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Hughes Associates, Inc.

2730 University Boulevard West, Suite 902, Wheaton, MD 20902 (301) 949-0505 FAX (301) 942-2298

May 21, 1990

Mr. Bruce G. Campbell
Sr. Principal Fire Protection Engineer
E G & G Rocky Flats Plant
P.O. Box 464
Golden, Colorado 80402-0464

Subject: Hydraulic Model Update
HAI No. 3044

RECEIVED

AUG 29 1994

OSTI

Dear Bruce:

We have completed our analysis/update of the computerized hydraulic model study of the site wide water distribution system. I have enclosed several items to update your current data files:

1. one reproducible mylar sepia of the updated water distribution system map;
2. ten (10) prints of the updated water distribution system map; and,
3. one 3-1/2-in. disk to update your existing data files.

As we discussed during my site visit of February 28 through March 2, 1990, the T-130 Trailer Complex, with its low static pressure of 50 psi, required an hydraulic verification of the new sprinkler system. This system review required hydraulically calculating the proposed system layout using the Rocky Flats Hydraulic Model. Once calculated, it was determined that the proposed system design would deliver the minimum density of 0.15 gpm/sq.ft for a 1500 sq.ft area of application. It was also determined that for the most remote trailers, T-130-H, T-130-I, and T-130-J, a 6-in. supply main should be utilized to insure the minimum densities are achieved. Through this process, we have determined that the existing water supply conditions are sufficient to meet the hydraulic requirements at the T-130 Trailer Complex.

As part of this contract, we have also updated the existing hydraulic model of all the changes/additions to the site. These changes have been made to both the water distribution map and the data files.

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

Mr. Campbell
May 21, 1990
Page Two

If you have any questions after reviewing these items, please call.

Sincerely,

A handwritten signature in dark ink, appearing to be 'JAC' or 'JACe', written in a cursive style.

Joseph A. Castellano

JAC/cdp

Enclosures

cc: Jerry Perstein, Hughes Associates, Inc.

HUGHES ASSOCIATES, INC.
FIRE PROTECTION CONSULTING

(301) 949-0505

2730 University Boulevard West, Suite 902, Wheaton, Maryland 20902

HYDRAULIC MODEL

ANALYSIS OF WATER DISTRIBUTION SYSTEM

ROCKWELL INTERNATIONAL

ROCKY FLATS, COLORADO

Prepared by

HUGHES ASSOCIATES, INC.

FIRE PROTECTION ENGINEERS & CONSULTANTS

Jerry Perstein, P.E.

Joseph A. Castellano, BS/FPE

JANUARY 20, 1989

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

HYDRAULIC MODEL

ANALYSIS OF WATER DISTRIBUTION SYSTEM

ROCKWELL INTERNATIONAL: ROCKY FLATS, COLORADO

INTRODUCTION:

Rockwell International requested an analysis of the existing plant site water supply distribution system at Rocky Flats, Colorado, to determine its adequacy. On 26-29 September 1988, Hughes Associates, Inc., Fire Protection Engineers, accompanied by Rocky Flats Fire Department engineers and suppression personnel, conducted water flow tests at the Rocky Flats plant site. Thirty-seven flows from various points throughout the plant site were taken on the existing domestic supply/fire main installation to assure a comprehensive and thorough representation of the Rocky Flats water distribution system capability. The analysis was completed in Four Phases which are described, together with a summary of General Conclusions and Recommendations, as follows:

Phase I . . . Actual Flows:

Several available representative drawings of the water system were reviewed with Rocky Flats personnel to determine the points at which flows would be taken to enable development of the analysis.

Computer based analyses were made for all of the thirty-seven flows that were subsequently taken to determine Hazen-Williams coefficients for the existing piping. These coefficients numerically describe the present conditions of the various segments of the distribution network. The analyses showed that many areas in the network have different flow coefficients. With further investigation revealing that various sections were installed at different times, the differences in coefficients can be thus explained. In order to determine coefficients that reflected actual conditions, several analyses were computer generated for each individual observed flow.

In addition to the computer created interpretations with which determinations of the various Hazen-Williams coefficients were established, the actual flow tests also indicated an apparent obstruction (plugging) in the piping

segment that was subsequently designated as #125 in the computer program input and output. Because of this observation, and subsequent computer analyses confirmations, pipe #125 was arbitrarily assigned a coefficient of 50, and this remained constant throughout all stages of the analyses that were generated to project existing conditions. In the Phase IV calculations which project conditions accruing from recommended changes to attain system improvements, replacement pipe #125 was assigned a coefficient of 88 which is similar to that which was determined for other piping segments in the same area.

Results of the Phase I efforts produced the conclusions illustrated in the Phase I summary table reproduced on sheet A which follows (and becomes a part of) this report. The various columns (in the table) reading from left to right represent:

Flow Test Title:

Computer file designator for each actual flow test.

Observed Flow in GPM:

Amount of water flowing during test.

Flowing Hydrant No. (Node):

Location of flow with hydrant no. as designated by Rocky Flats and node no. as designated by the computer hydraulic program.

Observed Press in PSI Stat.-Resid:

Pressure observed during flow test with the static pressure followed by the residual pressure (in pounds per square inch) for each of the water flows.

At Hydrant No. (Node):

Location of the hydrant at which the observed pressures were read during the water flow tests.

Closed Valve (Pipe #):

Specific valves were closed during certain tests in order to obtain complete data for total analysis; certain pipe designations (as assigned by the computer hydraulic program) were assigned a diameter of 0.001-in. to simulate no flow in that pipe -- this column designates which pipe or pipes were so designated in each applicable calculation to reflect the closing of specific valves.

Calculated HAZ.WMS.COEF. Stl.-DI-CI-CI-#125:

This indicates the calculated Hazen Williams Coefficient determined for each pipe in the hydraulic calculation program for each flow as observed with Stl. representing steel pipe; DI representing ductile iron pipe; the first CI representing the most recently installed cast iron pipe; the second CI representing earlier installed cast iron pipe; and #125 representing the arbitrarily assigned Hazen Williams Coefficient for the obstructed piping described earlier in this Phase I of the report.

Calc'd Resid. Press:

This represents a calculated residual pressure (in pounds per square inch) that most nearly approximates the observed residual pressure for each flow test in determining the logical Hazen William Coefficients indicated in the proceeding column.

Pressure @ Supply Stat.-Resid:

Since the supply point and the observed flow and pressure points were in different locations, the observing and recording of the supply pressures (static-residual in pounds per square inch) provided a necessary additional factor enabling complete system analysis.

On Sheets nos:

This provides a "table of contents" by designating on which sheets each of the computerized hydraulic calculations components are printed.

Phase II: Selected Theoretic Sampling of Flows for Average Hazen Williams Coefficients

Following the several generations of computer analyses that produced the Phase I described results, we deemed it advisable to determine an average Hazen-Williams coefficient for basic groupings of pipe rather than to produce an unwieldy assortment of numerous different factors that would result from averaging each of the original 37 flows. The computer generated results, which are shown on output sheets nos. 264 through 333, reflect that in 80% of the representative locations selected, the averaging of system wide coefficients produced results acceptably close to those derived in the Phase I work. The table describing this Phase II effort is reproduced at the top of sheet B which follows

(and becomes a part of) this report. The column designations for this Phase II table are identical to those described for the Phase I table.

Phase III: Simulation of Closed Valve Phase II Flows with
All Valves Open:

Since several of the flows in Phase I were intentionally conducted with various control valves closed in order to produce interpretable, comparative data, these same simulations were repeated in Phase II. Having been satisfied that the Phase II effort produced generally acceptable "averaged" results, the 60% of the total simulated flows "taken" with "closed" valves in Phase II were rerun with all valves theoretically "open", in Phase III, but using the same average Hazen-Williams coefficients. The Phase III computer generated results are reproduced on output sheets nos. 334 through 375 and the table describing this effort is reproduced on the lower half of sheet B which follows (and becomes a part of) this report.

Phase IV: Repeat of Phase II Theoretic Flows with All
Recommended Changes

The results for the first three phases do not indicate any serious deficiency in the capability of the existing system to deliver sufficient water at adequate pressures to augment a typical automatic fire suppression system. Although recommended improvements, with resultant water flows (results are reproduced on output sheets nos. 376 through 449) are the results of the Phase IV exercise, the basic reasons for our recommended improvements are to eliminate potential exposure to total interruption of protection to any plant site area as the result of one disablement to the system. The table representing the recapitulation of this Phase IV effort is reproduced on Sheet C which follows (and becomes a part of) this report. The column designation interpretations for this table are similar to that described for the Phase II table, except that the third and fourth columns from Phase II (and Phase III) are eliminated.

General: Conclusions and Recommendations:

Two drawings (sheet FP-1 and FP-2) have been prepared and accompany this report. Sheet FP-1 shows the water supply distribution system as it is currently believed to exist. In the numbering of the nodes (reference points) and pipes, for the hydraulic calculations, four pipes are designated as "dummies". These (which are designated as pipes nos. 80, 89, 161, 171 were assigned lengths of 3,000 ft. and diameters of 0.001-in., each) were provided to allow for later inclusion to accommodate possible improvements that the study might recommend.

Sheet FP-2 shows the distribution system with the study's recommended improvements. Two of the four "dummies" were used. In reading the various calculations results, occasional omissions of pipe numbers will be noticed; these are the "dummies" which were "zeroed out" of the calculation output analyses.

Repeating from the foregoing Phase IV description, this water supply was determined to be generally adequate. Twenty-two control valves are recommended to be added, and three piping additions are recommended; however, the valve recommendations are specifically intended to reduce the number of "units" exposed to service interruption from any single disablement to five or less. For interpretation of this report, a "unit" is designated as one sprinkler riser or one fire hydrant.

The recommended piping changes are a pipe loop connection addition between buildings 115 and 131 (pipe number 171); installation of a cross at node 47 (between buildings 708 and 883); and replacement and relocation of pipe 125 (west of building 776).

Sufficient nodes (reference points) in the hydraulic calculations program are provided between interconnecting segments to allow simulation of available flow virtually anywhere on the system. This will facilitate future planning. If not all recommendations are able to be completed as part of a single project, adjustments for alternate simulated results can be accomplished by applying the appropriate programmed commands to the basic data.

A copy of the hydraulic calculations program (named "SEDAN"), together with a user's manual, are also provided as a part of this report (hydraulic model analysis). This will enable "in-house" planning for future water supply distribution alterations or additions.

In the application of the program (which is designed for use with a P.C.), there are capacity (number of nodes and number

of pipes) limitations which are described in the user's manual. There are also elevation designation limitations in which the program cannot accommodate elevations higher than 3,200 feet. As a consequence all elevations designations in this Rocky Flats Hydraulic Model calculations have been reduced by 5000 ft. from their actual elevations above sea level. Since all elevation designations retain their relative positions in this program application, the final results are not effected by this 5000 ft. designated discrepancy.

The hydraulic calculations for this report were performed using a program prepared by the Gessler Group, Inc., of Ft. Collins, CO, expressly for this hydraulic model for Rocky Flats. That program together with all the data (stored on accompanying disks) used in the four Phases of calculations, are delivered accompanying this report.

This report was prepared by Jerry Perstein, P.E., and Joseph A. Castellano, staff engineer of Hughes Associates, Inc., Wheaton, MD.

SEDAN INPUT LISTING

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PAGE 1 OF

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DATE _____

MODE	ELEV.	K-1	K-2	K-3	COMMENT	PSI	GPM	PIPE	BEG.	END	LGTH	DIA	FITS	G-VN	B-VN	CK-VN	HVC	COMMENTS
1								1										
2								2										
3								3										
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5								5										
6								6										
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MODE	ELEV.	K-1	K-2	K-3	COMMENT	PSI	GPM	PIPE	BEG.	END	LGTH	DIA.	FTS	G-Vo	B-Vo	CK-Vo	HVC	COMMENTS
	251							251										
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2730 University Boulevard West, Suite 902, Wheaton, Maryland 20902

January 12, 1989

Preparation of Hydraulic Model for Analysis of Water
Distrubution System at Rockwell, International - Rocky Flats,
Colorado facility.

Phase I:

On 26-29 September 1988, Hughes Associates, Inc., Fire Protection Engineers, accompanied by Rocky Flats Fire Department engineers and suppression personnel, conducted water flow tests at the Rocky Flats plant site. Thirty-seven flows were taken on the existing integrated water distribution/fire main system at locations throughout the plant to assure a comprehensive and thorough representation of the Rocky Flats distribution system. Several available representative drawings were reviewed with Rocky Flats personnel and reproduced as necessary to develop the hydraulic calculations plot plans.

Based on the observed flow results, computer generated analyses for all thirty-seven flows were promulgated to determine Hazen-Williams coefficients for the existing piping reflecting the present conditions of the distribution network. The various generations of the analyses produced results indicating that many areas in the network were exhibiting differing flow coefficients. This prompted further investigation which revealed that various portions were installed during irregular time intervals. In order to determine coefficients that approximated actual conditions, several intermediate analysis generations were completed for comparison to each individual observed flow. An apparent incongruity in the Hazen-Williams coefficients is under the column labelled #125; both observed and theoretically determined result data indicated that this particular segment of piping is plagued with inefficient flow capability.

It was from these various intermediate steps that the coefficients (that are listed in the Phase I cover sheet) were determined by combining the various stages of data into a final product. Phase I, for which the observed and adjusted coefficient equivalents are innumrated, has its calculation results reproduced on sheet numbers 1 through 263.

(u)

REVIEWED FOR CLASSIFICATION
BY: Chris S. Dyche
DATE: 1-17-89

Phase II:

Following the several generations of computer analyses that produced the foregoing described results, it was deemed necessarily advisable to determine an average Hazen-Williams coefficient for basic groupings of pipe rather than to produce an unwieldy assortment of numerous different factors. The computer generated results, which are shown on sheets 264 through 333, reflect that in 80% of the representative locations selected, the averaging of system wide coefficients produced results acceptably close to those derived in the Phase I section.

Phase III:

Since several of the flows in Phase I were intentionally conducted with various control valves closed in order to produce interpretable, comparative data, these same simulations were repeated in Phase II. Having been satisfied that the second phased effort produced generally acceptable "averaged" results, 60% of the simulated flows with "closed" valves in phase II were rerun with all valves "open", but using the same average Hazen-Williams coefficients. The Phase III computer generated results are reproduced on sheets 334 through 375.

Phase IV:

The indicated results for the first three phases do not indicate any serious perceived deficiency in the capability of the existing system to deliver sufficient water at adequate pressures to augment a typical automatic fire suppression system. Although recommended improvements, with resultant water flows (results are reproduced on sheets 376 through 449) are the results of the Phase IV exercise, the basic reasons for our recommended improvements are to eliminate potential exposure to total interruption of protection to any plantsite area as the result of one disabling interruption to the system. Twenty-two control valves are recommended to be added, and three piping additions are recommended. These recommendations are specifically intended to reduce the number of "units" exposed to service interruption from any single disablement to five or less. For interpretation of this report, a "unit" is designated as one sprinkler riser or one fire hydrant.

General:

Two drawings have been prepared to accompany this report. These are the previously referenced plot plans. Sheet FP1 shows the water supply distribution system as it is currently believed to exist. In the numbering of the nodes (reference points) and pipes, four pipes are designated as "dummies".

These were provided to allow for possible recommended improvements as the study authors opined might be necessary during the early phases of preparation.

Sheet FP2 shows the system with recommended improvements. Two of the four "dummies" were used. In reading the various calculations results, occasional omissions of pipe numbers will be noticed; these are the "dummies" which were "zeroed out" of the calculation analyses.

The recommended piping changes are a pipe loop connection addition between buildings 115 and 131 (pipe number 171); installation of a cross at node 47 (between buildings 708 and 883); and replacement of pipe 125 (west of building 776).

Sufficient nodes are provided between interconnecting locations to allow simulation of available flow virtually anywhere on the system. This will facilitate future planning. If not all recommendations are planned for completion as part of a single project, adjustments for other simulated results can be accomplished by adding or deleting the appropriate programmed commands to the basic data.

The hydraulic calculations for this report were promulgated by using a program prepared by the Gessler Group, Inc., of Ft. Collins, CO, expressly for this hydraulic model for Rocky Flats. That program together with all the data (stored on accompanying disks) used in the four Phases of calculations, are delivered accompanying this report.

This report was prepared by Jerry Perstein, P.E., and Joseph A. Castellano, staff engineer of Hughes Associates, Inc., Wheaton, MD.

PHASE I: ACTUAL FLOWS (09-88) for ROCKY FLATS HYDRAULIC MODEL PROJECT: SEPTEMBER-DECEMBER, 1988

FLOW TEST TITLE	OBSERVED FLOW in GPM	FLOWING HYDRANT No. (node)	OBSERVED PRESS.in PSI STAT.-RESID.	at HYDRANT No. (NODE)	CLOSED VALVE (PIPE#)	CALCULATED HAZ.-WMS. COEF. Stl-DI.-CI.-CI-#125	CALC'D PRESSURE RESID. & SUPPLY PRESS. STAT.-RES.	on SHEETS Nos.
PIPING INPUT (as-is).....1-4								
Rocky01	1125	1-5 (30)	66-60	1-6 (27)	33	110-130-110-100-050	59.0	66-60 5-11
Rocky02	1105	1-5 (30)	66-62	1-6 (27)	-0-	110-130-110-100-050	61.3	66-62 12-18
Rocky03	1650	1-5 (30)	66-52	1-6 (27)	-0-	110-130-110-100-050	59.6	66-61 19-25
Rocky04	1090	1-10(22)	58-52	1-8 (18)	-0-	110-130-100-090-050	50.7	66-62 26-32
Rocky05	1520	1-10(22)	58-38	1-8 (18)	17	110-130-080-070-050	37.9	66-62 33-39
Rocky06	1030	1-10(22)	58-46	1-8 (18)	17	110-130-080-070-050	45.8	66-62 40-46
Rocky07	1760	1-10(22)	58-45	1-8 (18)	-0-	110-130-090-080-050	46.4	66-61 47-53
Rocky08	1405	3-15(137)	80-74	3-13(146)	-0-	110-130-135-125-050	72.2	66-62 54-60
Rocky09	1260	3-15(137)	80-68	3-13(146)	31/151	110-130-110-100-050	67.7	66-62 61-67
Rocky10	1290	3-15(137)	80-68	3-13(146)	31	110-130-085-075-050	68.5	66-62 68-74
Rocky11	2330	3-14/15(149/137)	80-58	3-13(146)	31	110-130-095-065-050	57.7	66-61 75-81
Rocky12	2180	3-14/15(149/137)	80-50	3-13(146)	31/151	110-130-100-090-050	50.0	66-61 82-88
Rocky13	1200	4-7 (66)	72-68	4-9 (65)	-0-	110-130-105-095-050	66.6	66-62 89-95
Rocky14	1060	4-7 (66)	72-52	4-9 (65)	67	110-130-088-078-050	52.3	66-62 96-102
Rocky15	1280	4-7 (66)	72-34	4-6 (65)	67	110-130-070-060-050	34.0	66-62 103-109
Rocky16	1760	4-7/6-3(66/63)	72-64	4-9 (65)	-0-	110-130-100-090-050	64.6	66-61 110-116
Rocky17	1720	5-2 (128)	75-45	3-3 (129)	31/143	110-130-070-060-050	45.5	66-62 117-123
Rocky18	1980	5-2 (128)	75-60	3-3 (129)	31	110-130-090-080-050	60.0	66-62 124-130
Rocky19	1010	7-15(104)	92-48	7-10(100)	31/112/125/134	110-130-085-075-050	48.5	66-62 131-137
Rocky20	980	7-15(104)	92-44	7-10(100)	31/112/125	110-130-066-056-050	43.2	66-63 138-144
Rocky21	1280	7-15(104)	92-82	7-10(100)	31	110-130-075-065-050	82.7	66-62 145-151
Rocky22	1090	7-15(104)	92-50	7-16(102)	31/113/134/135	110-130-095-085-050	50.3	66-63 152-158
Rocky23	1355	7-16(102)	92-79	7-10(100)	31	110-130-077-067-050	79.5	66-60 159-165
Rocky24	1215	7-15/16(104/102)	92-22	7-10(100)	31/112/125/134	110-130-080-070-050	23.4	66-61 166-172
Rocky25	1340	7-15/16(104/102)	92-24	7-10(100)	31/112	110-130-030-030-030	24.3	66-62 173-179
Rocky26	2450	7-15/16(104/102)	92-64	7-10(100)	31	110-130-077-067-050	64.6	66-61 180-186
Rocky27	1260	7-20(114)	88-78	7-5 (92)	31/81/126	110-130-070-060-050	80.2	66-62 187-193
Rocky28	2020	7-20(114)	88-68	7-5 (92)	31	110-130-065-055-050	69.1	66-62 194-200
Rocky29	1920	7-21/22(74/96)	88-70	7-5 (92)	31/81/126	110-130-085-075-050	71.6	66-62 201-207
Rocky30	1960	7-21/22(74/96)	88-68	7-5 (92)	31/81	110-130-075-065-050	68.3	66-61 208-214
Rocky31	1060	8-3 (52)	85-65	8-5 (56)	31/56/81	110-130-083-073-050	65.3	66-63 215-221
Rocky32	1350	8-3/4(52/53)	85-56	8-5 (56)	31/56/81	110-130-083-073-050	55.8	66-62 222-228
Rocky33	2135	8-3/4(52/53)	85-55	8-5 (56)	31/56	110-130-087-077-050	54.9	66-62 229-235
Rocky34	2470	8-3/4(52/53)	85-60	8-5 (56)	31	110-130-075-065-050	59.3	66-60 236-242
Rocky35	2480	8-3/4(52/53)	80-62	8-5 (56)	-0-	110-130-075-065-050	62.2	66-62 243-249
Rocky36	1050	9-5 (82)	110-100	9-4 (81)	31/90	110-130-110-100-050	97.5	66-62 250-256
Rocky37	1135	9-5 (82)	110-102	9-4 (81)	31	110-130-115-105-050	98.7	66-60 257-263

PHASE II: SELECTIVE SAMPLING OF ORIGINAL FLOW TESTS WITH THEORETICALLY COMPUTED AVERAGE HAZEN-WILLIAMS COEFFICIENTS

FLOW TEST TITLE	OBSERVED FLOW in GPM	FLOWING HYDRANT No. (node)	OBSERVED PRESS.in PSI STAT.-RESID.	at HYDRANT No. (NODE)	CLOSED VALVE (PIPE#)	AVERAGE HAZ.-WMS. COEF. St1-DI.-CI.-CI-#125	CALC'D RESID. PRESS.	PRESSURE @ SUPPLY STAT.-RES.	on SHEETS Nos.
RockA12	2180	3-14/15(149/137)	80-50	3-13(146)	31/151	110-130-88-78-50	44.2	66-61	264-270
RockA04	1090	1-10(22)	58-52	1-8 (18)	-0-	110-130-88-78-50	50.4	66-62	271-277
RockA16	1760	4-7/6-3(66/68)	72-64	4-9 (65)	-0-	110-130-88-78-50	62.9	66-61	278-284
RockA21	1280	7-15(104)	92-82	7-10(100)	31	110-130-88-78-50	84.5	66-62	285-291
RockA37	1135	9-5 (82)	110-102	9-4 (81)	31	110-130-88-78-50	96.5	66-60	292-298
RockA18	1980	5-2 (128)	75-60	3-3 (129)	31	110-130-88-78-50	59.5	66-62	299-305
RockA03	1650	1-5 (30)	66-52	1-6 (27)	-0-	110-130-88-78-50	59.0	66-61	306-312
RockA35	2480	8-3/4(52/53)	80-62	8-5 (56)	-0-	110-130-88-78-50	66.3	66-62	313-319
RockA30	1960	7-21/22(74/96)	88-68	7-5 (92)	31/81	110-130-88-78-50	72.3	66-61	320-326
RockA22	1090	7-15(104)	92-50	7-16(102)	31/113/134/135	110-130-88-78-50	44.3	66-63	327-333

PHASE III: REPEAT THEORETICAL FLOWS SIMULATING ALL VALVES IN THEIR OPEN POSITIONS

FLOW TEST TITLE	OBSERVED FLOW in GPM	FLOWING HYDRANT No. (node)	OBSERVED PRESS.in PSI STAT.-RESID.	at HYDRANT No. (NODE)	CLOSED VALVE (PIPE#)	AVERAGE HAZ.-WMS. COEF. St1-DI.-CI.-CI-#125	CALC'D RESID. PRESS.	PRESSURE @ SUPPLY STAT.-RES.	on SHEETS Nos.
RockB12	2180	3-14/15(149/137)	80-50	3-13(146)	-0-	110-130-88-78-50	60.0	66-61	334-340
RockB21	1280	7-15(104)	92-82	7-10(100)	-0-	110-130-88-78-50	84.9	66-62	341-347
RockB37	1135	9-5 (82)	110-102	9-4 (81)	-0-	110-130-88-78-50	96.7	66-60	348-354
RockB18	1980	5-2 (128)	75-60	3-3 (129)	-0-	110-130-88-78-50	62.5	66-62	355-361
RockB30	1960	7-21/22(74/96)	88-68	7-5 (92)	-0-	110-130-88-78-50	75.0	66-61	362-368
RockB22	1090	7-15(104)	92-50	7-16(102)	-0-	110-130-88-78-50	66.7	66-63	369-375

PHASE IV: REPEAT SELECTIVE SAMPLING OF FLOW TESTS WITH RECOMMENDED CHANGES AND ALL VALVES OPEN

FLOW TEST TITLE	OBSERVED FLOW in GPM	FLOWING HYDRANT No. (node)	CLOSED VALVE (PIPE#)	AVERAGE HAZ.-WMS. COEF. Stl-DI.-CI.-CI-#125	CALC'D PRESSURE RESID. @ SUPPLY PRESS. STAT.-RES.	on SHEETS Nos.
Piping Input Recommended Revisions						376-379
RockC12	2180	3-14/15 (142/137)	-0-	110-130-88-78-88	69.1	66-60 380-386
RockC04	1090	1-10 (22)	-0-	110-130-88-78-88	49.7	66-60 387-393
RockC16	1760	4-7/6-3 (66/68)	-0-	110-130-88-78-88	62.0	66-60 394-400
RockC21	1280	7-15 (104)	-0-	110-130-88-78-88	83.3	66-60 401-407
RockC37	1135	9-5 (82)	-0-	110-130-88-78-88	96.8	66-60 408-414
RockC18	1980	5-2 (128)	-0-	110-130-88-78-88	60.6	66-60 415-421
RockC03	1650	1-5 (30)	-0-	110-130-88-78-88	58.1	66-60 422-428
RockC35	2480	8-3/4 (52/53)	-0-	110-130-88-78-88	64.7	66-60 429-435
RockC30	1960	7-21/22 (74/96)	-0-	110-130-88-78-88	74.5	66-60 436-442
RockC22	1090	7-15 (104)	-0-	110-130-88-78-88	84.2	66-60 443-449

**DATE
FILMED**

10/27/94

END