFORNIA ALASKA OREGON WASHINGTON TEXAS GEORGIA FLORIDA COLORADO

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d) Query - What will happen to the offsite flows from the east when that area is developed?

- Because of the topography, development of Area O-S-1 and O-S-2 (Figure 2) would most likely result in some flows being turned into the 17th site via the road at the east boundary. A conservative estimate of 30 c.f.s. being diverted onto the site would not pose any problems for the streets or drainage way. The remaining area from O-S-1 and O-S-2 could be diverted directly into the channel.

e) Query - The drainage channel approximately 2,000' downstream of the site lacks definition. Will this area of the channel be able to handle the additional flows added to it by the 17th site?

- The cross-section of the channel, as determined by actual field survey, in its narrowest section, will handle 1163 c.f.s. (Area = 72 ft^2, P = 32.5, slope = 5%, n = 0.035) The channel should be re-defined by grading in the areas shown on Plat M-22-Z. If the channel slope is increas d by 0.2% between pt. 1 and pt. 2 (See M-22-Z), the channel depth can be increased by 2' at pt. 2. With a 10' bottom and 2:1 side slopes, this section will handle in excess of 2700 c.f.s. By reworking the channel between pts. 1 & 2, channel capacity can be increased to handle the upstream flows.

The cross sections below offer a visual explanation of the above narrative.

MURRAY-McCORMICK, INC.
ENVIRONMENTAL DESIGN
ARCHITECTURE · ENGINEERING · PLANNING · SURVEYING

October 20, 1975

City of Albuquerque
P.O. Box 1293
Albuquerque, New Mexico 87103

Attention: Mr. Kleston H. Laws, Drainage Engineer

Dear Mr. Laws:

The enclosed plats for the Four Hills, 17th Installment drainage report have been modified as per your comments on the initial review.

The plat for the 5th Installment is enclosed for your information to show which lot will be used for the street extension of the 17th Installment. The on-site drainage map of the 17th Installment has been modified as follows: the drainage channel (Section B-B) has been moved to the street "T" intersection; Area A-3 will drain down the street, onto Bernalillo Place S.E. and into the natural channel; the off-site ditch-dike intercepting areas O-S-1 and O-S-2 will be moved 50' off of the boundary in order to leave room for a turn-around at the east end of the site; a typical cross-section of the natural channel is shown so that any grading changes will not affect the final form.

We hope these changes will prove satisfactory to you. Please don't hesitate to call us if you have any questions.

Sincerely,

Christopher L. Weiss

CLW:cmh

Enclosures

2601 WYOMING BLVD., NE. SUITE F/ALBUQUERQUE, NEW MEXICO 87110/505-292-1936
CALIFORNIA ALASKA OREGON WASHINGTON TEXAS GEORGIA FLORIDA COLORADO

DRAINAGE SYSTEM DESIGN DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
INLET	LINE SEGMENT	LENGTH OF SEGMENT FT.	INLET TIME MIN.	FLOW TIME MIN.	TIME OF CONCENTRATION MIN.	RUNOFF COEFFICIENT "C"	RAINFALL INTENSITY "I" IN/HR	TRIBUTARY AREA "A" ACRES	RUNOFF "Q" CFS	ACCUMULATED RUNOFF CFS	VELOCITY OF DRAIN FT/SC	SIZE OF PIPE IN.	TOP OF INLET BEGIN RUN FT.	TOP PIPE END RUN FT.	HYDRAULIC GRADIENT FT/FT	INVERT ELEV. BEGIN RUN FT.	INVERT ELEV. END RUN FT.	SLOPE OF PIPE FT/FT	CAPACITY OF PIPE CFS	REMARKS
1	1-2	172	25	0.5	25.0	.31	1.55	5.92	2.84	2.84	3.60	24"	06.50	5.28	.0071	03.45	03.28	.0010	18.0	
2	2-3	320	11	0.5	25.5	.90	1.90	6.79	11.61	14.45	6.00	24"	07.50	04.32	.0099	03.28	02.32	.0030	21.5	
3	3-4	438	10	1.0	26.0	.90	1.88	9.72	16.44	30.89	7.60	30"	06.70	03.38	.0076	02.32	00.88	.0034	39.5	
4	4-5	470	12	0.8	27.0	.90	1.84	2.18	5.89	36.78	9.60	30"	08.83	01.98	.0145	00.88	99.48	.0051	48.0	
5	5-7	416	10	1.5	27.8	.90	1.80	9.72	15.75	52.53	8.00	36"	05.90	01.00	.0118	99.48	98.00	.0036	62.0	
6	6-7	440	34			.50	1.60	8.59	6.87		7.40	24"	05.50	01.00	.0101	02.36	98.00	.0099	24.0	
7	7-8	892	11	2.0	29.3	.90	1.74	6.78	10.62	70.02	7.50	42"	04.50	98.63	.0065	98.00	95.13	.0032	74.0	
8	8-16	232	14	.2	31.3	.90	1.70	10.47	10.62	80.64	8.30	42"	05.50	98.17	.0315	96.22	94.67	.0067	50.0	
9	9-13	422	14	.1	14.0	.90	2.70	4.82	11.19	11.19	3.60	24"	06.80	MH	.0086	03.77	03.36	.0010	21.0	
11	11-12	236	14	.1	14.0	.90	3.00	2.18	5.89	5.89	5.20	24"	09.12	07.85	.0054	06.08	05.85	.0010	18.0	
12	12-14	94	11	.1	14.1	.90	3.00	0.54	1.46	7.35	8.20	24"	09.20	07.75	.0058	05.85	05.75	.0010	17.0	
14	14-13	18	0.32	.1	14.2	.90	3.00	0.11	0.32	7.67		24"	09.21	05.36	.1225	05.75	03.36	.0315	60.0	
10	10-15	326	12	.1	12.0	.90	3.00	3.18	5.89	13.56	1.56	24"	08.12	6.75	.0114	5.08	4.75	.0011	25.0	
15	15-13	26	0.32	.3	14.5	.90	3.10	0.11	0.32	13.88	7.76	24"	09.21	05.36	.0116	4.75	03.36	.0115	26.0	
13	13-16	314		.1		MH to MH				25.07	11.96	24"		96.67		3.36	94.67	.0276	36	

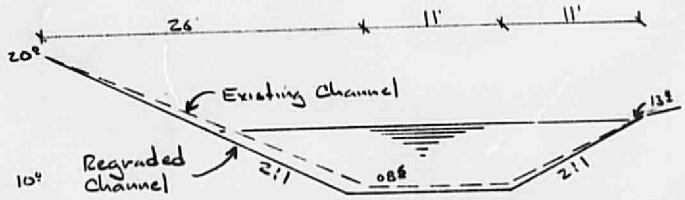
DRAINAGE SYSTEM DESIGN DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
INLET	LINE SEGMENT	LENGTH OF SEGMENT FT.	INLET TIME MIN.	FLOW TIME MIN.	TIME OF CONCENTRATION MIN.	RUNOFF COEFFICIENT "C"	RAINFALL INTENSITY "I" IN/HR	TRIBUTARY AREA "A" ACRES	RUNOFF "Q" CFS	ACCUMULATED RUNOFF CFS	VELOCITY OF DRAIN FT/SC	SIZE OF PIPE IN.	TOP OF INLET BEGIN RUN FT.	TOP PIPE END RUN FT.	HYDRAULIC GRADIENT FT/FT	INVERT ELEV. BEGIN RUN FT.	INVERT ELEV. END RUN FT.	SLOPE OF PIPE FT/FT	CAPACITY OF PIPE CFS	REMARKS
16	MH																			
16	16-20	372		0.2						105.7	10	48"	08.40	97.17	.0283	94.67	93.17	.0057	150	
17	17-18	196		0.9	12.50	.90	2.8	1.14	2.87		34	24"	08.00	06.96	.0053	04.96	03.75	.0061	16	
18	18-19	32		0.1	13.40	.90	2.7	0.85	2.07	4.94	5	24"	06.79	05.55	.1012	03.75	03.55	.0062	24	
19	19-20	108		0.1	13.50	.90	2.7	1.24	3.00	7.94	7	24"	06.79	05.15	.0013	03.55	03.15	.0056	9	
20	MH				113.4															
20	21	508										48"				93.17	89.61	.0070	122	
21		Headwall																		

DRAINAGE SYSTEM DESIGN DATA

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
INLET	LINE SEGMENT	LENGTH OF SEGMENT FT.	INLET TIME MIN.	FLOW TIME MIN.	TIME OF CONCENTRATION MIN.	RUNOFF COEFFICIENT "C"	RAINFALL INTENSITY "I" IN/HR	TRIBUTARY AREA "A" ACRES	RUNOFF "Q" CFS	ACCUMULATED RUNOFF CFS	VELOCITY OF DRAIN FT/SC	SIZE OF PIPE IN.	TOP OF INLET BEGIN RUN FT.	TOP PIPE END RUN FT.	HYDRAULIC GRADIENT FT/FT	INVERT ELEV. BEGIN RUN FT.	INVERT ELEV. END RUN FT.	SLOPE OF PIPE FT/FT	CAPACITY OF PIPE CFS	REMARKS
22	22-23	492	41.0	3.6	41.0	.61	1.30	13.48	10.7	10.70	3.52	24	06.80	4.58	.0024	3.76	2.58	.0024	35	
23	23-25	482		1.8	44.6	.90	1.25	9.72	10.93	21.63	4.58	30	07.50	4.60	.0056	2.58	2.10	.0010	31	
24	24-25	458			12.0	.90	3.00	2.18	5.89	5.89	7.75	24	09.41	4.60	.0116	6.37	2.10	.0090	21	
25	25-27	506		0.9	46.4	.90	1.20	2.18	2.35	29.87	9.81	30	10.20	3.23	.0138	2.10	00.73	.0171	48	
26	26-27	546	14.0	2.7	14.0	.90	2.30	15.06	31.17	31.17	3.37	36	05.80	3.73	.0038	01.67	00.73	.0017	40	
27	27-28	456		0.6	47.3	.90	1.18	9.72	10.32	71.36	11.76	42	07.50	1.72	.0127	00.73	98.22	.0032	112	
28	28-29	154		0.2	48.9	.57	1.15	4.30	2.81	74.17	13.77	42	03.80	1.40	.0080	98.22	97.90	.0021	90	
29			HEADWALL																	

Four Hills - 17th Installment



Cross-Section @ Pt 1.

Natural Channel ~
Area = 114 ft²
P = 35'

$Q = \frac{1.486}{n} \frac{a^{5/3}}{P^{2/3}} S^{1/2}$ where $S = 5\%$, $n = 0.035$

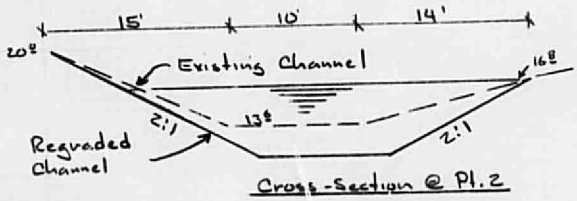
$Q = 42.457 \frac{(114)^{5/3}}{(35)^{2/3}} (0.05)^{1/2}$

$Q = \underline{2382}$ cfs

Reworked Channel ~
Area = 140 ft²
P = 37'

$Q = 42.457 \frac{(140)^{5/3}}{(37)^{2/3}} (0.05)^{1/2}$

$Q = \underline{3233}$ cfs



Cross-Section @ Pt. 2

Natural Channel ~
Area = 72 ft²
P = 32.5'

$Q = 42.457 \frac{(72)^{5/3}}{(32.5)^{2/3}} (0.05)^{1/2}$

$Q = \underline{1163}$ cfs

Reworked Channel ~
Area = 122 ft²
P = 34'

$Q = 42.457 \frac{(122)^{5/3}}{(34)^{2/3}} (0.05)^{1/2}$

$Q = \underline{2714}$ cfs

MURRAY-McCORMICK, INC.
ENVIRONMENTAL DESIGN
ENGINEERING·PLANNING·SURVEYING
2501 WYOMING BLVD., NE SUITE F / ALBUQUERQUE, NEW MEXICO 87110 / 505-255-1986

JOB NO. _____ DATE 10-22-75

PROJECT 4 Hills - 17th Installment

SCALE _____

DRAINAGE STUDY
OF CONDITIONS RELATIVE
TO THE DEVELOPMENT OF
EXTENSION OF FOUR HILLS VILLAGE

Prepared by:
RALPH K. HICKS AND ASSOCIATES, INC.
Civil Engineers, Land Surveyors,
and Land Planning Consultants
June 1971

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DRAINAGE STUDY RELATIVE TO THE DEVELOPMENT OF THE EXTENSION OF FOUR HILLS VILLAGE

I. GENERAL

This report is prepared in order to present findings of a study of storm runoff in the area proposed for development of the EXTENSION OF FOUR HILLS VILLAGE and to describe satisfactory methods for handling the runoff before, during and after development.

Since the development progress will dictate how the drainage pattern will be revised, the report will discuss the analysis under the following headings: Location, Existing Drainage Conditions, Proposed Drainage Plans and Conclusions.

II. LOCATION

The location of the area proposed for development is inside the City Limits of Albuquerque, Bernalillo County, New Mexico and is a portion of Section 35, Township 10 North, Range 4 East, N.M.P.M. This area is bounded on the North and West by Units No. 2, No. 3 and No. 5; on the East by unplatted land; and on the South by Sandia Military Reservation.

III. EXISTING DRAINAGE CONDITIONS

1. General

The area proposed for development is cut by one major and two minor arroyos extending across the property in a Northwesterly direction from its Easterly and Southerly Borders. The area proposed for development consists of two distinct types of terrain namely rugged granite type foothills and alluvian fan type mesa areas. In general, the rugged foothills occur near the eastern limit while the mesa areas are situated over most of the area to the West, to the Tijeras Arroyo.

2. Topography

The area lies in the Southeast Corner of Albuquerque situated at the West edge of the Manzano Mountains, South of Tijeras Canyon, and North of the Sandia Military Reservation. The exhibits consist of recent photography and xerox copies of the Tijeras, New Mexico seven and one half minute quadrangle.

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The photographic Exhibit "A" is at a scale of approximately 1"=1000' while the quadrangle Exhibit "B" is at a scale of approximately 1"=2000'. A third exhibit consists of a copy of a planning study of Four Hills Village Extension at a scale of 1"=200' prepared from areal photography by Koogle & Pouls Engineering, Inc.

3. Drainage Areas and Channels

At present there are two minor arroyos and areas which are shown on Exhibit "A". These two minor drainage areas join each other through a manmade channel which extends Southwesterly from a point about 1330 feet West of the East property line.

The drainage channel is located very near to a master planned street as shown on Exhibit "C".

A major arroyo enters the master planned area from the South about 2100 feet West of the Southeast Corner of Section 35, Township 10 North, Range 4 East, N.M.P.M. This arroyo has its watershed limits which extend into the Sandia Military Reservation (Manzano Base) and has a detention dam about 1180 feet East of the West section line, between Sections 34 and 35. Its area was traced out and is shown on Exhibit "B" due to restrictions on photo coverage in this area.

All other areas were traced out in the field with the aid of photographic coverage at a specific scale.

IV. PROPOSED DRAINAGE PLANS

1. General

In order to develop an adequate system of storm drainage for this development it was necessary to:

(a) Determine the drainage areas contributing flow from outside the area.
(b) Determine the state of development to be expected in the future.
(c) Determine the points at which runoff can converge and by using the areas described determine the quantities of flow to be expected.
(d) Determine the ability of the existing or proposed drainage channels or structures to handle the quantities of runoff expected.
(e) Determine and recommend the means by which the expected runoff can be safely carried across the subdivision.

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At present there are two minor arroyos and areas which are shown on Exhibit "A". These two minor drainage areas join each other through a manmade channel which extends Southwesterly from a point about 1300 feet West of the East property line.

The drainage channel is located very near to a master planned street as shown on Exhibit "C".

A major arroyo enters the master planned area from the South about 2100 feet West of the Southeast Corner of Section 35, Township 10 North, Range 4 East, N.M.P.M. This arroyo has its watershed limits which extend into the Sandia Military Reservation (Manzano Base) and has a detention dam about 1180 feet East of the West section line, between Sections 34 and 35. Its area was traced out and is shown on Exhibit "B" due to restrictions on photo coverage in this area.

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(f) Design additional channels and structures adequate to handle runoff in the area to be developed.

2. Drainage Areas

A study was made of contour maps and photographs of the area which could conceivably contribute storm runoff water that might affect the development. The contour maps used were prepared as follows: Exhibit "B" 1" = 2000' Tijeras Quadrangle Map by U. S. Geological Survey; Exhibit "C" from aerial photography by Koogle & Pouls Engineering, Inc. Exhibit "A" is a scale (1" = 1000') photograph prepared by Limbaugh Engineering, Inc. flown June 14, 1971.

From this study it was determined that three areas would have to be considered separately contributing from the East and South. These are shown on Exhibits "A" and "B" as A-1, B-1 and C-1. Fifteen smaller sub areas labeled A-2, A-3, A-4, B-2, C-2, C-3, D-1, D-2, F-1, F-2, F-3, G-1, H-1, J-1, and K-1 contribute from within Section 35 and are shown on Exhibit "C".

3. Runoff Quantities

The quantity of runoff to be expected from each area was determined using the "Rational" approach, Q=CIA: where Q=quantity of runoff in cubic feet per second; C=coefficient of runoff dependent on the type of surface drained or ratio of runoff to rainfall; I=intensity of rainfall in inches per hour for a duration equal to the accumulation time; and A=area of the contributing watershed in acres.

The areas (A) were outlined on a photograph and a contour map the first of which was field inspected since contours were not available except on the U.S.G.S. Quadrangle Map.

The intensity of rainfall (I) was determined assuming a 100 year frequency rainfall and the utilizing Intensity Duration Frequency Curve from the City of Albuquerque, Master Plan of Drainage as prepared by Gordon Herkenhoff and Associates in 1963 together with the expected accumulation times from each of the areas. These times were determined using probable future street and drainage channel alignments and grades, as shown assuming the overland flows to be across either poor grass, asphalt pavement or bare soil, depending on the probable type of development in each area and estimating the type of grading to be done in each area; assuming future streets to be asphalt paved with concrete curb and either crowned or flat surfaces. The times of flow were determined utilizing tables 5.00, 5.04 and 5.05 of Design by E. E. Seelye.

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The coefficient of runoff (C) was determined by assuming the maximum possible development in the area with a coefficient C=0.65 for areas beyond the mountainous limits and C=0.75 in the steeper more barren areas.

The quantities of flow summarized in the Section VII entitled Summary of Results and Computations for each point shown on Exhibit "C". Copies of the calculations used to determine the runoff quantities are indicated in the runoff computation sheets.

4. Drainage Channels and Facilities

All existing structure capacities, as well as, any proposed structures were verified from computer output tapes which utilizes Mannings Equation Q=AV where: $V=\frac{1.486}{n} R^{2/3}S^{1/2}$;

when A=cross-sectional area or channel or pipe in square feet; R=hydraulic radius of channel in feet (area divided by wetted perimeter); S=slope of channel facility in feet per foot; and "n" values of 0.015 for concrete and asphalt, .013 for pipes, .0225 for natural well defined channels, or a composite "n" value based on proportionate wetted surfaces with different values.

V. CONCLUSIONS AND RECOMMENDATIONS

On the basis of this study and its calculations it is concluded that the development of this area can be provided adequate storm drainage if the following recommendations are recognized:

1. The drainage pattern should, in general, follow the directions shown on the Planning Study executed in March 1971 and revised in June, 1971, as shown on Exhibit "C".

2. The June 1971 revision should reflect an East-West street 48 feet wide from about 1200 feet West of the East Section Line to a 65 feet drainage right of way about 800 feet North of the South Section Line.
   (a) This street should maintain a minimum grade of about 5% with right of way lines a minimum of 0.3 of a foot above high curb to the intersection of the first cross-street East of the drainage easement and with a maximum of 4 inch crown to the first cul-de-sac to the East of this.
   (b) This arroyo crossing should be designed as a dip section with a cutoff wall along its downstream side to protect the pavement from erosion.

3. A 32 feet street must be planned along just East of the mid-section line between 1700 feet and 2200 feet North of the South section line approximately one tier of lots East of the Speakman property.

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4. Two 40 feet drainage easements should be provided as follows:

(a) One 200 feet, more or less, easement about 300 feet North of the Southeast Corner of Section 35.

(b) A second, about 600 feet North of the Southerly Quarter Section Corner extending in a Southwesterly direction flowing into the major arroyo through a rip-rap type energy dissipator.

5. The downstream crossing of the major arroyo may also be paved but also with a protective cutoff wall on its downstream side. It should be realized that both crossings will require systematic maintenance after any major storms with attendant flood damage.

6. An open type concrete rundown should be provided about 100 feet south of Sagebrush Trail and about 500 feet West of Stagecoach Lane to provide for removing part of the flow from this North-South street just South of the twin concrete pipes.

7. The channel for the main arroyo from the limits of development to approximately where the 40 feet easement just North of the Quarter Section Corner should be lined as shown in the typical section and maintained at a grade of no less than 4.5%

An alternate solution might be an unlined channel also shown in Exhibit "C" is considered satisfactory in the interest of economy. This method requires a somewhat steeper grade, 5% as shown, to carry the same flow but will result in a satisfactory alternative, provided the owners downstream are satisfied.

If all of the above recommendations are honored this master plan of drainage should be adequate for orderly development of Four Hills Village.

Respectfully submitted,

Donald L. Campbell

Donald L. Campbell
P.E. & L.S. No. 3633

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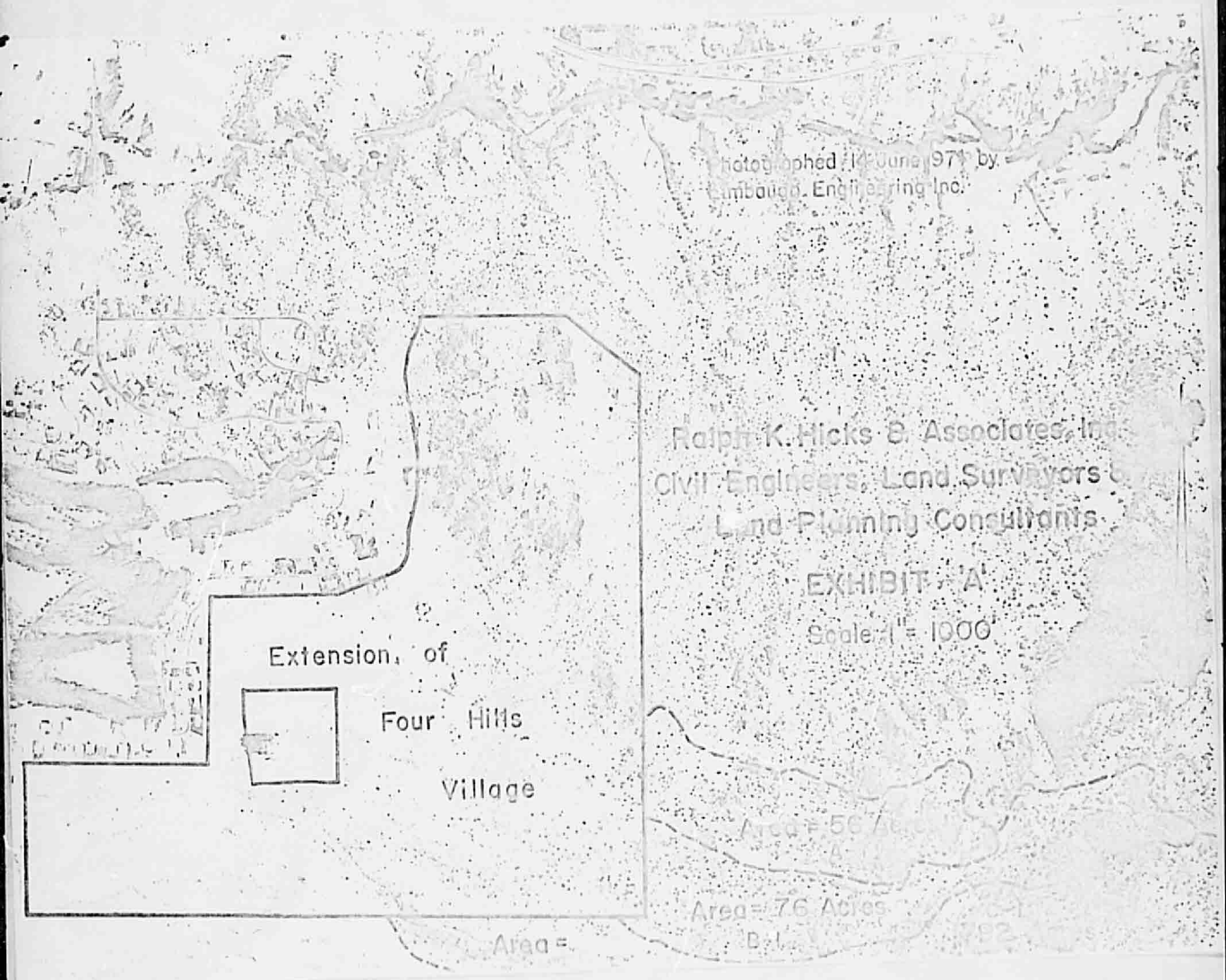

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VII. SUMMARY OF RESULTS

AREA NO.	AREA (IN ACRES)	Q (RUNOFF IN CFS)*	RUNOFF CUMULATIV (IN CFS)
A-1	56	137	
B-1	76	202	
C-1	792	1340	
A-2	19	36	173
D-1	15	54	
D-2	10	21	75
A-3	9	12	260
A-4	3	10	312
B-2	28	15	305
C-2	9	11	1968
C-3	41	43	2011
F-1	30	105	
F-2	17	33	138
F-3	4	7	145
G-1	28	72	
H-1	38	115	
J-1	28	86	
K-1	17	65	

*See "Runoff Computations" sheets 1 thru 18 for individual Qs and Exhibits "A", "B" and "C" for areas.

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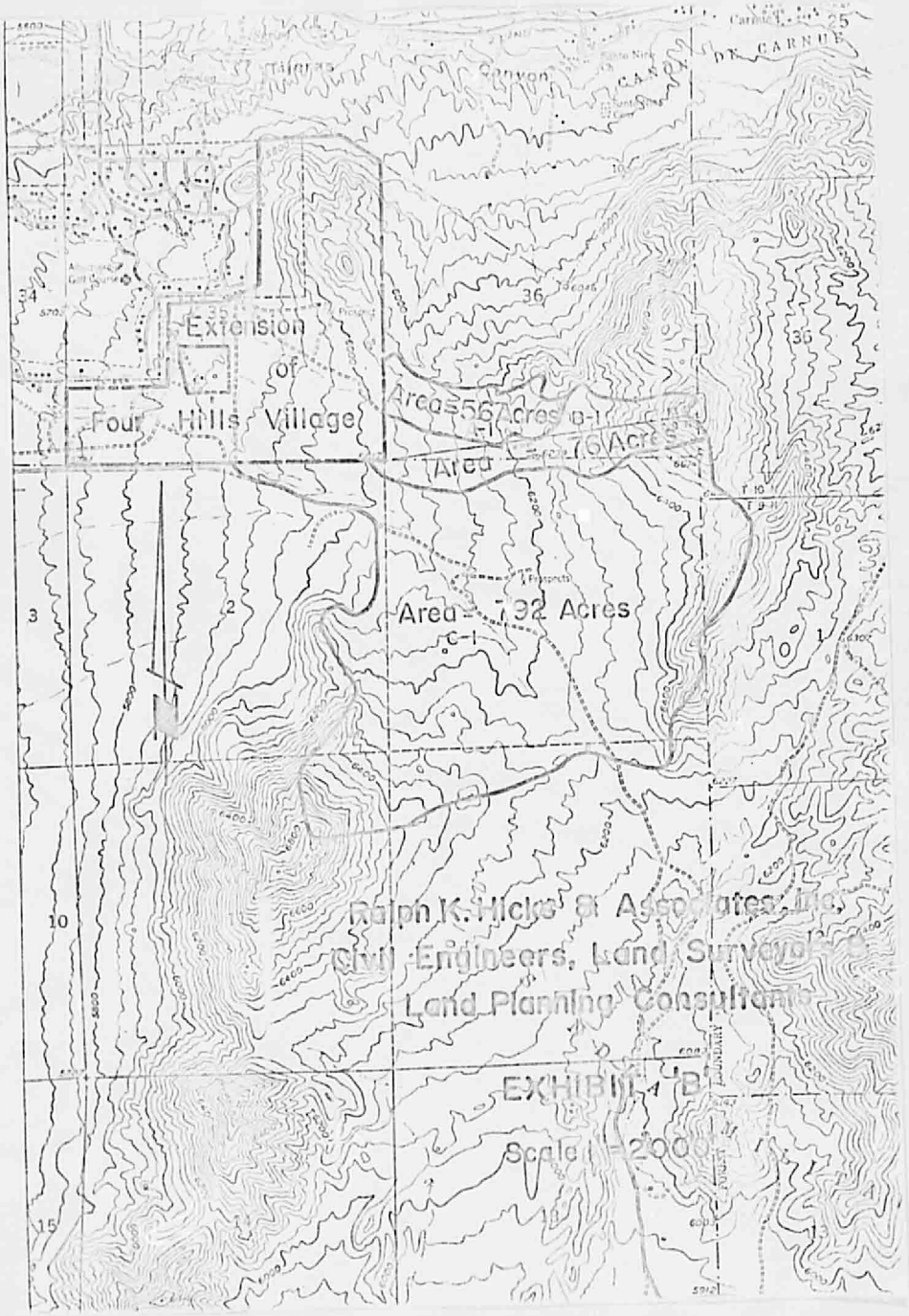

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RUNOFF COMPUTATIONS

SHEET No. 10
JOB No. F.H.

DRAINAGE AREA No. A-1

AREA = 56 ACRES

MAXIMUM OVERLAND FLOW L = 200' S = 1.0%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = 1000' S = 2.0%

CHANNEL No. 2 L = 2000' S = 5.0%

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 19.5 MIN.

CHANNEL No. 1 FLOW

VELOCITY = 4.1 FT/SEC

TIME = $\frac{1000}{4.1 \times 60}$ = 4.1 MIN.

CHANNEL No. 2 FLOW

VELOCITY = 3.5 FT/SEC

TIME = $\frac{2000}{3.5 \times 60}$ = 9.5 MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\times 60}$ = ____ MIN.

TOTAL ACCUMULATION TIME 33.1 MIN

$I = \frac{189}{T + 25} = 3.24$ in/hr

$Q = C I A = (.75)(3.24)(56) = 137$ CFS

DATE 6/17/91
COMP. BY. [illegible]
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RUNOFF COMPUTATIONS

SHEET No. 11
JOB No. 5H.

DRAINAGE AREA No. B-1

AREA = 76 ACRES

MAXIMUM OVERLAND FLOW L = 150' S = 1%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = 2000' S = 10%

CHANNEL No. 2 L = 850' S = 6%

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 17.6 MIN.

CHANNEL No. 1 FLOW

VELOCITY = 4.5 FT/SEC

TIME = $\frac{2000}{4.5 \times 60}$ = 7.4 MIN.

CHANNEL No. 2 FLOW

VELOCITY = 4.2 FT/SEC

TIME = $\frac{850}{4.2 \times 60}$ = 3.4 MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\times 60}$ = ____ MIN.

TOTAL ACCUMULATION TIME 28.2 MIN

$I = \frac{189}{T+25} = 3.55$ in/hr

$Q = C\,I\,A = (.75)(3.55)(76) = 202$ CFS

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RUNOFF COMPUTATIONS

SHEET No. 12
JOB No. F.H.

DRAINAGE AREA No. C-1

AREA = 792 ACRES

MAXIMUM OVERLAND FLOW. L = 150' S = 1.0%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = 4500' S = 7.0%

CHANNEL No. 2 L = 1800 S = 5.0%

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 17.6 MIN.

CHANNEL No. 1 FLOW

VELOCITY = 4.1 FT/SEC

TIME = $\frac{4500}{4.1 \times 60}$ = 18.3 MIN.

CHANNEL No. 2 FLOW

VELOCITY = 3.5 FT/SEC

TIME = $\frac{1800}{3.5 \times 60}$ = 22.9 MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\times 60}$ = ____ MIN.

TOTAL ACCUMULATION TIME 58.8 MIN

$I = \frac{189}{T+25} = 2.26$ IN/HR.

$Q = C\,I\,A = (.75)(2.26)(792) = 1340$ CFS

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RUNOFF COMPUTATIONS

SHEET No. 13
JOB No. 5-1.

DRAINAGE AREA No. D-2

AREA = 19 ACRES

MAXIMUM OVERLAND FLOW L = 350 S = .88

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = N-1 S = ____

CHANNEL No. 2 L = 1670 S = 6.3%

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME = 16.0 MIN.

OVERLAND FLOW

CHANNEL No. 1 FLOW

VELOCITY = ____ FT/SEC

TIME = ____ / ____ × 60 = 33.1 MIN.

CHANNEL No. 2 FLOW

VELOCITY = 17 FT/SEC

TIME = 1670 / (17 × 60) = 1.6 MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = ____ / ____ × 60 = ____ MIN.

TOTAL ACCUMULATION TIME 50.7 MIN

$I = \frac{169}{T + 25} = 2.50$ IN/HR

$Q = C I A = (.65)(2.50)(19) = 36$ CFS

137 + 36 = 173 CFS

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COMP. BY. DDC

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RUNOFF COMPUTATIONS

SHEET No. 14
JOB No. F-H

DRAINAGE AREA No. D-1

AREA = 15 ACRES

MAXIMUM OVERLAND FLOW L = 200' S = 20%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = 2200 S = 9.8%

CHANNEL No. 2 L = ____ S = ____

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 12.3 MIN.

CHANNEL No. 1 FLOW

VELOCITY = 21 FT/SEC

TIME = $\frac{2200}{21 \times 60}$ = 1.7 MIN.

CHANNEL No. 2 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = ____ MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = ____ MIN.

TOTAL ACCUMULATION TIME 14.0 MIN

$I = \frac{189}{T + 25} = 4.85$ in/hr

$Q = C\,I\,A = (.75)(4.85)(15) = 54$ CFS

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RUNOFF COMPUTATIONS

SHEET No. 16
JOB No. F.11.

DRAINAGE AREA No. D-2

AREA = 10 ACRES

MAXIMUM OVERLAND FLOW. L = 350 S = 5.7%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = D-1 S = _____

CHANNEL No. 2 L = 950 S = 2.3%

CHANNEL No. 3 L = _____ S = _____

ACCUMULATION TIME

OVERLAND FLOW = 19.0 MIN.

CHANNEL No. 1 FLOW

VELOCITY = _____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = 14.0 MIN.

CHANNEL No. 2 FLOW

VELOCITY = 10 FT/SEC

TIME = $\frac{950}{10 \times 60}$ = 1.6 MIN.

CHANNEL No. 3 FLOW

VELOCITY = _____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = _____ MIN.

TOTAL ACCUMULATION TIME 33.6 MIN

$I = \frac{189}{T+25} = 3.22$ IN/HR

$Q = C\,I\,A = (.65)(3.22)(10) = 21$ CFS

5%21 = 75 CFS

DATE 6/17/71

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RUNOFF COMPUTATIONS

SHEET No. 16
JOB No. F.H.

DRAINAGE AREA No. A-3

AREA = 9 ACRES

MAXIMUM OVERLAND FLOW. L = 200' S = 5%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = A-2 S = ____

CHANNEL No. 2 L = 1100 S = 4.0%

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 14.0 MIN.

CHANNEL No. 1 FLOW

VELOCITY = ____ FT/SEC

TIME = ____ / ____ × 60 = 50.7 MIN.

CHANNEL No. 2 FLOW

VELOCITY = 13.5 FT/SEC

TIME = 1100 / (13.5 × 60) = 1.4 MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = ____ / ____ × 60 = ____ MIN.

TOTAL ACCUMULATION TIME 66.1 MIN

$I = \frac{189}{T+25} = 2.08$ in/HR

$Q = CIA = (.65)(2.08)(9) = 12$ CFS

TSY 173 HR = 26.0 CFS

DATE 6/17/71

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RUNOFF COMPUTATIONS

SHEET No. 11
JOB No. F.H.

DRAINAGE AREA No. A-4

AREA = 3 ACRES

MAXIMUM OVERLAND FLOW L = 100 S = 2%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = 600' S = 50%

CHANNEL No. 2 L = ____ S = ____

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 9.5 MIN.

CHANNEL No. 1 FLOW

VELOCITY = 15 FT/SEC

TIME = $\frac{600}{15 \times 60}$ = 0.7 MIN.

CHANNEL No. 2 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = ____ MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = ____ MIN.

TOTAL ACCUMULATION TIME 10.2 MIN

$I = \frac{189}{T + 25} = 5.36$ in/HR

$Q = C\,I\,A = (.65)(5.36)(3) = 10$ CFS

202 + 10 = 312 CFS

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RUNOFF COMPUTATIONS

SHEET No. 18
JOB No. 5th

DRAINAGE AREA No. B-2

AREA = 31 28 ACRES

MAXIMUM OVERLAND FLOW L = 350 S = 4.3%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = B-1 S = ____

CHANNEL No. 2 L = 3700 S = 5.1%

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 19.0 MIN.

CHANNEL No. 1 FLOW

VELOCITY = ____ FT/SEC

TIME = ____ / 60 = 28.2 MIN.

CHANNEL No. 2 FLOW

VELOCITY = 15 FT/SEC

TIME = 3700 / (15 × 60) = 4.1 MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = ____ / 60 = ____ MIN.

TOTAL ACCUMULATION TIME 51.3 MIN

$I = \frac{189}{T+25} = 2.48$ IN/HR.

$Q = C\,I\,A = (.65)(2.48)(28) = 45$ CFS

260 + 45 = 305 CFS

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RUNOFF COMPUTATIONS

SHEET No. 19
JOB No. E.H.

DRAINAGE AREA No. C-2

AREA = 9 ACRES

MAXIMUM OVERLAND FLOW L = 350 S = 4.38

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = C-1 S = ____

CHANNEL No. 2 L = 1250' S = 5.12

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 10.1 MIN.

CHANNEL No. 1 FLOW

VELOCITY = ____ FT/SEC

TIME = ____ / ____ x 60 = 58.8 MIN.

CHANNEL No. 2 FLOW

VELOCITY = 27 FT/SEC

TIME = 1250 / 27 x 60 = 0.8 MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = ____ / ____ x 60 = ____ MIN.

TOTAL ACCUMULATION TIME 77.7 MIN

$I = \frac{189}{T + 25} = 1.84$ IN/HR

$Q = C I A = (.65)(1.84)(9) = 11$ CFS

312 + 305 + 1340 + 11 = 1968 CFS

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RUNOFF COMPUTATIONS

SHEET No. 20
JOB No. 5411

DRAINAGE AREA No. C-3

AREA = 41 ACRES

MAXIMUM OVERLAND FLOW L = 200 S = 6.0%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = C-2 S = _____

CHANNEL No. 2 L = 2350 S = 5.0%

CHANNEL No. 3 L = _____ S = _____

ACCUMULATION TIME

OVERLAND FLOW = 13.6 MIN.

CHANNEL No. 1 FLOW

VELOCITY = _____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = 77.7 MIN.

CHANNEL No. 2 FLOW

VELOCITY = 27 FT/SEC

TIME = $\frac{2350}{27 \times 60}$ = 1.5 MIN.

CHANNEL No. 3 FLOW

VELOCITY = _____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = _____ MIN.

TOTAL ACCUMULATION TIME 92.7 MIN

$I = \frac{189}{T + 25} = 1.61$ in/HR

$Q = C\,I\,A = (.65)(1.61)(41) = 43$ CFS

1968.43 = 2011

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RUNOFF COMPUTATIONS

SHEET No. 21
JOB No. FitH.

DRAINAGE AREA No. E-1

AREA = 30 ACRES

MAXIMUM OVERLAND FLOW L = 400' S = 25%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = 2600 S = 5.6%

CHANNEL No. 2 L = ____ S = ____

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 13.2 MIN.

CHANNEL No. 1 FLOW

VELOCITY = 16 FT/SEC

TIME = $\frac{2600}{\times 60}$ = 2.7 MIN.

CHANNEL No. 2 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\times 60}$ = ____ MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\times 60}$ = ____ MIN.

TOTAL ACCUMULATION TIME 15.9 MIN

$I = \frac{169}{T + 25} = 4.62$ in/HR

$Q = C I A = (.75)(4.62)(30) = 105$ CFS

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RUNOFF COMPUTATIONS

SHEET No. 22
JOB No. F14

DRAINAGE AREA No. F-2

AREA = 17 ACRES

MAXIMUM OVERLAND FLOW — L = 300 S = 6.0%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 — L = 2950' S = 2.5%

CHANNEL No. 2 — L = 600' S = 2.0%

CHANNEL No. 3 — L = F-1 S = ____

ACCUMULATION TIME

OVERLAND FLOW = 16.0 MIN.

CHANNEL No. 1 FLOW

VELOCITY = 11 FT/SEC

TIME = $\frac{2950}{11 \times 60}$ = 4.5 MIN.

CHANNEL No. 2 FLOW

VELOCITY = 10 FT/SEC

TIME = $\frac{600}{10 \times 60}$ = 1.0 MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = 15.9 MIN.

TOTAL ACCUMULATION TIME 37.4 MIN

$I = \frac{189}{T + 25} = 3.03$ IN/HR

$Q = C\,I\,A = (.65)(3.03)(17) = 33$ CFS

105 + 33 = 138

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RUNOFF COMPUTATIONS

SHEET No. 23
JOB No. F-H

DRAINAGE AREA No. F-3

AREA = 4 ACRES

MAXIMUM OVERLAND FLOW L = 200 S = 7.5%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = 500 S = 3.0%

CHANNEL No. 2 L = F-2 S = ____

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 10.0 MIN.

CHANNEL No. 1 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{500}{12 \times 60}$ = 0.7 MIN.

CHANNEL No. 2 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = 30.4 MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = ____ MIN.

TOTAL ACCUMULATION TIME 40.1 MIN

$I = \frac{189}{T + 5} = 2.58$ in/HR

$Q = C\,I\,A = (.65)(2.58)(4) = 7$ CFS

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RUNOFF COMPUTATIONS

SHEET No. 74
JOB No. 6116

DRAINAGE AREA No. 6-1

AREA = 28 ACRES

MAXIMUM OVERLAND FLOW L = 1000' S = 5.4%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = 1500 S = 7.3%

CHANNEL No. 2 L = ____ S = ____

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 20.5 MIN.

CHANNEL No. 1 FLOW

VELOCITY = 10 FT/SEC

TIME = $\frac{1500}{10 \times 60}$ = 2.5 MIN.

CHANNEL No. 2 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = ____ MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = ____ MIN.

TOTAL ACCUMULATION TIME 23 MIN

$I = \frac{189}{T + 25} = 3.94$ in/HR

$Q = CIA = (.65)(3.94)(28) = 72$ CFS

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RUNOFF COMPUTATIONS

SHEET No. 25
JOB No. FH

DRAINAGE AREA No. H-1

AREA = 38 ACRES

MAXIMUM OVERLAND FLOW — L = 350' S = 5.7%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 — L = 4000 S = 6.1%

CHANNEL No. 2 — L = ____ S = ____

CHANNEL No. 3 — L = ____ S = ____

ACCUMULATION TIME = 17.0 MIN.

OVERLAND FLOW

CHANNEL No. 1 FLOW

VELOCITY = 17 FT/SEC

TIME = $\frac{4000}{17 \times 60}$ = 3.9 MIN.

CHANNEL No. 2 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = ____ MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{\quad \times 60}$ = ____ MIN.

TOTAL ACCUMULATION TIME 21.9 MIN

$I = \frac{189}{T + 25} = 4.04$ in/HR

$Q = C I A = (.75)(4.04)(38) = 115$ CFS

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RUNOFF COMPUTATIONS

SHEET No. 26
JOB No. 6H.

DRAINAGE AREA No. V-1

AREA = 28 ACRES

MAXIMUM OVERLAND FLOW L = 300 S = 25

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = 2900 S = 52

CHANNEL No. 2 L = ____ S = ____

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 12.0 MIN.

CHANNEL No. 1 FLOW

VELOCITY = 15 FT/SEC

TIME = $\frac{2900}{15 \times 60}$ = 3.2 MIN.

CHANNEL No. 2 FLOW

VELOCITY = ____ FT/SEC

TIME = ____ x 60 = ____ MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = ____ x 60 = ____ MIN.

TOTAL ACCUMULATION TIME 15.2 MIN

$I = \frac{189}{T+25} = 4.70$ in/hr.

$Q = C\,I\,A = (.65)(4.70)(28) = 86$ CFS

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RUNOFF COMPUTATIONS

SHEET No. 21
JOB No. F.H.

DRAINAGE AREA No. K-1

AREA = 17 ACRES

MAXIMUM OVERLAND FLOW L = 300' S = 23%

MAXIMUM CHANNEL FLOW

CHANNEL No. 1 L = 1400' S = 2.5%

CHANNEL No. 2 L = 900' S = 14.0%

CHANNEL No. 3 L = ____ S = ____

ACCUMULATION TIME

OVERLAND FLOW = 9.6 MIN.

CHANNEL No. 1 FLOW

VELOCITY = 11 FT/SEC

TIME = $\frac{1400}{11 \times 60}$ = 2.1 MIN.

CHANNEL No. 2 FLOW

VELOCITY = 25 FT/SEC

TIME = $\frac{900}{25 \times 60}$ = 0.6 MIN.

CHANNEL No. 3 FLOW

VELOCITY = ____ FT/SEC

TIME = $\frac{\quad}{60}$ = ____ MIN.

TOTAL ACCUMULATION TIME 12.3 MIN

$I = \frac{189}{T + 25} = 5.07$ IN/HR

$Q = C\,I\,A = (.35)(5.07)(17) = 65$ CFS

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4. Master Plan of Drainage, City of Albuquerque, New Mexico and Environs 1963, by Gordon Herkenhoff and Associates

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3. Handbook of Hydraulics, by Horace W. King & Ernest F. Brater
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Rec'd
15 Oct 75

DRAINAGE STUDY
FOR THE DEVELOPMENT OF
FOUR HILLS VILLAGE
SEVENTEENTH INSTALLMENT

PREPARED FOR
PAUL'S HOMES INC.
729 FOUR HILLS ROAD S.E.
ALBUQUERQUE, NEW MEXICO 87123

PREPARED BY

MURRAY-McCORMICK, INC. ENVIRONMENTAL DESIGN
ENGINEERS, SURVEYORS & PLANNERS
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October 1975

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FIGURE I - SITE PLAN

FIGURE II - ESTIMATED RUNOFF - UNDEVELOPED STATE

FIGURE III - ESTIMATED RUNOFF - DEVELOPED STATE

FIGURE IV - TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS

FIGURE V - INTENSITY DURATION FREQUENCY CURVES

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GENERAL DISCUSSION

Four Hills Village, Seventeenth Installment, a proposed R-1 development, is located in the Northeast Heights of Albuquerque. It is entirely within the SW1/4 of Section 35, Township 10 North, Range 4 East, N.M.P.M.

The site, which encompasses 43.189 acres, slopes from east to west with an average slope of 6 to 7%. Its surface is covered with a light growth of weeds and cacti, and the surface soils are predominately of loose, decomposed granite. An existing residential development borders the west side, Kirtland East Air Base borders the south boundary and undeveloped land surrounds the remaining sides.

Flow patterns of the area include sheet flow with general accumulations into several small arroyos crossing the site. A large arroyo to the east and north of the site intercepts almost all upstream runoff, leaving only a small area to the east to contribute offsite flows onto the site. (See Figure II).

DESIGN CRITERIA

In analyzing the storm runoff, the Rational Formula, Q=CIA was used.

Where: Q = Maximum rate of runoff in cubic ft/sec.

A = Contributing area in acres

I = Avg. intensity of rainfall in inches per hour for a duration equal to the time of concentration. (Note: Where a

Time of Concentration [Tc] is less than 10 minutes from Figure IV, the Intensity value equal to ten minutes used as shown on the curve for a 100 year storm in Figure V).

C = Runoff Coefficient (No Unit), represents the integrated effects of infiltration, detention storage, evaporation, retention, flow routing, and interception which all affect the time distribution and peak rate runoff.

Quantities of runoff were computed on a 100 year storm frequency for both the undeveloped and the proposed final development form.

ESTIMATED RUNOFF - UNDEVELOPED STATE

Drainage within the boundary of the site is in the form of sheet flow with general accumulation into several small arroyos. The drainage characteristics can be divided into two drainage patterns. Flows from Area X empty into the drainage channel on the north side of the site, while Area Y empties onto an existing street at the southwest corner of the site. These street flows are carried thru the downstream street system and eventually dumped into a natural arroyo. (See Figure I).

The following table shows runoff in the undeveloped state.

TABLE 1

RUNOFF IN UNDEVELOPED STATE

Drainage Basin	Elev.Diff. (feet)	Length of Flow (feet)	Tc (Min)	I ("/hr)	C[1]	Area (Ac)	Q (cfs)
X	90	1800	10	5.4	0.35	29.97	57
Y	80	1900	10	5.4	0.35	13.22	25
					Total		82
0-S-1	35	600	10	5.4	0.35	8.38	16
0-S-2	70	1300	10	5.4	0.35	11.29	21

ESTIMATED RUNOFF - DEVELOPED STATE

Table 2 shows the results of calculations of runoff in the developed subdivision state.

TABLE 2

RUNOFF IN DEVELOPED STATE

Drainage Basin	Elev.Diff. (feet)	Length of Flow (feet)	Tc (Min)	I ("/hr)	C[2]	Area (Ac)	Q (cfs)
Area 1	100	2300	10	5.4	0.45	40.99	100
Area 2	-	--	10	5.4	0.45	2.20	5
					Total		105

The development of this site will result in lots ranging from 1/4 acre to 1/2 acre in size. The type of homes built will be

---

[1]Table XII, Master Plan of Drainage, City of Albuquerque, N.M. and Environs, 1963, G. Herkenhoff & Associates; C = 0.35

[2]Table 3-1, Urban Storm Drainage Criteria Manual, Volume I, Denver Regional Council of Governments.

customized for the individual buyer rather than the speculative type of construction. Because of this type of home construction, there will not be any more grading of the site. Rather, each lot will be graded as necessary for the home and the remainder left as close to natural grade as possible.

Because of this development policy, it would be difficult, if not impractical, for this study to call for ponding in each rear yard area. There are very few lots which lend themselves to natural ponding in the rear yards. The remaining lots would have to be extensively graded if rear yard ponding was the only acceptable solution.

capacity of downstream channel

However, because of the grading requirements, a viable alternative would be the following: allow uncontrolled runoff through out the site, and route these flows toward the drainage channel rather than allow them onto the downstream street system.

In more detail, refer to Figure I. Notice that presently some flows from the site and offsite areas empty onto the existing street system at the southwest corner. Also notice that where the flows make a 90° turn and proceed to the west, a very real problem exists (street intersection "A"). This intersection was not well constructed to handle the present flows. Referring to Figure II, notice that the flows from Area Y and 0-S-2 contribute $Q = (0.35)\ (5.11)\ (24.51) = 44$ cfs to the street at the southwest corner of the site. After development, Figure III, flows to this corner will be only 5 cfs. The remaining flows within the site,

100 cfs, will be routed toward the northwest corner of the site and dumped directly into the channel.

Analyzing the results, before development, Areas X and Y contribute a total flow rate of 82 cfs. Area X flowed directly into the channel; Area Y and 0-S-2 flowed onto the street system to the west of the site with a flow rate of 44 cfs. After development, Areas 1 and 2 contributed a total flow rate of 105 cfs. This is an overall increase of 23 cfs. However, the flows emptying onto the streets at the southwest corner of the site is reduced by 44 cfs - 5 cfs = 39 cfs. This reduction in flow rate should be beneficial to the street intersection "A".

Flows leaving the site at the northwest corner of the site will be routed to the drainage channel via a 10' drainage right-of-way along the west boundary of the site.

Offsite drainage, after development, will be intercepted by a temporary drainage swale along the east boundary of the site. A typical cross-section would have a 10' bottom, 2:1 side slopes, a shape of 1-1/4%, and a depth of flow of 3/4'. This will divert offsite flows until development of areas 0-S-1 and 0-S-2 occurs. velocity erosion

RECOMMENDATIONS AND SUMMARY

1. The 10' drainage right-of way at the northwest corner of the site should be lined with concrete and installed at a minimum slope of 1.0% grade (See Figure III). Adequate protection will have to be installed to allow the runoff to rundown into the channel to prevent erosion of the channel sides.

HYDROLOGY M23/D6 7 PLANS 2 of 2

2. The drainage channel along the north side of the site should be left in its natural slope. Where the boundary of the site protrudes into the channel, development might reduce the volume capacity of the channel. To offset this, the channel should be reshaped in those areas to retain its original floor area and slope as near as possible.

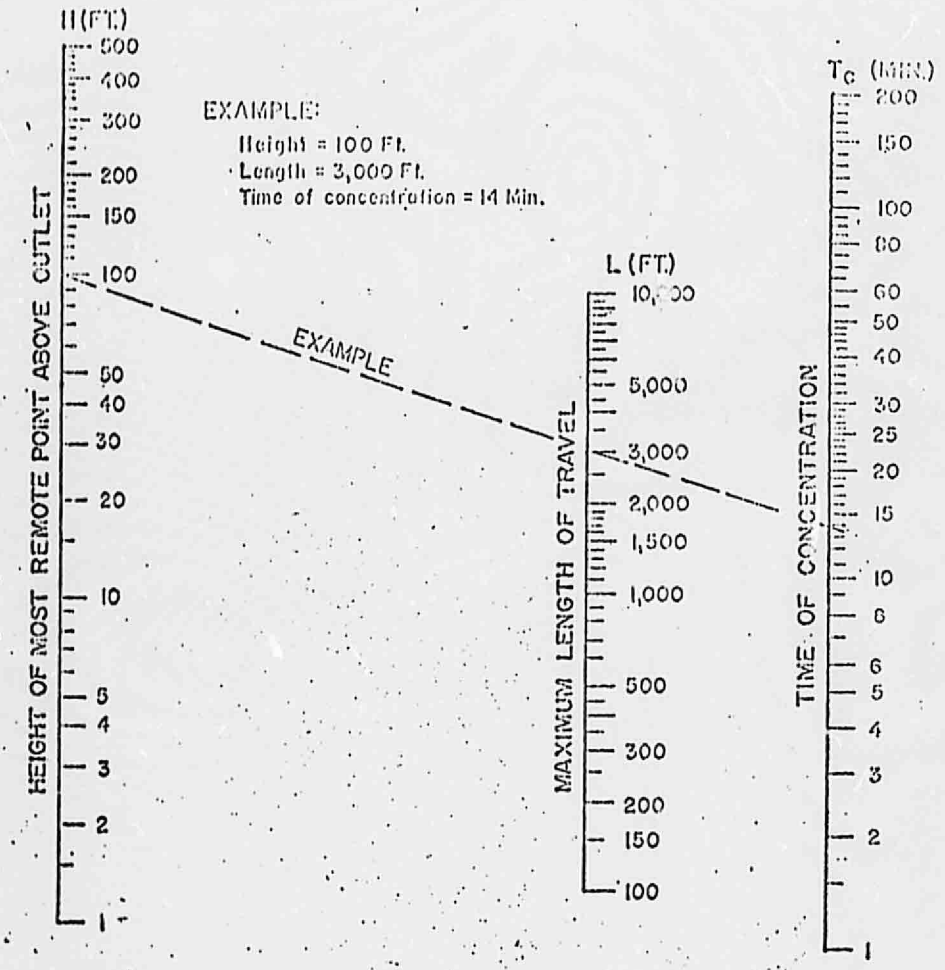
3. The lots bordering the north side of the site should be raised 2'± to provide adequate protection from the channel.

4. The offsite area 0-S-1 and 0-S-2 should be planned for development to route runoff flows as directly as possible into the channel without having to enter the 17th Installment.

In conclusion, the development of this site should not burden existing downstream drainage facilities. Furthermore, this site should have a beneficial effect on the drainage characteristics of the downstream street systems, particularly intersection "A".

Respectfully submitted,

Bo K. E. Johnson, N.M.P.E. #5922



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Civil Engineering, Vol. 10, No. 6, June 1940, p. 332

TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS

FIGURE IV

Reprinted from "Design of Roadside Drainage Channels - Hydraulic Engineering

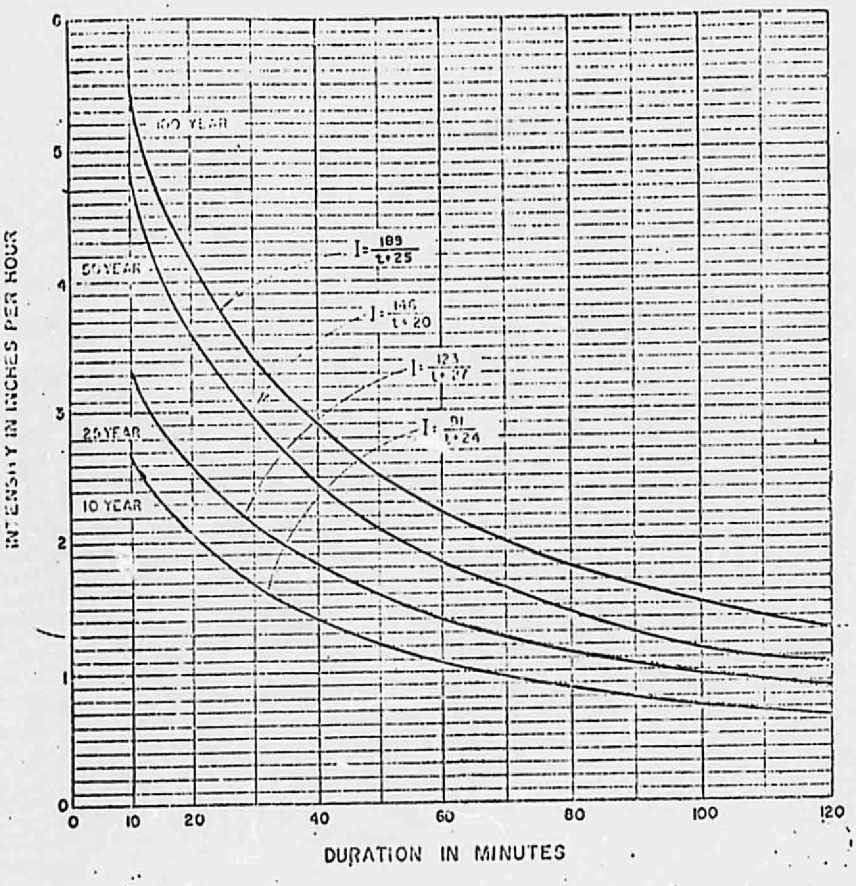

FIGURE V

MASTER PLAN OF DRAINAGE CITY OF ALBUQUERQUE - NEW MEXICO AND ENVIRONS	
INTENSITY DURATION FREQUENCY CURVES (ALBUQUERQUE AREA-1959)	
GORDON HERRINGER & ASSOC. CONSULTING ENGINEERS ALBUQUERQUE, NEW MEXICO	CHART 1

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