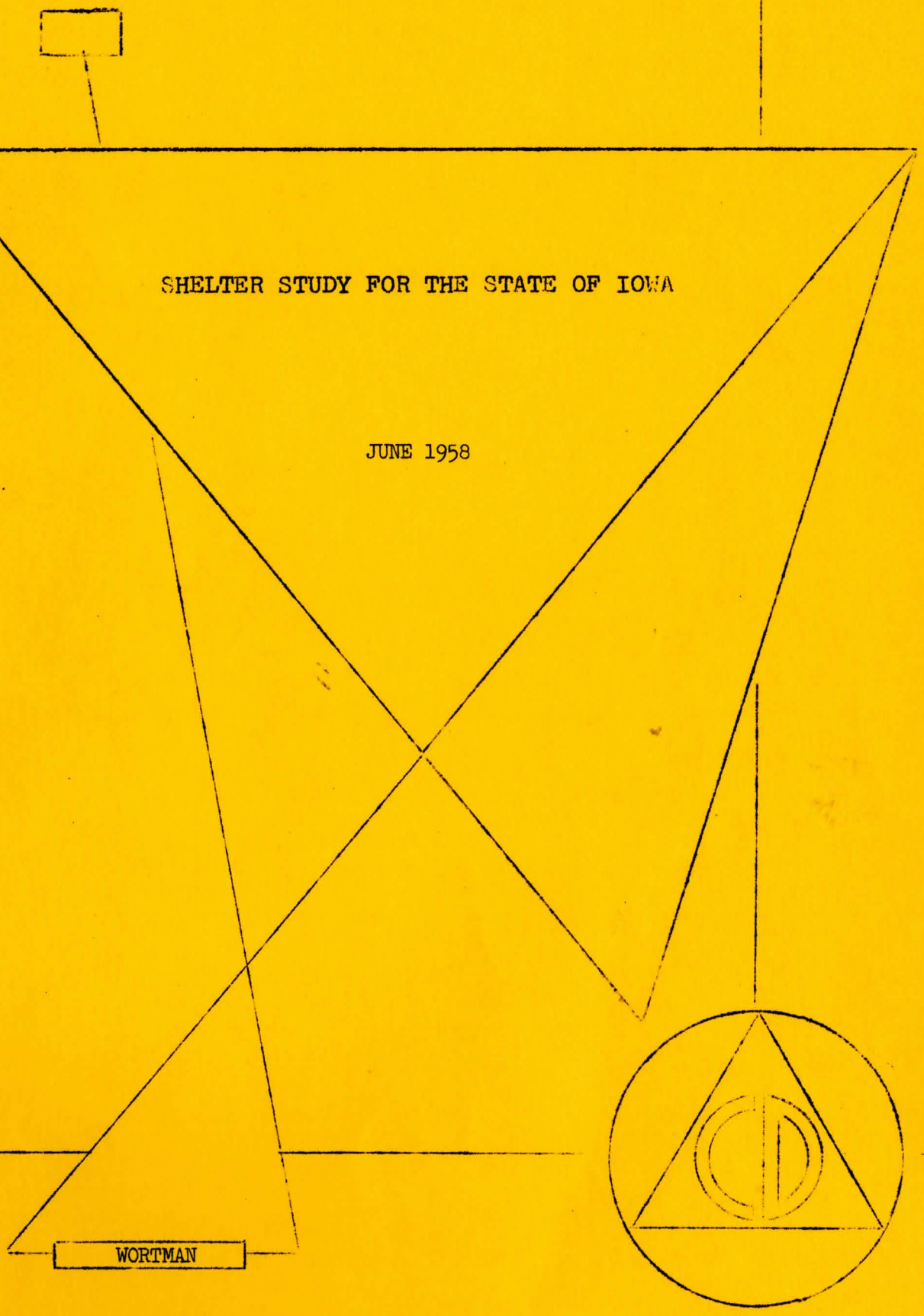
SHELTER STUDY FOR THE STATE OF IOWA

JUNE 1958



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I

INTRODUCTION

In the age of nuclear weapons the type of war which can be waged presents many problems that heretofore have not been present. The use of thermal nuclear weapons so increases the extent of destruction available to the enemy that planning for the survival of the people is made more difficult. Two possibilities are available to protect the people from the effects of an attack upon this country; one of which is the planned evacuation of the people from the target areas resulting in a dispersion of the population. Another possibility is the construction of shelters to protect the population from the effects of nuclear weapons. It is this last possibility, shelters, which is the object of this study.

The Effects of Nuclear Weapons. The effects of nuclear weapons are very diversified; however, three definite effects can be studied in relation to shelters. The three effects are the blast effect, the thermal radiation effect, and the effect of radiation fallout. The effect of blast and radiation fallout are the two important effects of nuclear weapons for which shelters must be built. The effect of thermal radiation occurs so closely with the blast effect that any shelter designed to withstand blast will also withstand the effects of thermal radiation.

Area of Study. The study of shelters for the protection from the effects of blast is limited to the seven target areas in the State. These seven target areas are as follows: Davenport, Critical Target Area; Cedar Rapids, Council Bluffs, Des Moines, Dubuque, Sioux City and Waterloo Target Areas. The area of study for the construction of fallout shelters in the State would include the entire State less that area defined as targets.

Assumptions. Several assumptions have been made for conducting a shelter study for the State of Iowa. One assumption is the size of weapons that might be used upon any target in the State. Four weapon sizes have been considered as possibilities which are: a 20 MT bomb, a 30 MT bomb, a 60 MT bomb, and four 5 MT bombs placed in such a manner that the 30 psi rings touch. The psi rings, as a result of each weapon being dropped on a target, are imposed upon the maps included in the study as an attachment. Another assumption is the location of ground zero in determining the exact location of the psi over pressure rings. In all but two targets ground zero is assumed to be the geographic center of the target area. In the other two targets, Council Bluffs and Davenport, the fact that these targets are part of a target complex which extends across state lines was considered. This criteria is the same for all weapons except the four 5 MT bombs in which case the bombs were placed

so that the most damage would result to the particular target area.

A third assumption is the population data used. The statistical analysis is based upon 1950 resident population found in the Bureau of Census report for 1950. This data has preference over any updated data available because the distribution of the resident population within an urban target area is available and in addition, the distribution of population within a county by townships. The updated data is not available with the stratification or distribution as available in the 1950 data.

Validity of Statistical Data. It must be realized that the data presented is not without bias, which results from the fact that the data was estimated without the benefit of a sample or survey which would remove the bias. For the purpose of this study, with the time and funds allotted, the estimates, as determined, will serve the purposes for which it is intended - an initial study of the shelter requirement in the State of Iowa.

In addition, only the resident population data is used. This does not present a complete analysis of the effects of nuclear weapons upon a target. However, if daytime population concentrations had been collected by survey, the survival percentages in each target area would have been less.

The theory concerning the validity of shelters is based entirely upon the statistical analysis of the 20 MT bomb.

The results obtained, however, do give an indication of the results which probably would have been obtained if the analysis had been completed for each of the other assumed weapons.

II

SURVIVAL PERCENTAGES

The survival percentages for the seven target areas are based upon the various overpressure rings of a 20 MT bomb. This information is presented in Table I. The data presented in Table I is plotted on Figures I through VII. The base population figure used in the determination of the survival percentages is the evacuation population as previously determined for the State Survival Plan for each target area.

Analysis of Table I. The survival percentages as presented in Table I do not present a very optimistic picture for the validity of shelters for protection against blast effect in the State of Iowa. It is noted (see Table I) that without any shelters above 2 pounds per square inch (psi) design levels the percent survival in the target areas varies from less than one percent in Sioux City to 15 percent in Waterloo. If shelters were constructed of 10 psi design levels the survival percentage increases, yet the highest percent of survival is 33 percent in the Waterloo target area, while the lowest survival percentage with 10 psi shelter design level is Sioux City with 4 percent survival.

If the criteria is established that at least 50 percent

of the population must survive to justify the construction of shelters, then at a design level of 20 psi 50 percent of the population would survive in one city, Waterloo. Only one city would have at least 50 percent survival with shelter design levels of 30 psi, Waterloo. However, in two other cities the survival percentage is close enough to 50 percent that it might be justifiable to build shelters at 30 psi design levels. These two target areas are Des Moines with 49 percent survival and Council Bluffs with 46 percent survival. At the design level of 50 psi four target areas would have survival of 50 percent or more; and at 100 psi one additional target area would obtain 50 percent survival or greater. (Note Table I) Even at this design level two target areas would still have a surviving population of less than 50 percent - Dubuque and Sioux City.

The table reflects the concentration of the resident population in each city. In each area with possible exception of Waterloo, the population is concentrated into a small geographic area. This is a characteristic of a state whose basic economy is agricultural and lacks any large industrialized areas. Consequently, the survival percentages are not very high in the state. In the case of Waterloo, however, the population is dispersed over a wide area rather than concentrated into a small area. This is a result of several suburban areas located around the city which have high population concentration, and is what one would normally assume from the growth patterns of the urban areas.

Effects of Larger Weapons Upon Survival Percentages.

The use of either of the other assumed weapons upon any target in the State would decrease the percentage of survival in the target areas. This would occur because the area of destruction, as a result of blast effect, would be greater in each of the target areas. It is because of the lack of time and the findings of a 20 MT bomb analysis that the survival percentages for the other bomb sizes have not been determined.

III

COST OF SHELTERS IN RELATION TO SURVIVAL

The cost per person of constructing shelter is the same cost as used in the St. Louis Shelter Study. It is felt that these costs represent fairly close the cost of constructing shelters in this state. The costs per person for the construction of shelters at various shelter design levels are as follows: a 10 psi shelter design costs 165 dollars per person, a 20 psi shelter design costs 200 dollars per person, a 30 psi shelter design costs 235 dollars per person, a 50 psi shelter design costs 285 dollars per person, and a 100 psi design shelter costs 415 dollars per person. The percent of survival (20 MT bomb) shelter design levels (psi) and cost per person for each target area is shown in Figures IA through VIIA. In addition, each figure has a tabulation of percent cost increase through the various shelter design levels and the percent survival increment as the design level is increased.

Shelter Costs. If an optimum shelter design level of 30 psi is assumed then for each target area the cost of constructing shelters in relation to survival percentage from a 20 MT bomb is as follows: In the Cedar Rapids target area the cost of shelter construction would be approximately 24 million dollars and 32 percent of the population would survive. The shelter construction cost in the Council Bluffs target area would be approximately 13 million dollars and 46 percent of the population would survive. The Davenport target area would require approximately 23 million dollars to construct shelters and 38 percent of the population would survive. In the Des Moines target area the shelter construction cost would be approximately 51 million dollars and 49 percent of the population would survive. The Dubuque target area shelter construction cost would be approximately 15 million dollars and 19 percent of the population would survive. The construction cost of shelters in the Sioux City target area would be approximately 21 million dollars and 21 percent of the population would survive. The Waterloo target area shelter construction cost would be approximately 26 million dollars and 50 percent of the population would survive. The total shelter cost for the State of Iowa for protection from a 20 MT weapon would be approximately 172 million dollars.

The total cost of constructing shelters for the larger weapons would increase because the population which would

need shelters would increase. However, it is doubtful that the increased number of shelters would increase the survival percentages. It is felt that the converse would occur; the total cost of shelters would increase and the percent of survival would decrease. The above statement is based upon the knowledge that the target areas have centralized populations in a small geographic area, while the destruction rings from larger weapons increase in radius.

IV

SHELTER LOCATION FOR BLAST EFFECT

The shelter location for each of the target areas is presented in Tables II through VIII. The tables contain the resident population as of 1950 by county stratified by township and the estimated shelter needs to protect the population from the blast effect. In addition, two methods of estimating the size of the shelters to the number of shelters which should be constructed is presented. The size of the shelters in column 6 is determined by estimating the number of shelters, column 5, needed for the resident population in each township based upon an estimate of placing the shelters by geographic location. Then an assumption was made that shelters should be constructed of three sizes which are: 100 person shelters in the rural areas, 1000 person shelters in the more densely populated small communities and townships and 2000 person shelters in the target cities. The findings

under this assumption are presented in columns 7 and 8 of the tables.

It is noted that by basing the number of shelters upon the population and geographic location will require less shelters than arbitrarily setting a shelter size and determining the number of shelters. (See Tables II through VIII) However, it is felt that due to the characteristics of the rural areas, low concentration of population, the latter criteria is more realistic in determining the number of shelters needed to protect the people from the effects of blast. The construction of more and smaller shelters may increase the cost of constructing shelters per person, but data to substantiate this has not been determined. The increased cost of constructing shelters, if such an increase is present, would be justified in that it is more likely that the population in the rural areas would have a better chance of reaching the shelters in the event of an attack than if the shelters were located over a wide area and constructed of a larger size.

V

FALLOUT SHELTERS IN THE STATE

A statistical study of fallout shelters for the State of Iowa has not been made due to the lack of time; however, several problems and considerations in determining the fallout shelter needs are presented. The type of shelter needed

to protect the population from the effects of nuclear radiation need not cost as much per person as the cost of constructing shelters for protection against blast. However, it must be realized that the number of shelters needed for the protection against radiation fallout will be greater than the need of shelters for the protection against blast, thus increasing total costs. The size of the shelters in the fallout areas can be larger, if needed, due to the element of time. More time will be available to reach the fallout shelters than the time which will be available to reach the blast shelters.

So far, the consideration has been that shelters be constructed for the protection of populations from the hazards of fallout. However, in an agricultural state such as Iowa, consideration should be made for the protection of livestock and grain from the effects of nuclear radiation. This would present additional problems in the design of shelters and would, of course, increase the total cost of constructing shelters for the protection against the fallout effects. The decision concerning the construction of fallout shelters for livestock and grain is based in part upon social costs vs. social benefits. This means that if the cost of constructing the shelters in the long run is less than the benefits received then such construction would be justified. It is felt that if the need ever arose in which the shelters for livestock and grain were used the benefit would more than out-weigh the cost of

construction. Therefore, the nation would be assured a potential food supply to aid recovery in the post-attack period.

VI
SUMMARY AND CONCLUSIONS

The shelter study as presented is based entirely upon the complete utilization of shelters rather than evacuation. Because it is impossible to predict which method an enemy might use to deliver a bomb upon any target in the State, it seems advisable to consider the combination of evacuation and shelters in the State of Iowa. This is based upon the findings of this study and as the situation changes a later study may arrive at different findings.

In summarizing the shelter study for the State of Iowa it is noted that the survival percentages as presented in Table I indicate that the survival percentage for 4 of the targets at 30 psi shelter design levels would be considerably less than 50 percent. Even at a 100 psi shelter design level two target areas would still have less than 50 percent survival of the population of the target area.

In determining the cost of shelters for the State a 30 psi shelter design level was assumed and for a 20 MT weapon the total cost for constructing shelters in the State is approximately 172 million dollars. This is based upon a shelter construction cost of 235 per person. It was felt that a larger weapon size than 20 MT would increase the

shelter cost while the percent of survival of any target area would decrease.

The number of shelters needed in any one of the target areas was determined two ways. One, the location was based upon geographic considerations and the other by establishing an assumed size, then determining the number of shelters required. The latter method was thought to be the better of the two methods for locating shelters; for while costs may be increased the implementation time for the utilization of the shelters would be less, particularly in the sparsely populated rural areas.

The basic problem in the construction of shelters for the protection against fallout radiation is whether or not to include the use of shelters for the protection of livestock and grain as well as people. Such a consideration is based upon the social cost vs. the social benefit principle, which in this case would justify the construction of shelters for the protection of all resources -- human, animal and others.

It should be noted that the determination of the statistical analysis is based upon the most optimum damage situation which could be devised for each of the target areas. Any deviation from the assumed ground zero in any target area would increase the survival percentage regardless of the size of bomb which might be dropped by the enemy.

This study has considered only the protection of the

population from enemy attack, but the shelters, if constructed, could be used also for protection from natural disasters which might affect any area, i.e., a tornado or high winds.

A more detailed analysis of the needs and requirements of shelters in the State of Iowa could have been made if time had been available. A more complete study would have placed considerably more emphasis upon the construction of shelters for the protection against radiation fallout. This should include a detailed analysis of the feasibility and cost of construction shelters for the protection of livestock and other essential resources from the dangers of radioactivity. Another area of study is the construction of shelters in the target areas to protect essential resources from all the effects of nuclear weapons. While this study is basically concerned with the protection from nuclear weapons, some planning for shelter protection against bacteriological and chemical warfare should be considered. This is particularly true in an agricultural area where defense against such types of attack assumes considerable importance.

TABLE I.

Percent survival seven target cities of Iowa, 20 MT bomb based upon shelter design resistance levels of 2 psi, 10 psi, 20 psi, 30 psi, 50 psi, and 100 psi.

TARGET AREA	% SURV. 2 PSI	% SURV. 10 PSI	% SURV. 20 PSI	% SURV. 30 PSI	% SURV. 50 PSI	% SURV. 100 PSI
Cedar Rapids	3	26	29	32	41	52
Council Bluffs	9	20	39	46	55	64
Davenport	3	23	25	38	53	64
Des Moines	2	17	19	49	55	61
Dubuque	3	12	17	19	28	43
Sioux City	(1)	4	5	21	29	38
Waterloo	15	33	50	50	62	72

(1) LESS THAN 1%, ACTUAL .4%

SOURCE: 1950 United States Census Of Population, Department Of Commerce, Bureau Of Census, estimated population in each target area from studies conducted for evacuation, IOWA SURVIVAL PLAN, ANNEX W; population in each psi ring estimated by D.E.W.

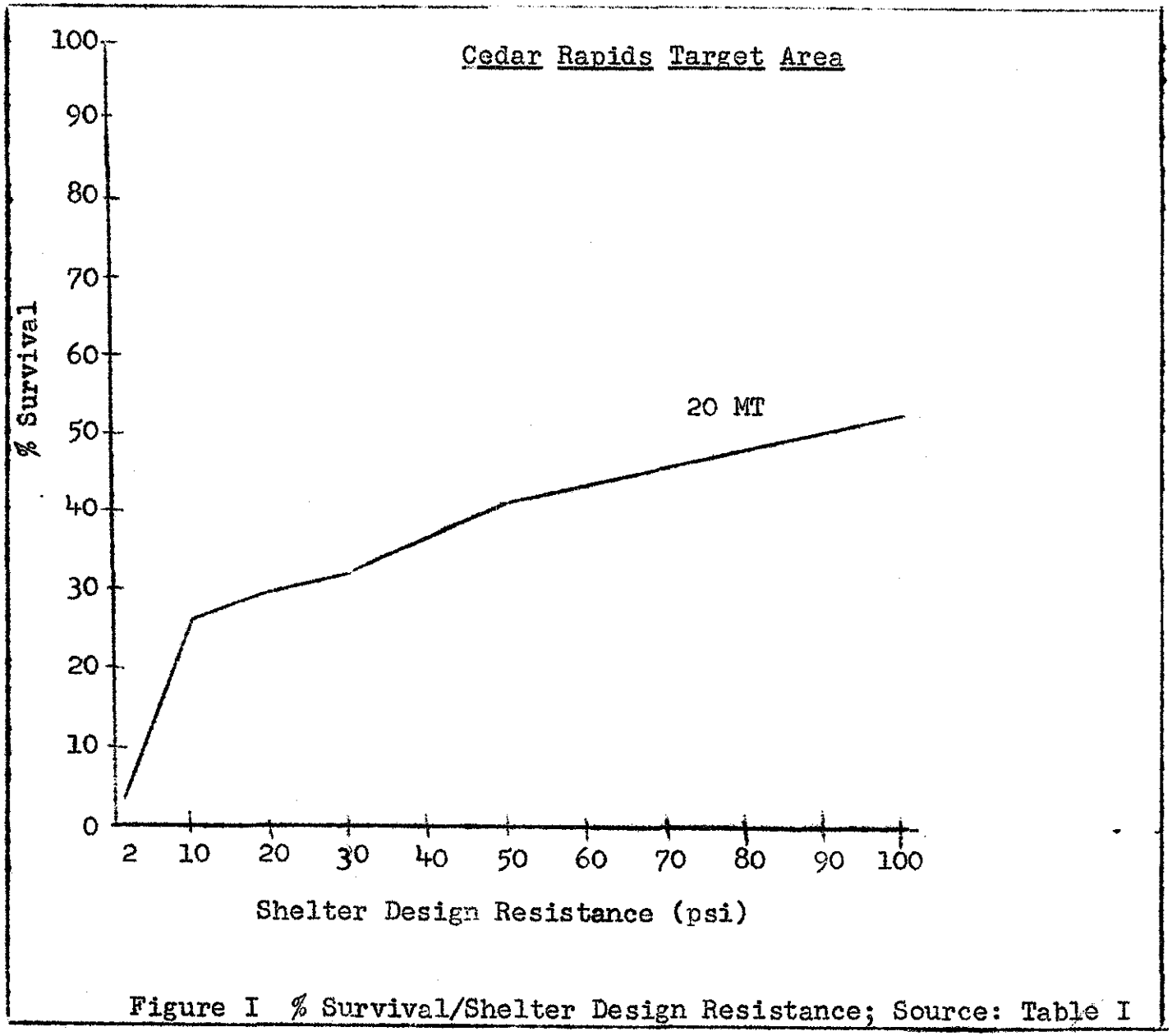


Figure I % Survival/Shelter Design Resistance; Source: Table I

CEDAR RAPIDS TARGET AREA

DESIGN PSI	10	20	30	50	100
PERCENT COST INCREASE	21	18	21	46	
PERCENT SURVIVAL INCREMENT	3	3	9	11	

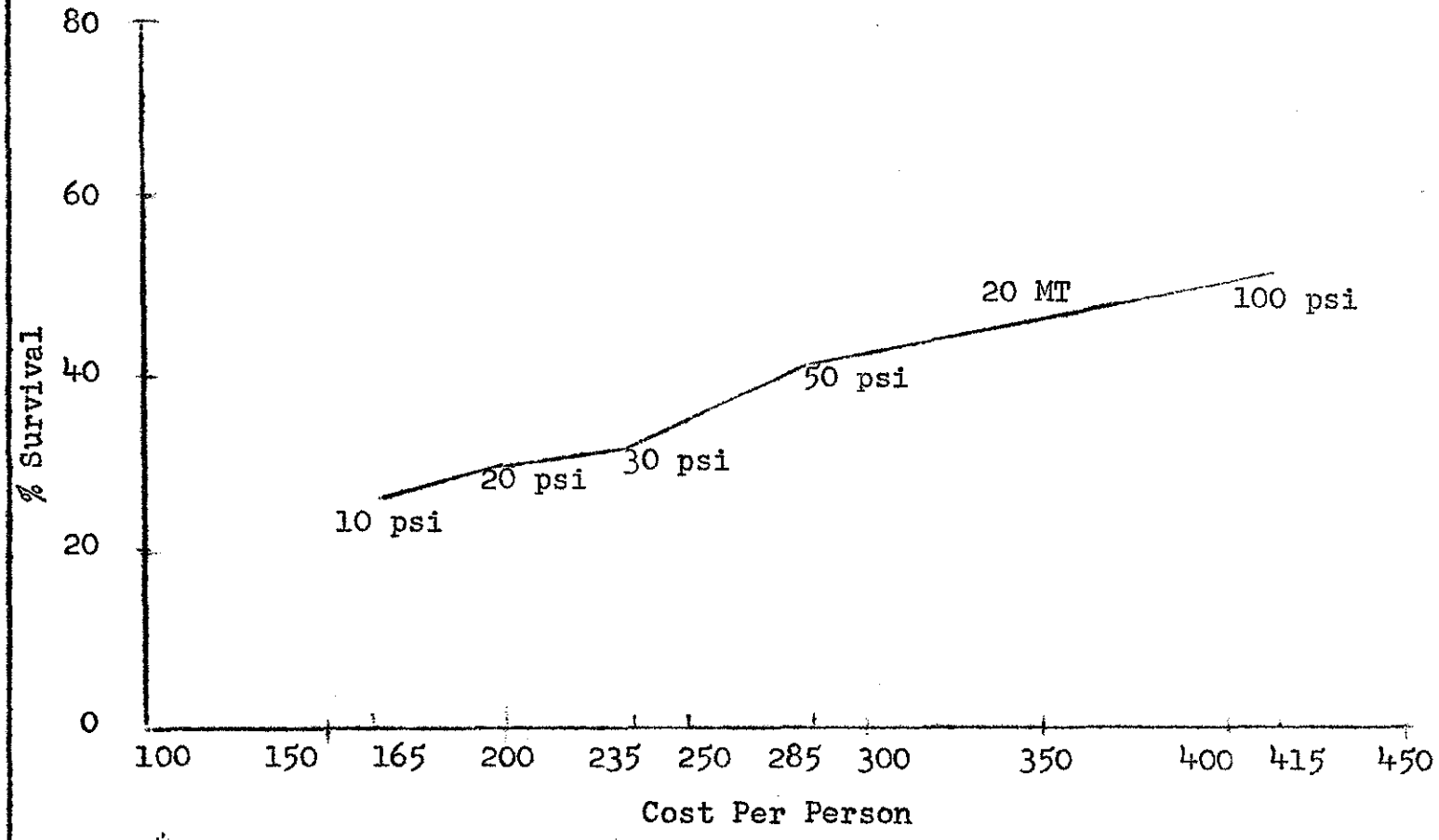


Figure I-A Survival Percentages/Shelter Design Levels (Psi)/Cost Per Person
Source: Table I Survival In Public Shelters, FCDA, 1957

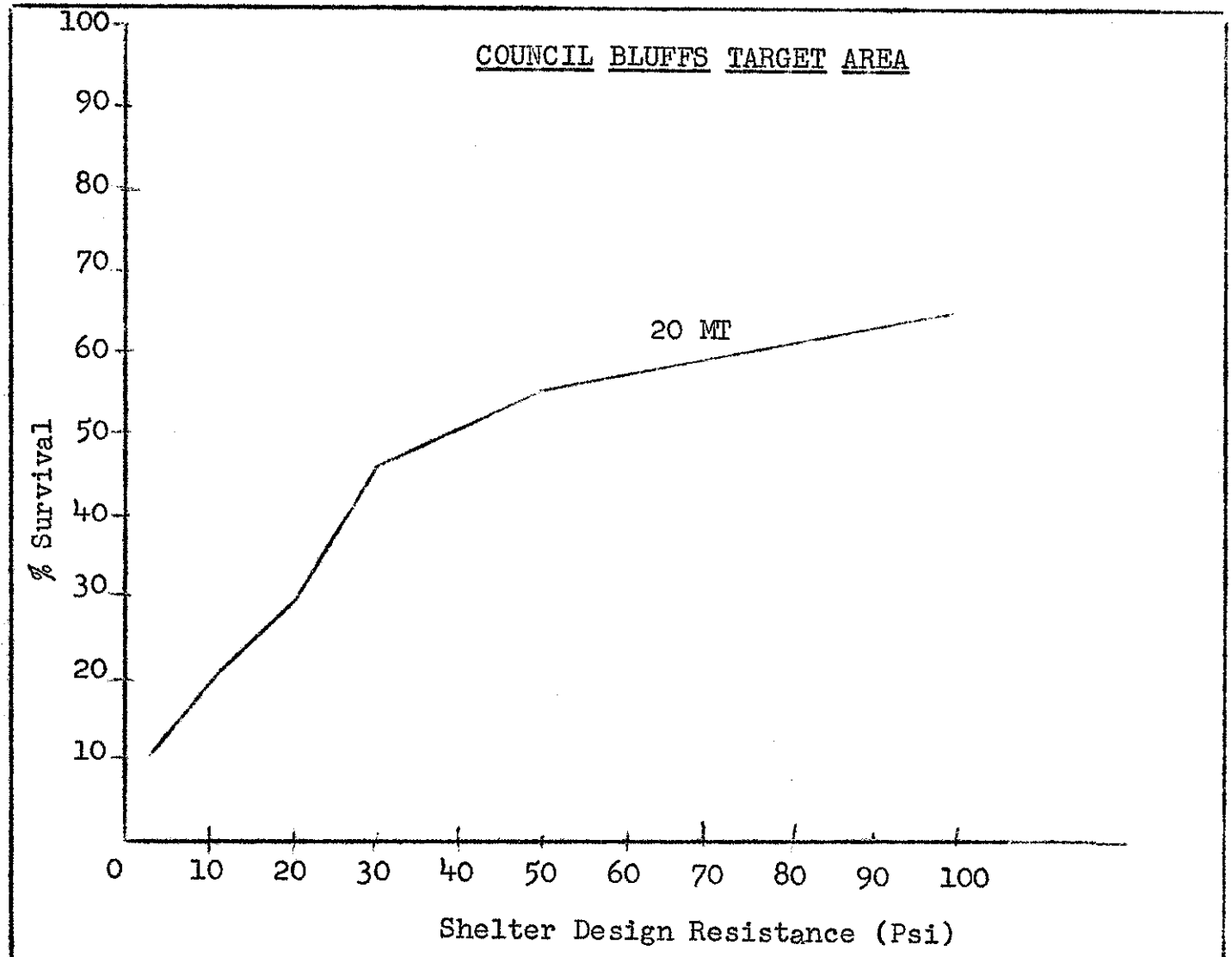


Figure II % Survival/Shelter Design Resistance, Source: Table I

COUNCIL BLUFFS TARGET AREA

DESIGN PSI	10	20	30	50	100
PERCENT COST INCREASE	21	18	21	46	
PERCENT SURVIVAL INCREMENT	19	7	9	9	

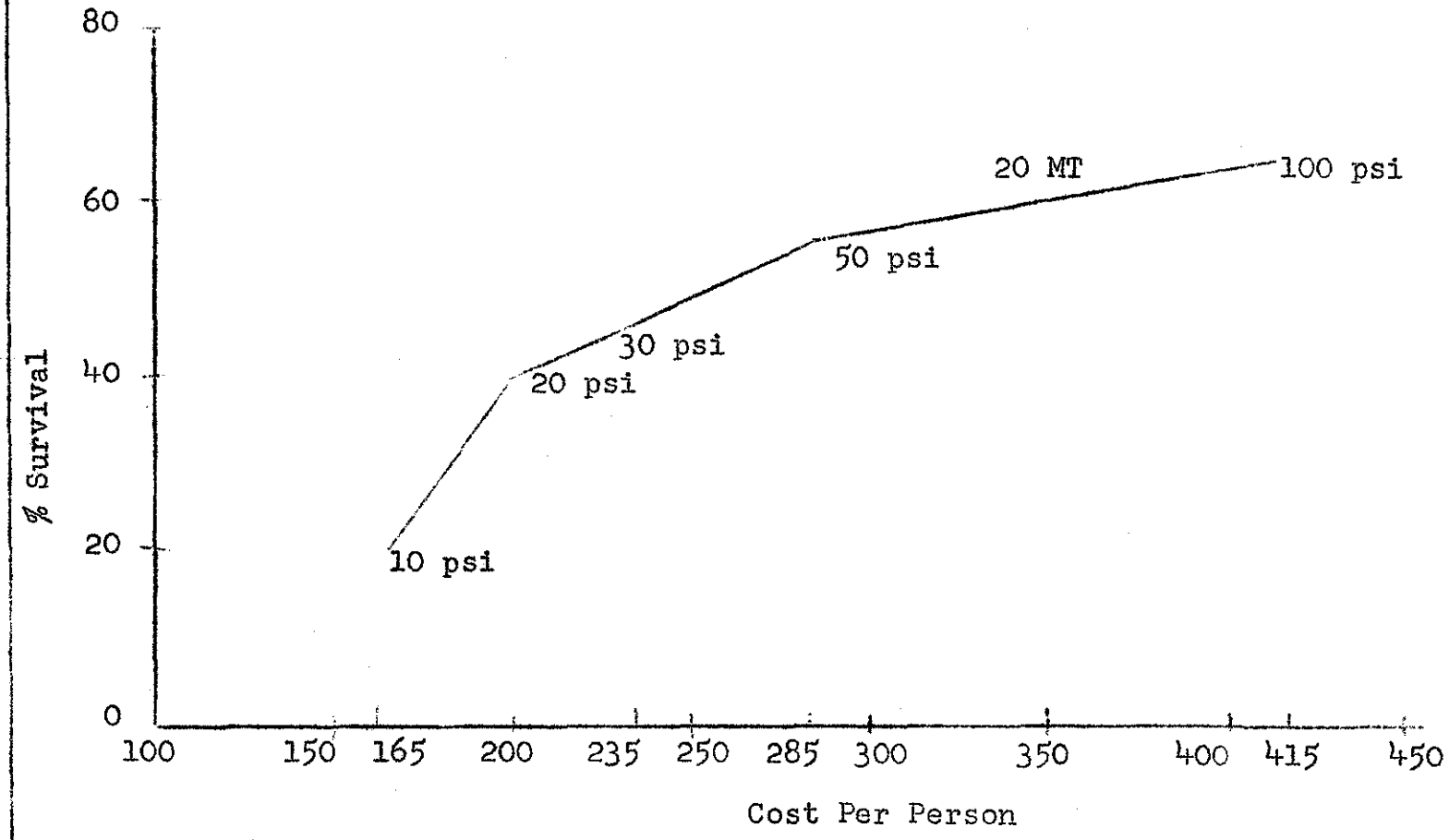


Figure II-A Survival Percentages/Shelter Design Levels (Psi)/Cost Per Person
Source: Table I, Survival In Public Shelters, FCDA, 1957

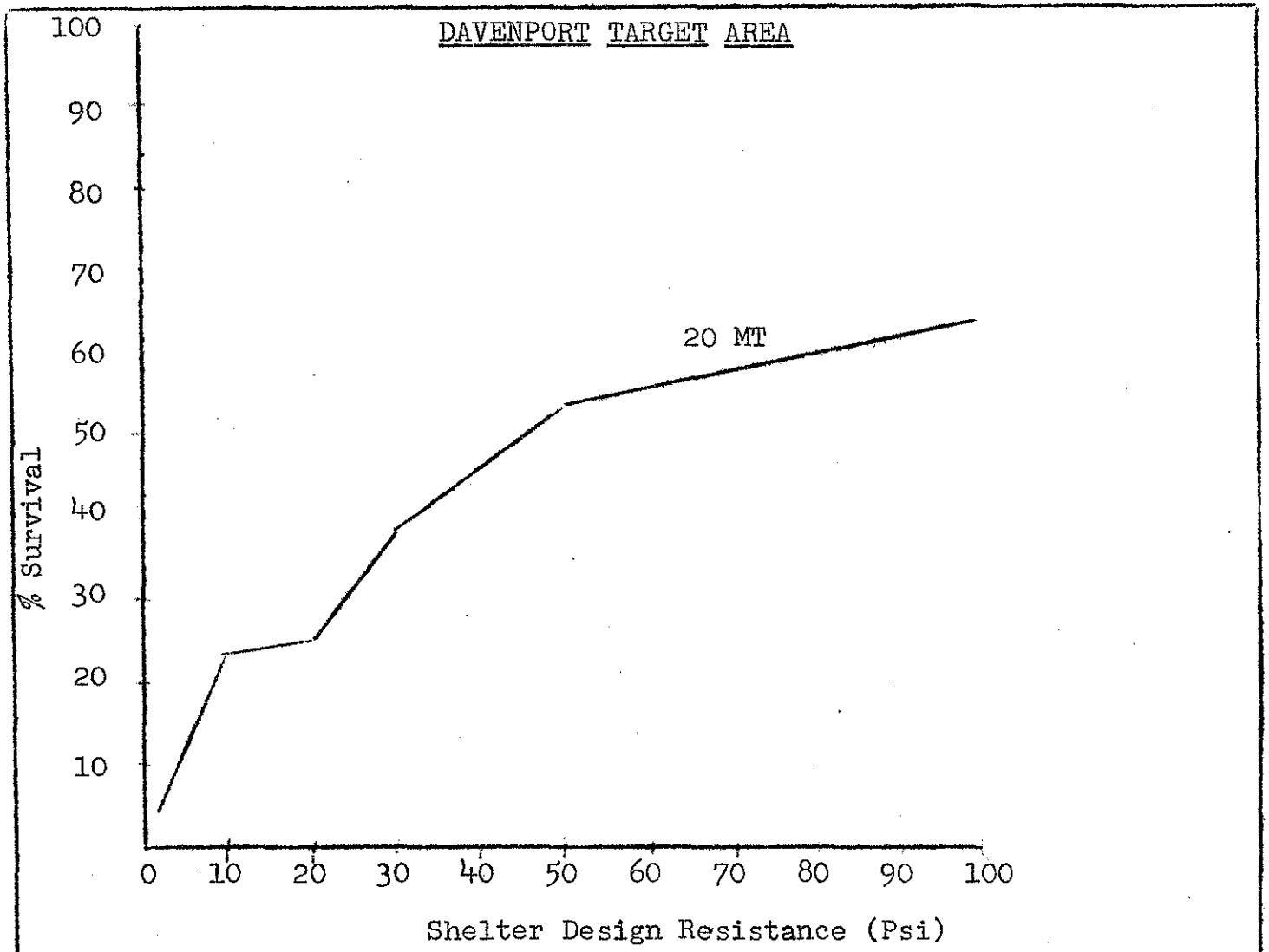


Figure III % Survival/Shelter Design Resistence, Source: Table I

DAVENPORT TARGET AREA

DESIGN PSI	10	20	30	50	100
PERCENT COST INCREASE	21	18	21	46	
PERCENT SURVIVAL INCREMENT	2	13	15	11	

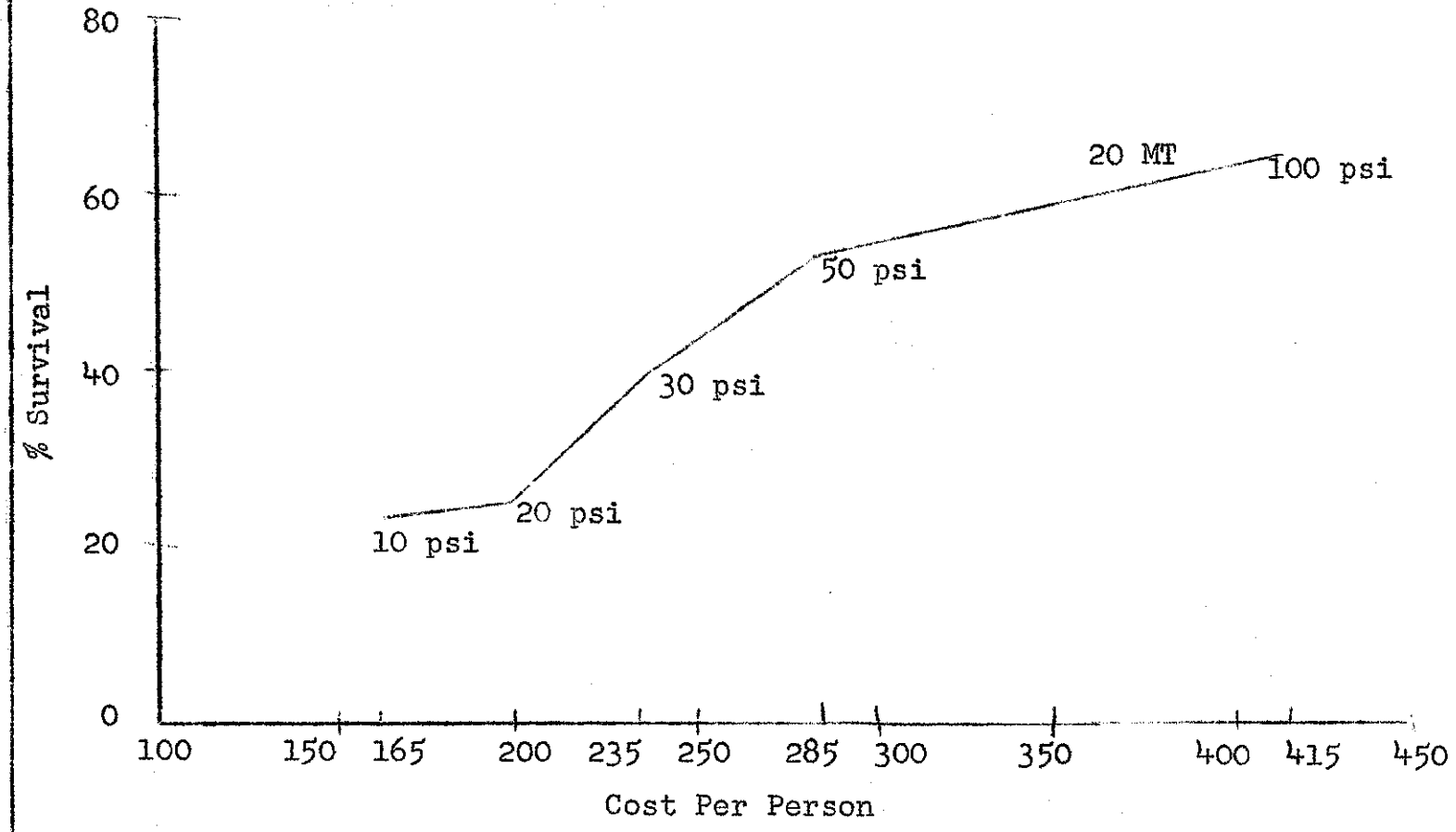


Figure III-A Survival Percentages/Shelter Design Levels (Psi)/Cost Per Person
Source: Table I Survival In Public Shelters, FCDA, 1957

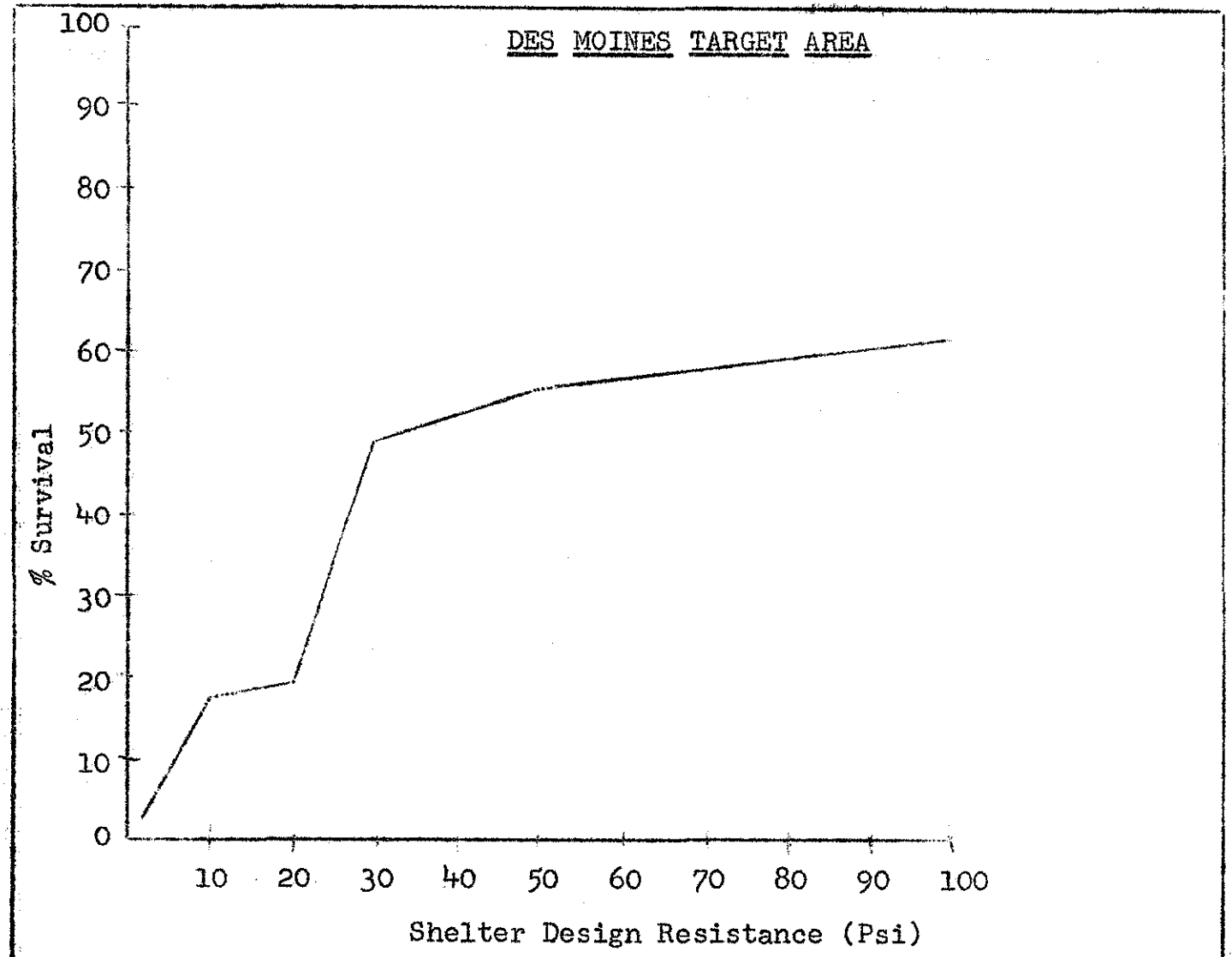


Figure IV % Survival/Shelter Design Resistance, Source: Table I

DES MOINES TARGET AREA

DESIGN PSI	10	20	30	50	100
PERCENT COST INCREASE	21	18	21	46	
PERCENT SURVIVAL INCREMENT	2	30	6	6	

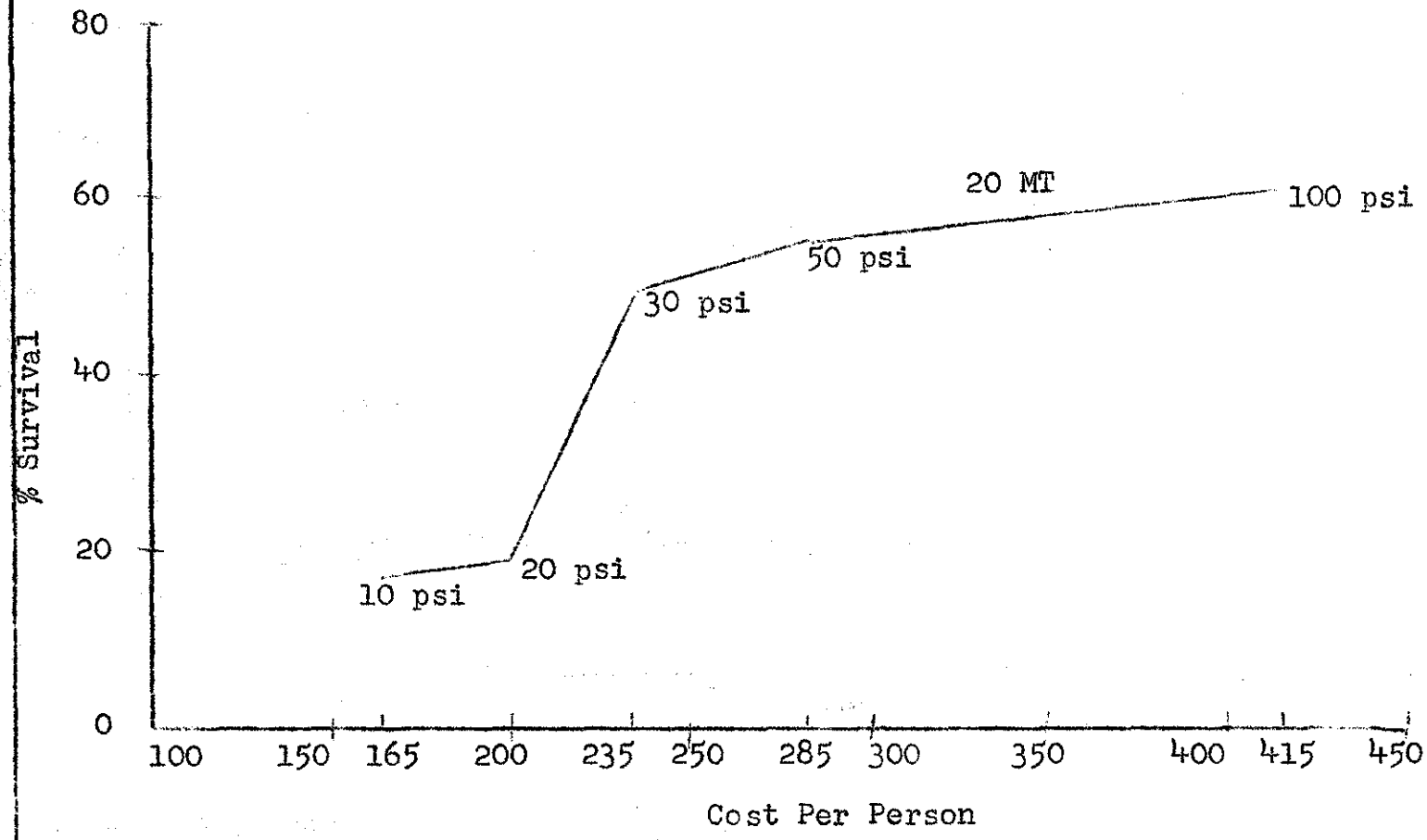


Figure IV-A Survival Percentages/Shelter Design Levels (Psi)/Cost Per Person
Source: Table I Survival In Public Shelters, FDCA, 1957

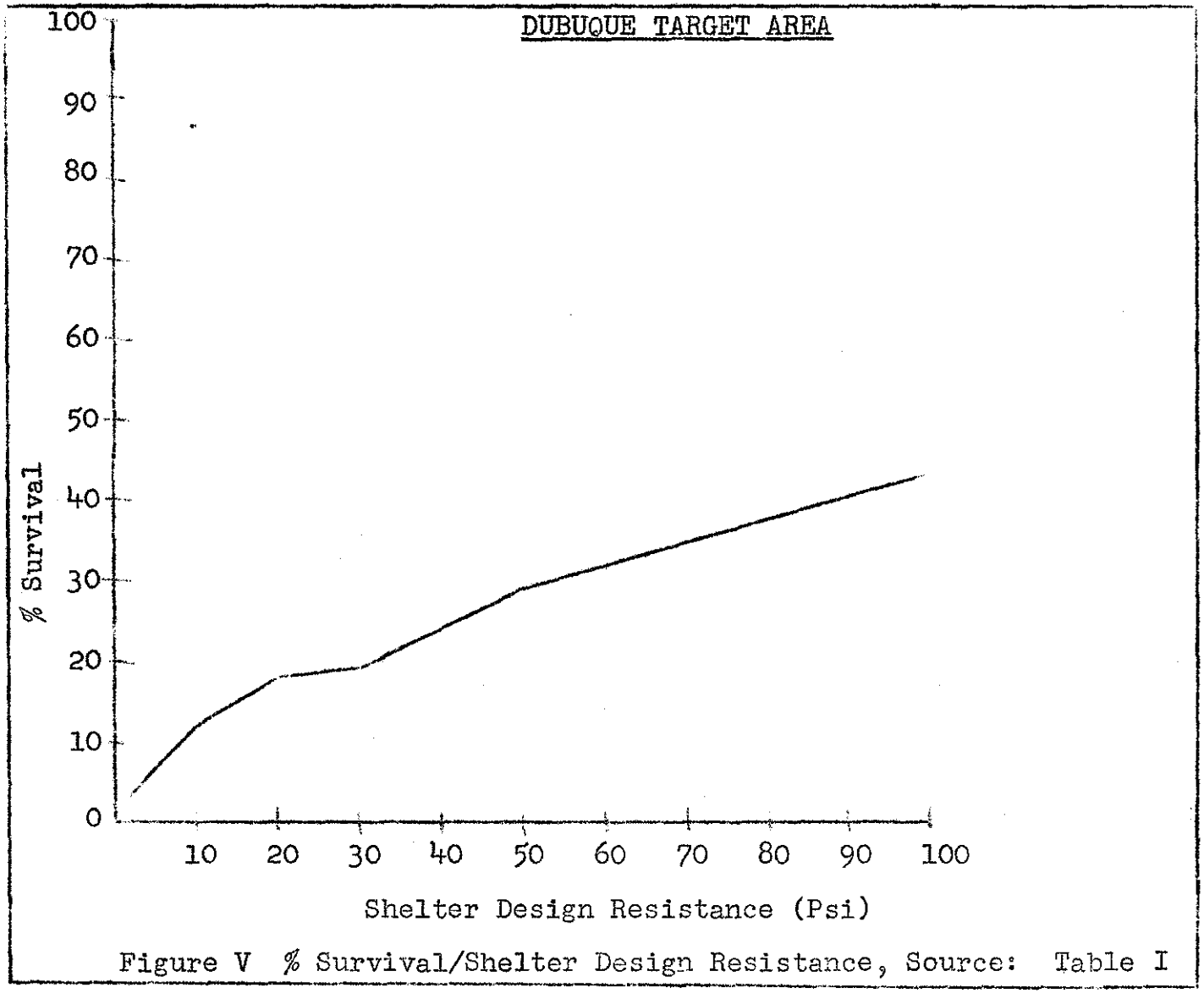


Figure V % Survival/Shelter Design Resistance, Source: Table I

DUBUQUE TARGET AREA

DESIGN PSI	10	20	30	50	100
PERCENT COST INCREASE	21	18	21	46	
PERCENT SURVIVAL INCREMENT	5	2	9	15	

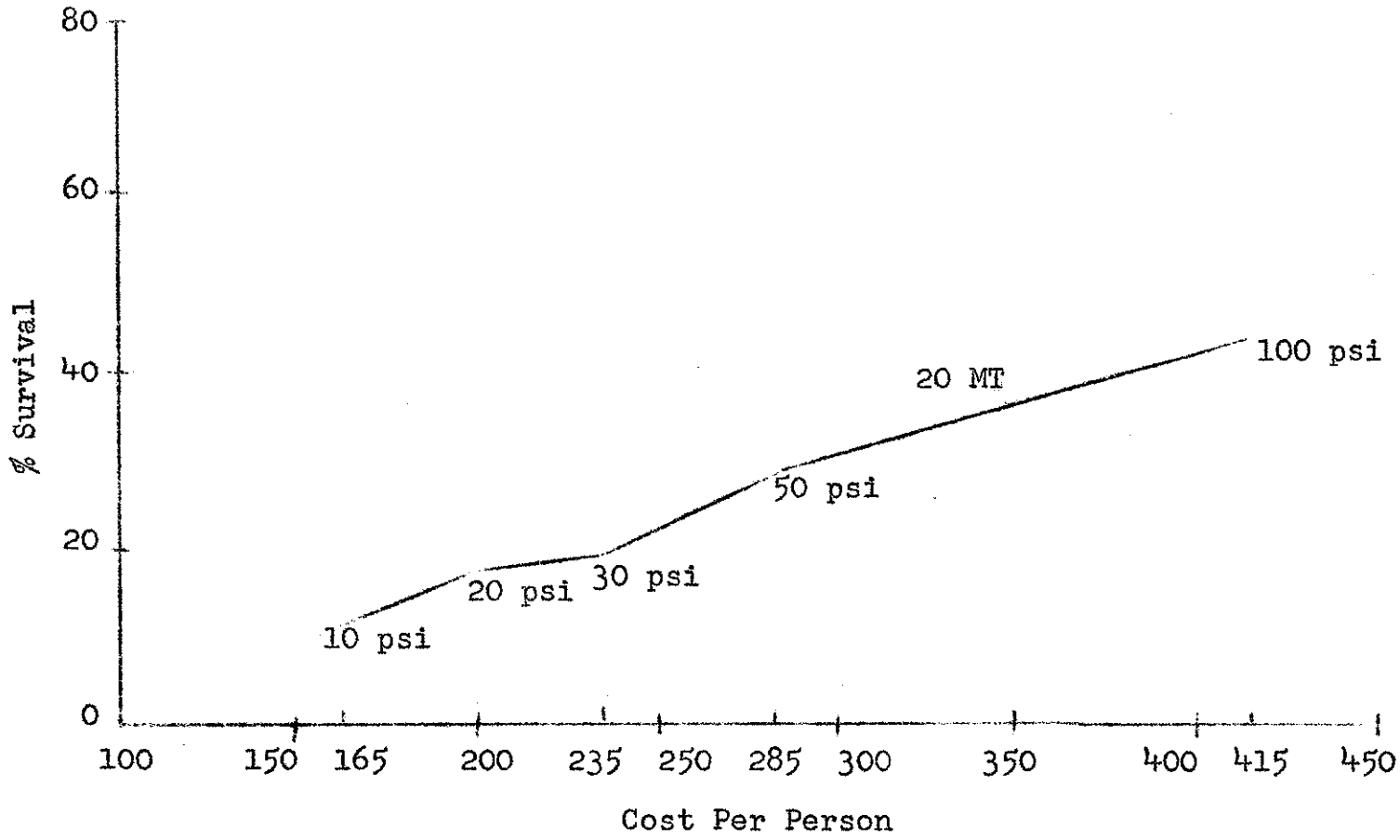


Figure V-A Survival Percentages/Shelter Design Levels (Psi)/Cost Per Person
Source: Table I, Survival In Public Shelters, FCDA, 1957

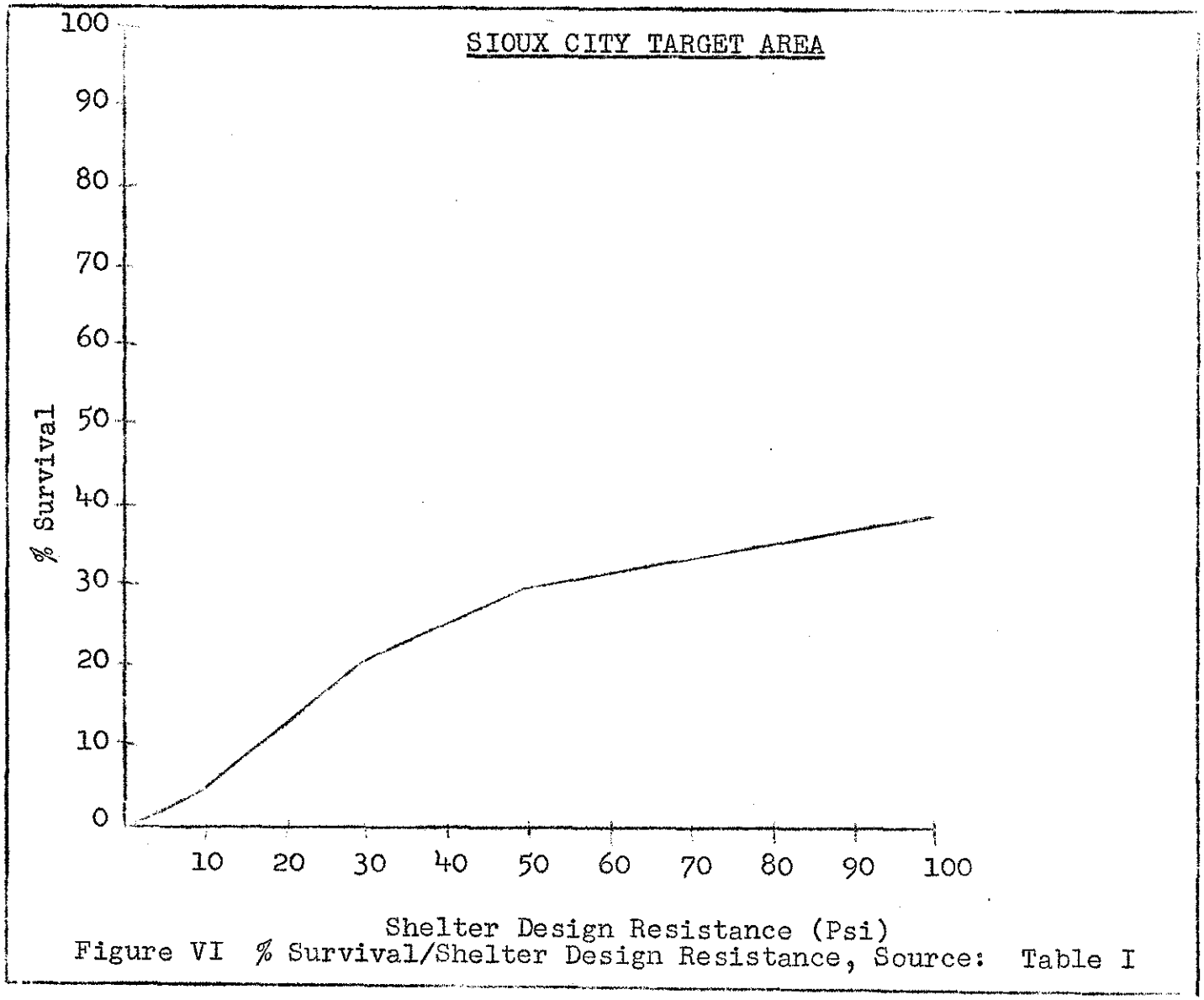


Figure VI % Survival/Shelter Design Resistance, Source: Table I

SIOUX CITY TARGET AREA

DESIGN PSI	10	20	30	50	100
PERCENT COST INCREASE	21	18	21	46	
PERCENT SURVIVAL INCREMENT	1	16	8	9	

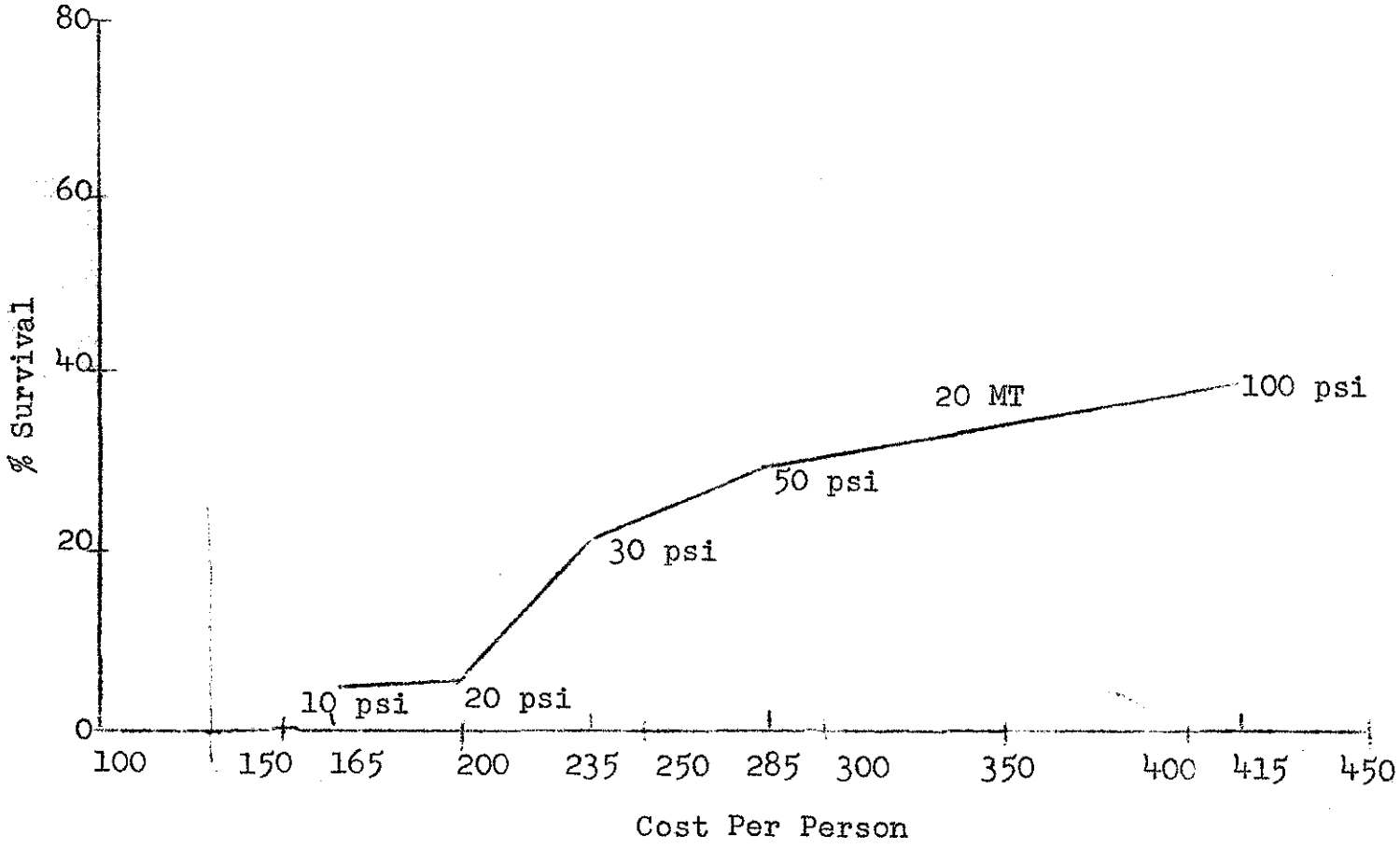


Figure VI-A Survival Percentages/Shelter Design Levels (Psi)/Cost Per Person
Source: Table I, Survival In Public Shelters, FCDA, 1957

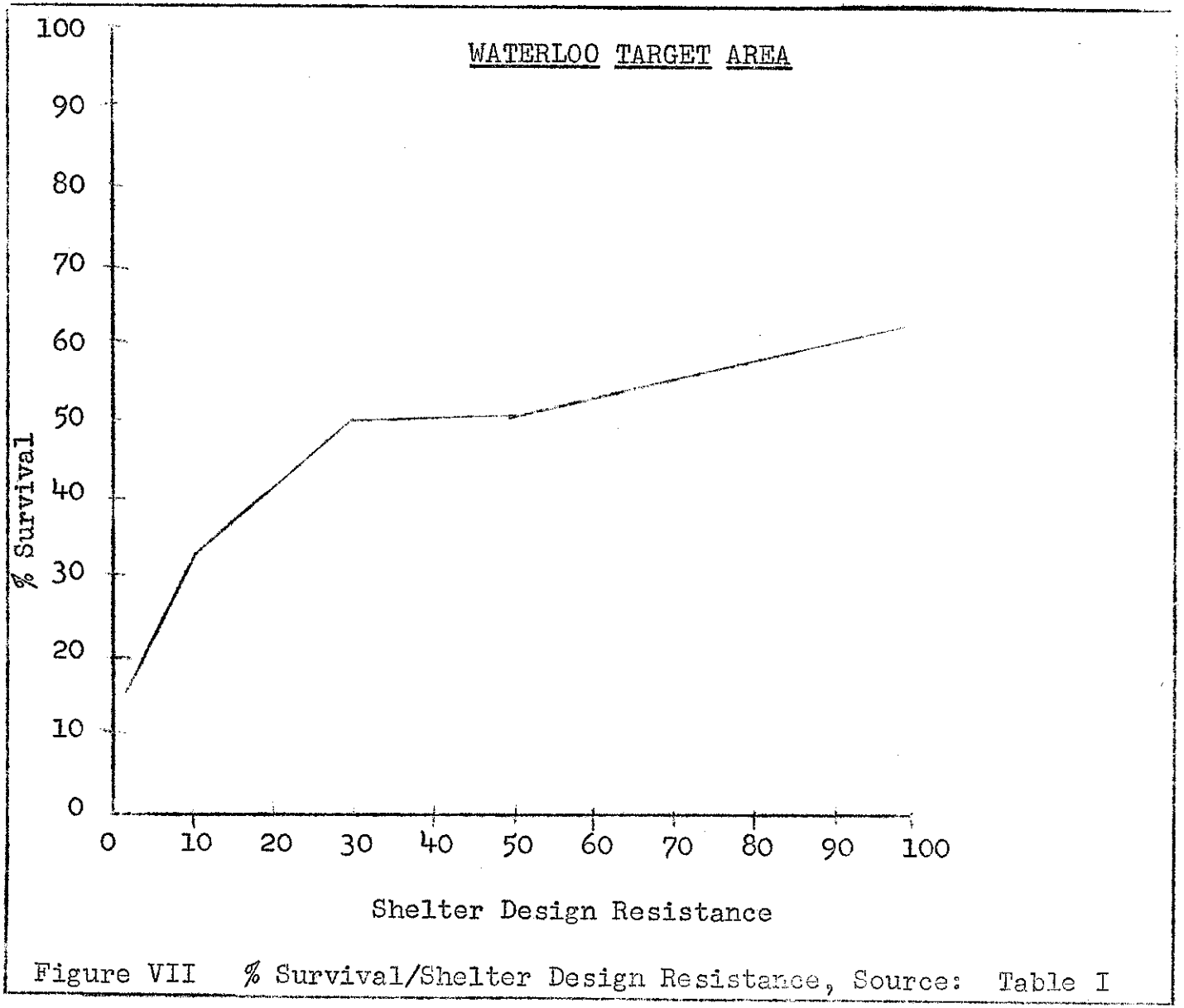


Figure VII % Survival/Shelter Design Resistance, Source: Table I

WATERLOO TARGET AREA

DESIGN PSI	10	20	30	50	100
PERCENT COST INCREASES	21	18	21	46	
PERCENT SURVIVAL INCREMENTS		17	0	12	10

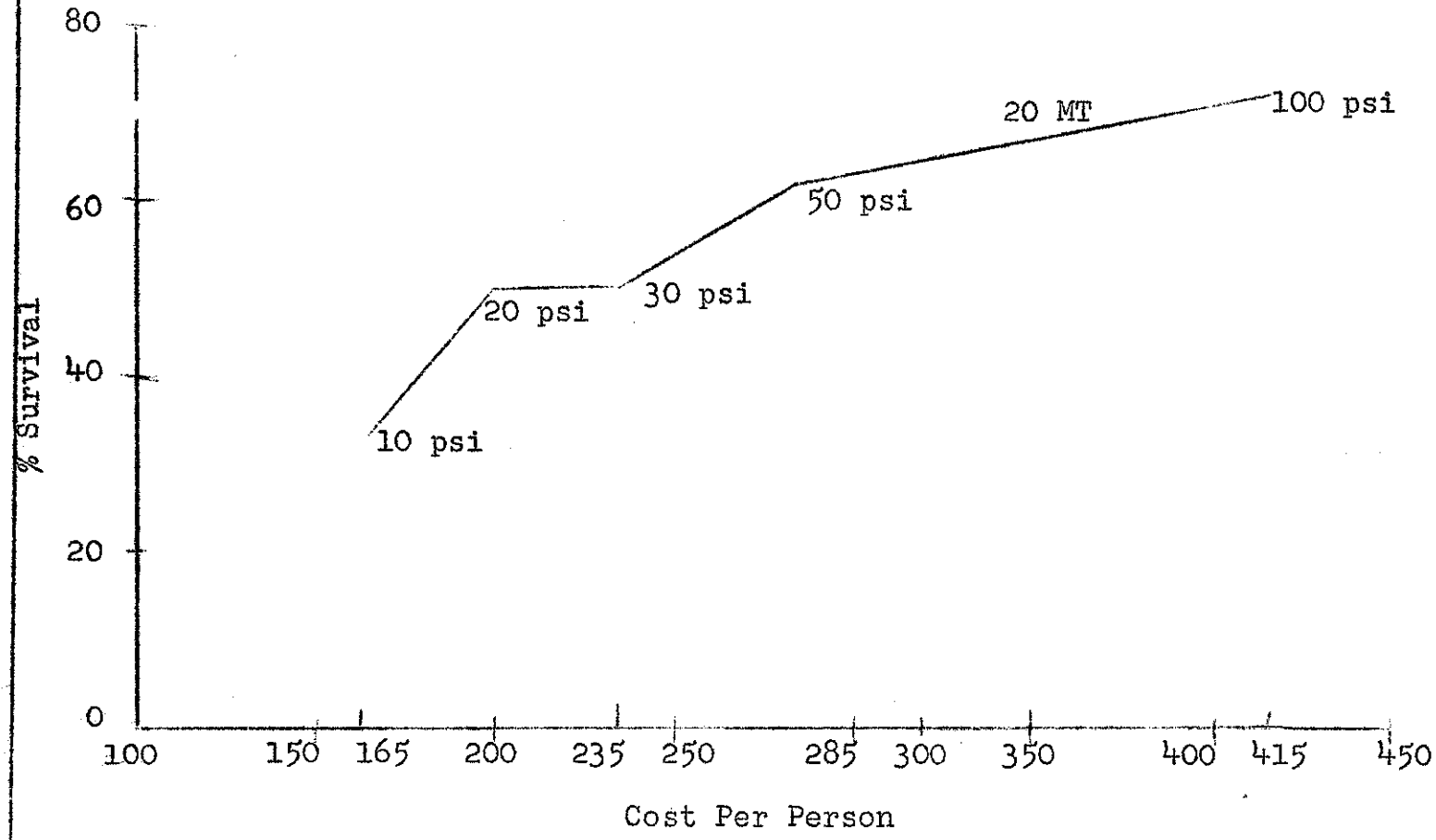


Figure VII-A Survival Percentages/Shelter Design Levels (Psi)/Cost Per Person
Source: Table I, Survival In Public Shelters, FCDA, 1957

TABLE II.

Counties, townships, resident population (1950) in 2 psi ring, number of shelters and size by geographic area and number of shelters by assumed size for Cedar Rapids target area. (Population in thousands)

1	2	3	4	5	6	7	8
COUNTY	TOWNSHIP	ASSN'D MAP NO.	RES. POP IN 2 PSI RING	NO. SHELT.	SHELT. SIZE	SHELT. SIZE ASSM'D.	NO. SHELT.
Linn	Washington	1	.6	2	300	100	6
Linn	Otter Creek	2	.3	2	150	100	3
Linn	Maine	3	.5	1	500	100	5
Linn	Buffalo	4	.6	2	300	100	6
Linn	Marion	5	8.0	16	500	1,000	8
Linn	Monroe	6	1.9	4	500	100	19
Linn	Fayette	7	.5	2	250	100	5
Benton	Canton	8	.2	2	100	100	2
Benton	Fremont	9	.8	4	200	100	8
Linn	Clinton	10	1.9	4	500	100	19
Linn	Linn	11	.5	2	250	100	5
Linn	Bertram	12	1.2	3	400	100	12
Benton	Florence	13	.6	2	300	100	6
Linn	Fairfax	14	1.0	5	200	100	10
Linn	College	15	1.3	6	200	100	13
Linn	Putnam	16	.7	4	200	100	7
Linn	Franklin	17	2.0	4	500	100	20
Johnson	Big Grove	18	.4	2	200	100	4
Johnson	Jefferson	19	.6	3	200	100	6
Johnson	Monroe	20	.4	2	200	100	4
Linn	Cedar Rapids	21	72.3	37	2,000	2,000	37
TOTAL COLUMNS 4 and 5			96.3	109	TOTAL		160 @ 100 8 @1000 37 @2000 === 205 Shelters

SOURCE: 1950 United States Census of Population, U. S. Department of Commerce, Bureau of Census, estimated by D.E.W.

TABLE III.

Counties, townships, resident population (1950) in 2 psi ring, number of shelters and size by geographic area and number of shelters by assumed size for Council Bluffs target area. (Population in thousands)

1	2	3	4	5	6	7	8
COUNTY	TOWNSHIP	ASSN'D. MAP NO.	RES. POP IN 2 PSI RING	NO. SHELT.	SHELT. SIZE	SHELT. SIZE ASSM'D.	NO. SHELT.
Pottawattamie	Rockford	1	.2	1	200	100	2
Pottawattamie	Hazel Dell	2	.4	2	200	100	4
Pottawattamie	Crescent	3	.6	4	150	100	6
Pottawattamie	Lake	4	.8	4	200	100	8
Pottawattamie	Garner	5	1.0	5	200	100	10
Pottawattamie	Lewis	6	2.2	11	200	100	22
Mills	St. Marys	7	.1	1	100	100	1
Mills	Oak	8	.3	2	150	100	3
Pottawattamie	Council Bluffs	9	45.4	23	2,000	2,000	23
	TOTAL COLUMNS 4 and 5		50.1	53		TOTAL	56 @ 100 23 @2000 === 79 Shelt.

SOURCE: 1950 United States Census of Population, Department of Commerce, Bureau of Census, estimated by D.E.W.

TABLE IV.

Counties, townships, resident population (1950) in 2 psi ring, number of shelters and size by geographic area and number of shelters by assumed size for Davenport target area. (Population in thousands)

1	2	3	4	5	6	7	8
COUNTY	TOWNSHIP	ASSN'D. MAP NO.	RES. POP IN 2 PSI RING	NO. SHELT.	SHELT. SIZE	SHELT. SIZE ASSM'D.	NO. SHELT.
Scott	Allens Grove	1	.1	1	100	100	1
Scott	Winfield	2	.3	2	150	100	3
Scott	Butler	3	.4	2	200	100	4
Scott	Princeton	4	.2	1	200	100	2
Scott	Lincoln	5	.6	4	150	100	6
Scott	Sheridan	6	1.2	4	300	100	12
Scott	Hickory	7	.5	4	125	100	5
Scott	Cleona	8	.1	1	100	100	1
Muscatine	Fulton	9	.4	2	200	100	4
Scott	Blue Grass	10	1.5	5	300	100	15
Scott	Davenport	11	2.8	7	400	100	28
Scott	Pleasant Valley	12	3.2	6	600	100	32
Scott	Le Claire	13	2.3	6	400	100	23
Scott	Bettendorf	14	5.1	5	1,000	1,000	5
Scott	Rockingham	15	1.4	5	300	100	14
Scott	Buffalo	16	2.4	6	400	100	24
Muscatine	Montpelier	17	.3	2	150	100	3
Scott	Davenport	18	74.5	38	2,000	2,000	38
	TOTAL COLUMNS 4 and 5 - 97.1			101		TOTAL	177 @ 100 5 @1000 38 @2000 === 220 Shelt.

SOURCE: 1950 United States Census of Population, U. S. Department of Commerce, Bureau of Census, estimated by D.E.W.

TABLE V.

Counties, townships, resident population (1950) in 2 psi ring, number of shelters and size by geographic area and number of shelters by assumed size for Des Moines target area. (Population in thousands)

1	2	3	4	5	6	7	8
COUNTY	TOWNSHIP	ASSN'D. MAP NO.	RES. POP IN 2 PSI RING	NO. SHELT.	SHELT. SIZE	SHELT. SIZE ASSM'D.	NO. SHELT.
Polk	Jefferson	1	.5	2	250	100	5
Polk	Madison	2	.1	1	100	100	1
Polk	Crocker	3	2.3	4	600	100	23
Polk	Douglas	4	.4	2	200	100	4
Polk	Franklin	5	.2	1	200	100	2
Polk	Beaver	6	.7	2	350	100	7
Polk	Clay	7	1.4	7	200	100	14
Polk	Delaware	8	2.9	6	500	100	29
Polk	Saylor	9	4.4	9	500	100	44
Polk	Webster	10	4.0	8	500	100	40
Dallas	Walnut	11	.6	3	200	100	6
Dallas	Boone	12	.3	3	100	100	3
Polk	Walnut	13	3.9	8	500	100	39
Polk	Four Mile	14	1.1	5	200	100	11
Polk	Camp	15	.6	3	200	100	6
Polk	Allen	16	.7	4	200	100	7
Polk	Bloomfield	17	10.2	10	1,000	1,000	10
Madison	Lee	18	.1	1	100	100	1
Warren	Linn	19	.8	4	200	100	8
Warren	Greenfield	20	.9	5	200	100	9
Warren	Allen	21	1.3	6	200	100	13

(Continued)

TABLE V. (Cont'd)

1	2	3	4	5	6	7	8
COUNTY	TOWNSHIP	ASSN'D. MAP NO.	RES. POP IN 2 PSI RING	NO. SHELT.	SHELT. SIZE	SHELT. SIZE ASSM'D.	NO. SHELT.
Warren	Palmyra	22	.2	2	100	100	2
Warren	Richland	23	.1	1	100	100	1
Warren	Lincoln	24	.1	1	100	100	1
Warren	Jefferson	25	.1	1	100	100	1
Polk	Des Moines	26	178.0	89	2,000	2,000	89
TOTAL COLUMNS 4 and 5			215.9	188		TOTAL	307 @ 100 10 @1000 89 @2000 === 406 Shelt.

SOURCE: 1950 United States Census of Population, U. S. Department of Commerce, Bureau of Census, estimated by D.E.W.

TABLE VI.

Counties, townships, resident population (1950) in 2 psi ring, number of shelters and size by geographic area and number of shelters by assumed size for Dubuque target area. (Population in thousands)

1	2	3	4	5	6	7	8
COUNTY	TOWNSHIP	ASSN'D. MAP NO.	RES. POP IN 2 PSI RING	NO. SHELT.	SHELT. SIZE	SHELT. SIZE ASSM'D.	NO. SHELT.
Dubuque	Concord	1	.1	1	100	100	1
Dubuque	Jefferson	2	.8	4	200	100	8
Dubuque	Peru	3	.8	4	200	100	8
Dubuque	Dubuque	4	4.1	4	1,000	1,000	4
Dubuque	Center	5	.8	4	200	100	8
Dubuque	Iowa	6	.1	1	100	100	1
Dubuque	Taylor	7	.3	1	300	100	3
Dubuque	Vernon	8	.8	4	200	100	8
Dubuque	Table Mound	9	1.1	4	300	100	11
Dubuque	Mosalem	10	.6	4	150	100	6
Jackson	Tete Des Morts	11	.1	1	100	100	1
Jackson	Prairie Springs	12	.3	2	150	100	3
Dubuque	Washington	13	.3	2	150	100	3
Dubuque	Prairie Creek	14	.3	1	300	100	3
Dubuque	Dubuque	15	50.5	16	2,000	2,000	16
TOTAL COLUMNS 4 and 5			60.9	53.0		TOTAL	63 @ 100 4 @1000 16 @2000 === 83 Shelt.

SOURCE: 1950 United States Census of Population, U. S. Department of Commerce, Bureau of Census, estimated by D.E.W.

TABLE VII.

Counties, townships, resident population (1950) in 2 psi ring, number of shelters and size by geographic area and number of shelters by assumed size for Sioux City target area. (Population in thousands)

1	2	3	4	5	6	7	8
COUNTY	TOWNSHIP	ASSN'D. MAP NO.	RES. POP IN 2 PSI RING	NO. SHELT.	SHELT. SIZE	SHELT. SIZE ASSM'D.	NO. SHELT.
Plymouth	Sioux	1	.2	1	200	100	2
Plymouth	Liberty	2	.1	1	100	100	1
Plymouth	Hungerford	3	.2	2	100	100	2
Plymouth	Perry	4	.6	4	150	100	6
Plymouth	Hancock	5	.2	2	100	100	2
Woodbury	Concord	6	.6	4	150	100	6
Woodbury	Floyd	7	.1	1	100	100	1
Woodbury	Woodbury	8	1.9	5	400	100	19
Woodbury	Liberty	9	.3	3	100	100	3
Woodbury	Sioux City	10	83.9	42	2,000	2,000	42
TOTAL COLUMNS 4 and 5			88.1	65		TOTAL	42 @ 100 42 @2000
						===	84 Shelt.

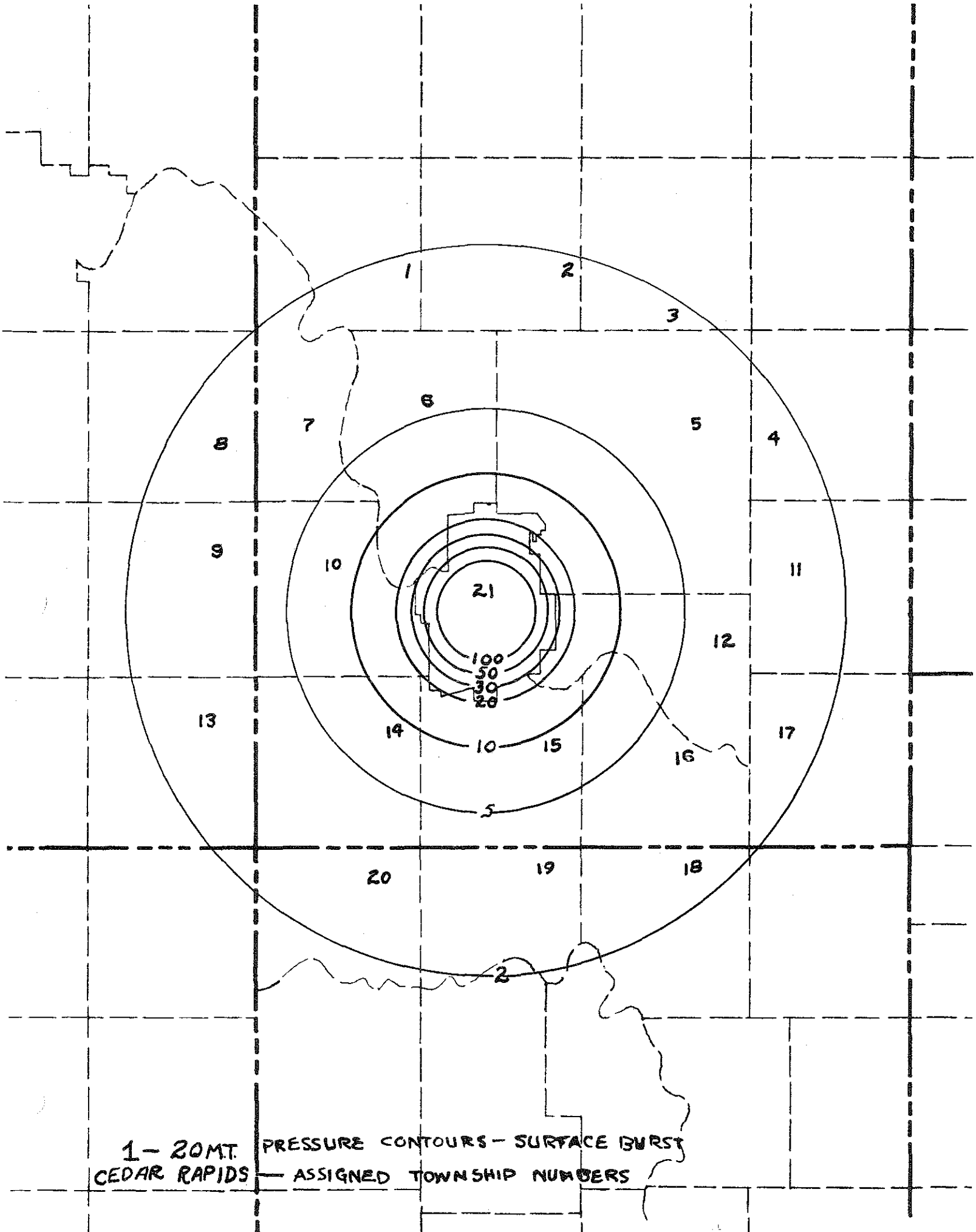
SOURCE: 1950 United States Census of Population, U. S. Department of Commerce, Bureau of Census, estimated by D.E.W.

TABLE VIII.

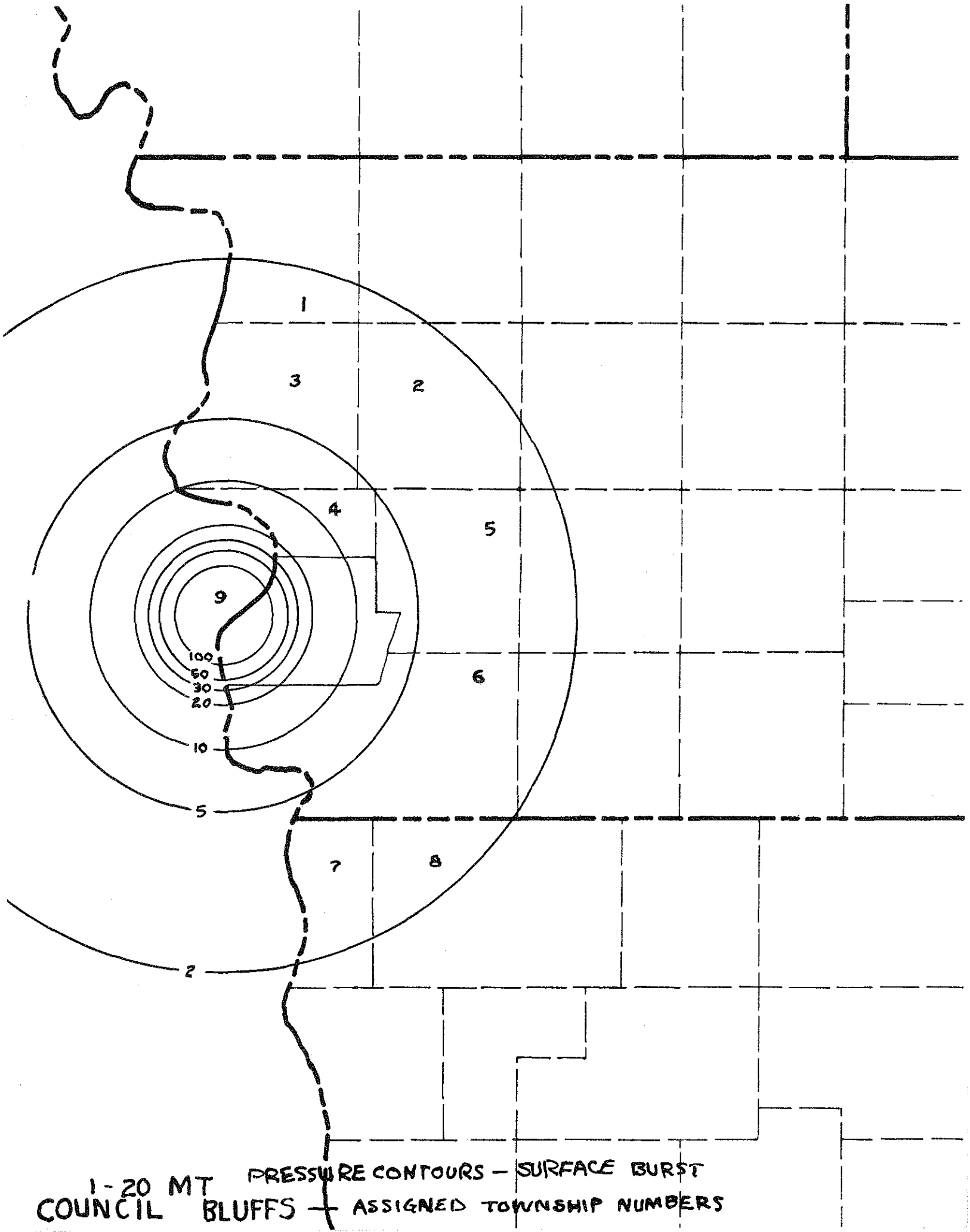
Counties, townships, resident population (1950) in 2 psi ring, number of shelters and size by geographic area and number of shelters by assumed size for Waterloo target area. (Population in thousands)

1	2	3	4	5	6	7	8
COUNTY	TOWNSHIP	ASSN'D. MAP NO.	RES. POP IN 2 PSI RING	NO. SHELT.	SHELT. SIZE	SHELT. SIZE ASSM'D.	NO. SHELT.
Bremer	Jackson	1	.4	2	200	100	4
Bremer	Jefferson	2	.5	2	250	100	5
Bremer	Maxfield	3	.5	2	250	100	5
Blackhawk	Lester	4	.3	2	150	100	3
Blackhawk	Bennington	5	.6	4	150	100	6
Blackhawk	Mt. Vernon	6	1.1	5	200	100	11
Blackhawk	Washington	7	1.0	5	200	100	10
Blackhawk	Union	8	.4	4	100	100	4
Butler	Beaver	9	.4	2	200	100	4
Grundy	Fairfield	10	.3	3	100	100	3
Blackhawk	Cedar Falls	11	15.8	10	150	1,000	16
Blackhawk	East Waterloo	12	2.0	4	500	100	20
Blackhawk	Poyner	13	1.4	7	200	100	14
Blackhawk	Barclay	14	.3	3	100	100	3
Blackhawk	Fox	15	.2	2	100	100	2
Blackhawk	Cedar	16	.9	3	300	100	9
Blackhawk	Orange	17	1.1	4	300	100	11
Blackhawk	Blackhawk	18	1.2	4	300	100	12
Grundy	Grant	19	.4	2	200	100	4
Blackhawk	Lincoln	20	.3	2	150	100	3
Blackhawk	Eagle	21	.4	4	100	100	4
Blackhawk	Waterloo	22	65.1	33	2,000	2,000	33
TOTAL COLUMNS 4 and 5			94.6	109		TOTAL	137 @ 100 16 @1000 33 @2000 === 186 Shelt.

SOURCE: 1950 United States Census of Population, U. S. Department of Commerce, Bureau of Census, estimated by D.E.W.

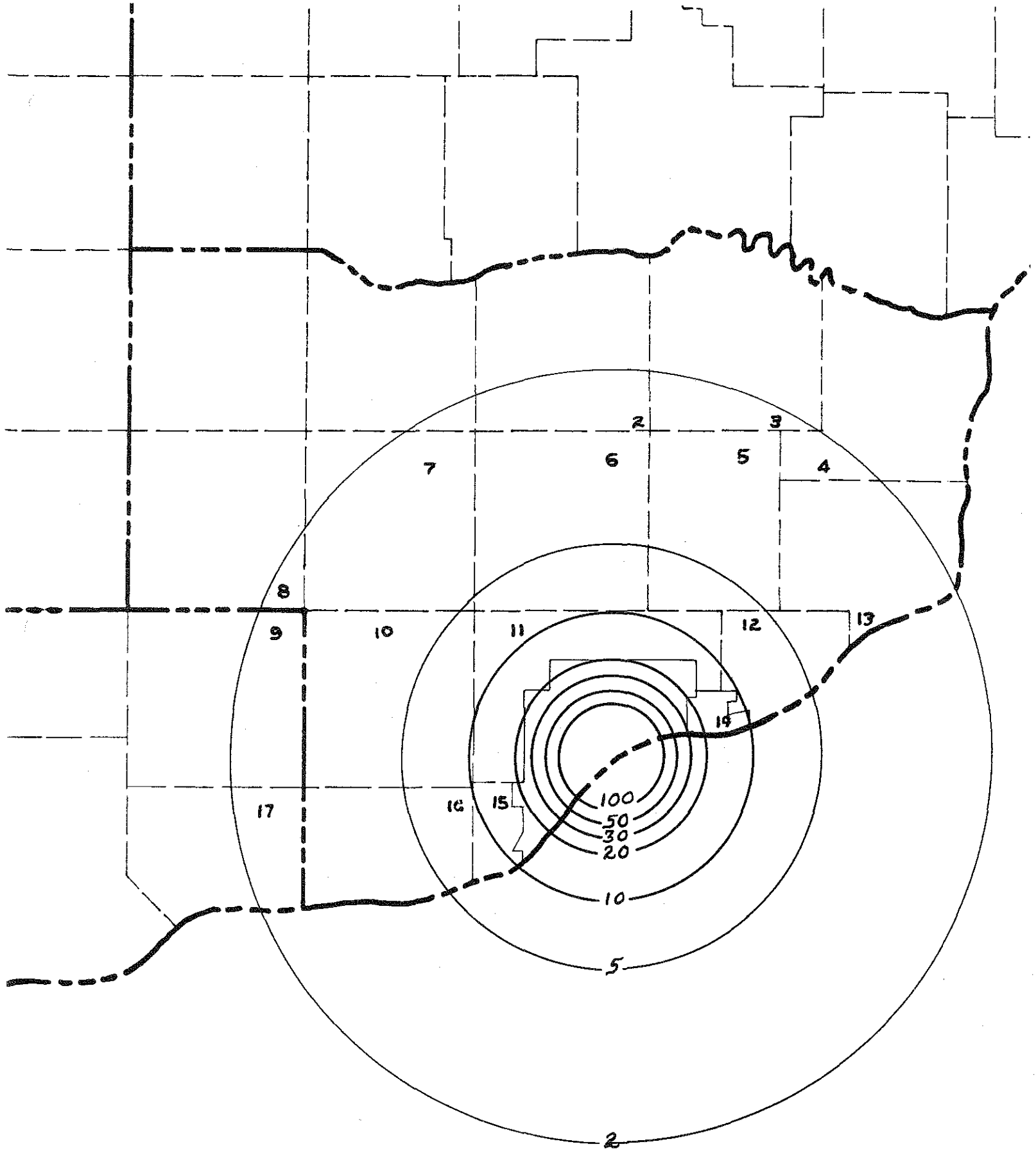


1 – 20 M.T. PRESSURE CONTOURS – SURFACE BURST
CEDAR RAPIDS — ASSIGNED TOWNSHIP NUMBERS

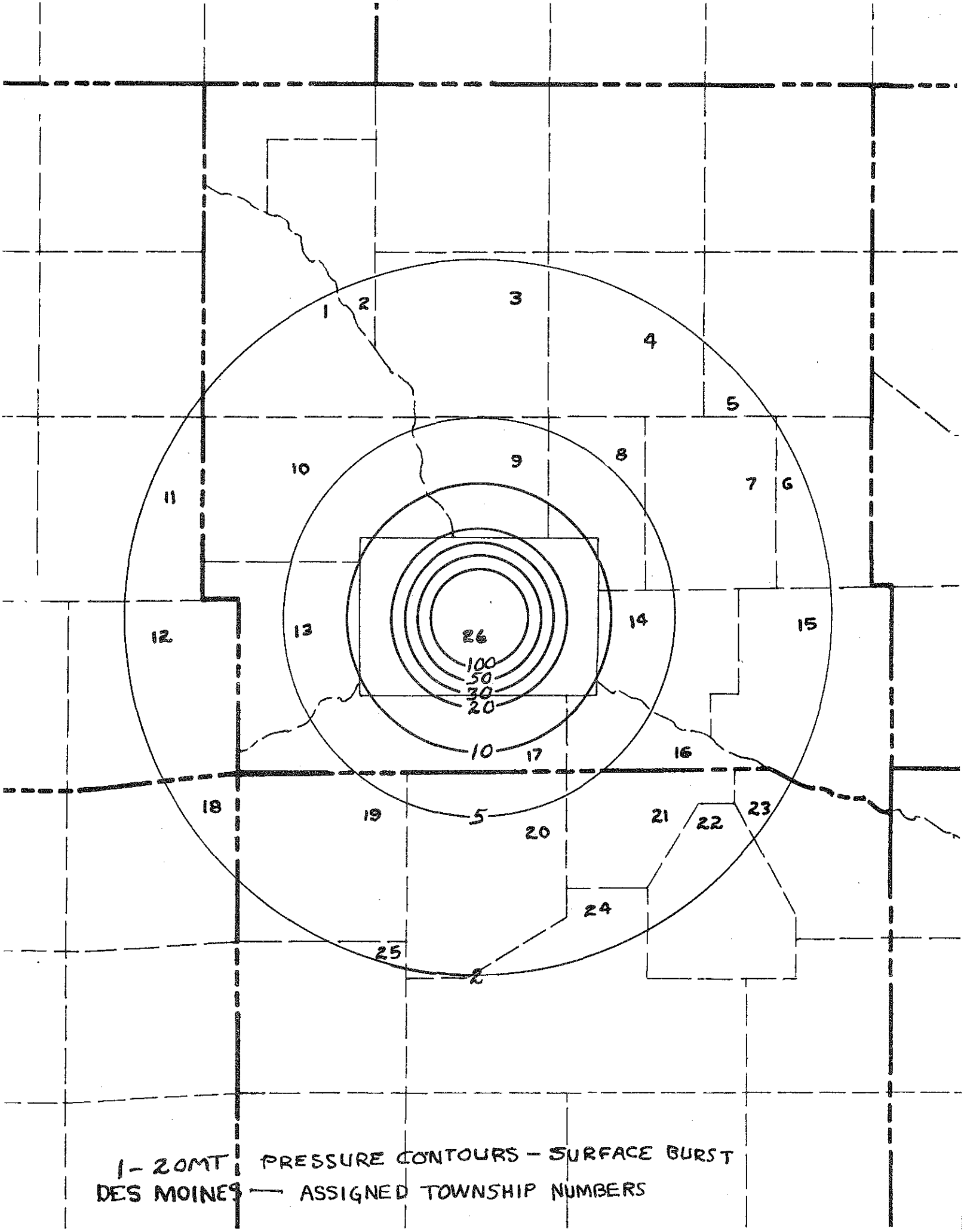


1-20 MT PRESSURE CONTOURS — SURFACE BURST

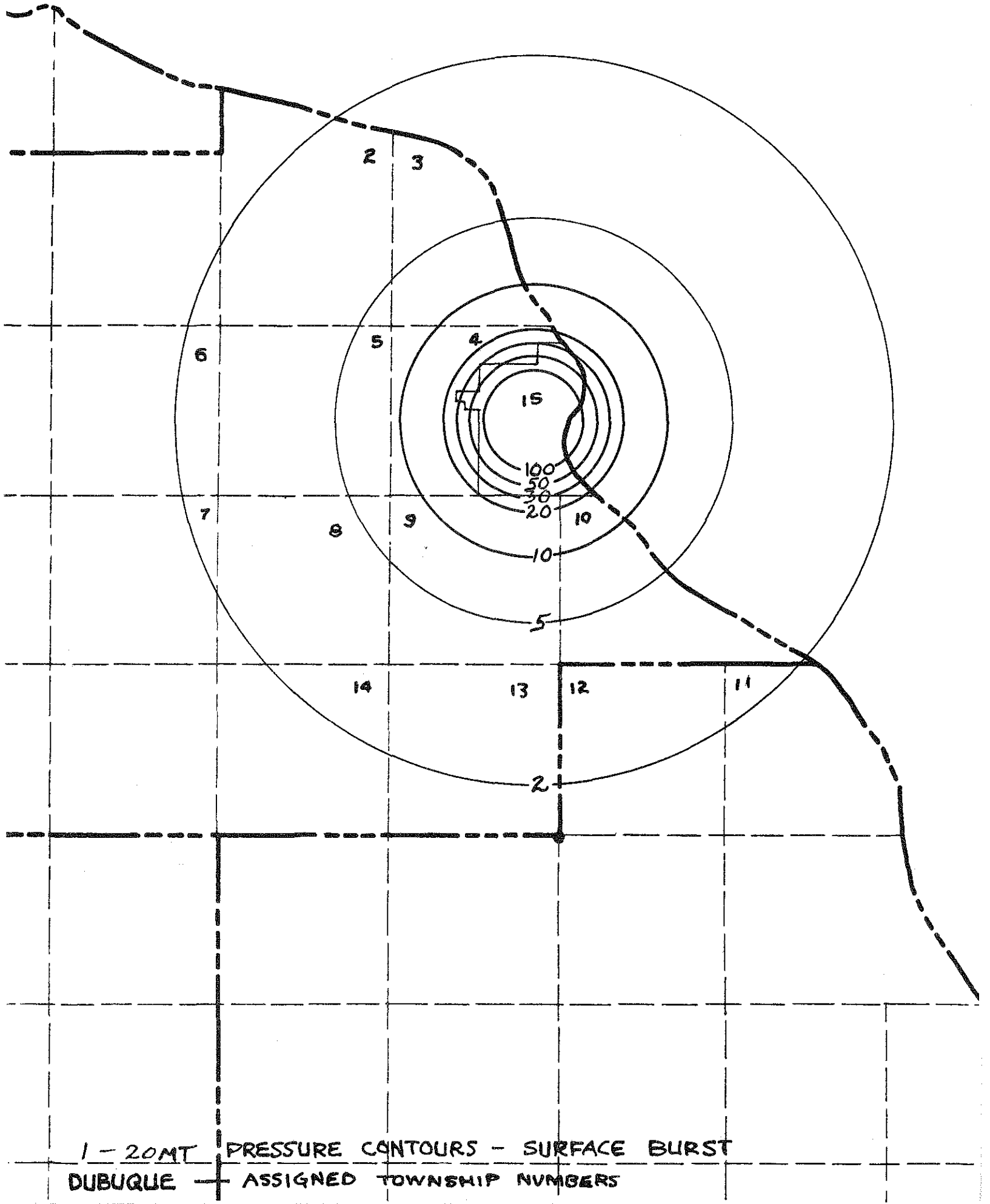
COUNCIL BLUFFS — ASSIGNED TOWNSHIP NUMBERS



1-20MT PRESSURE CONTOURS - SURFACE BURST
DAVENPORT — ASSIGNED TOWNSHIP NUMBERS

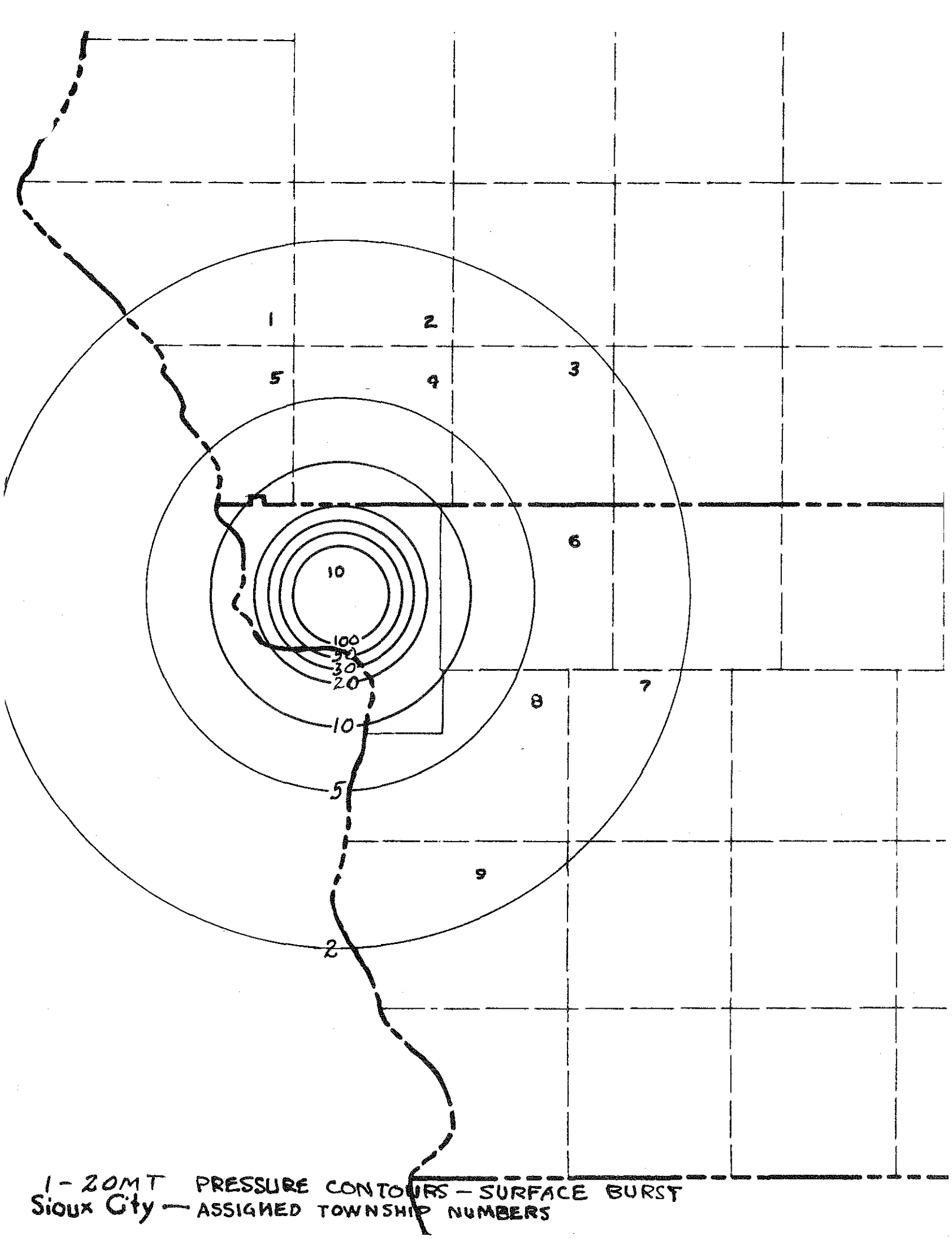


1-20MT PRESSURE CONTOURS - SURFACE BURST
DES MOINES — ASSIGNED TOWNSHIP NUMBERS

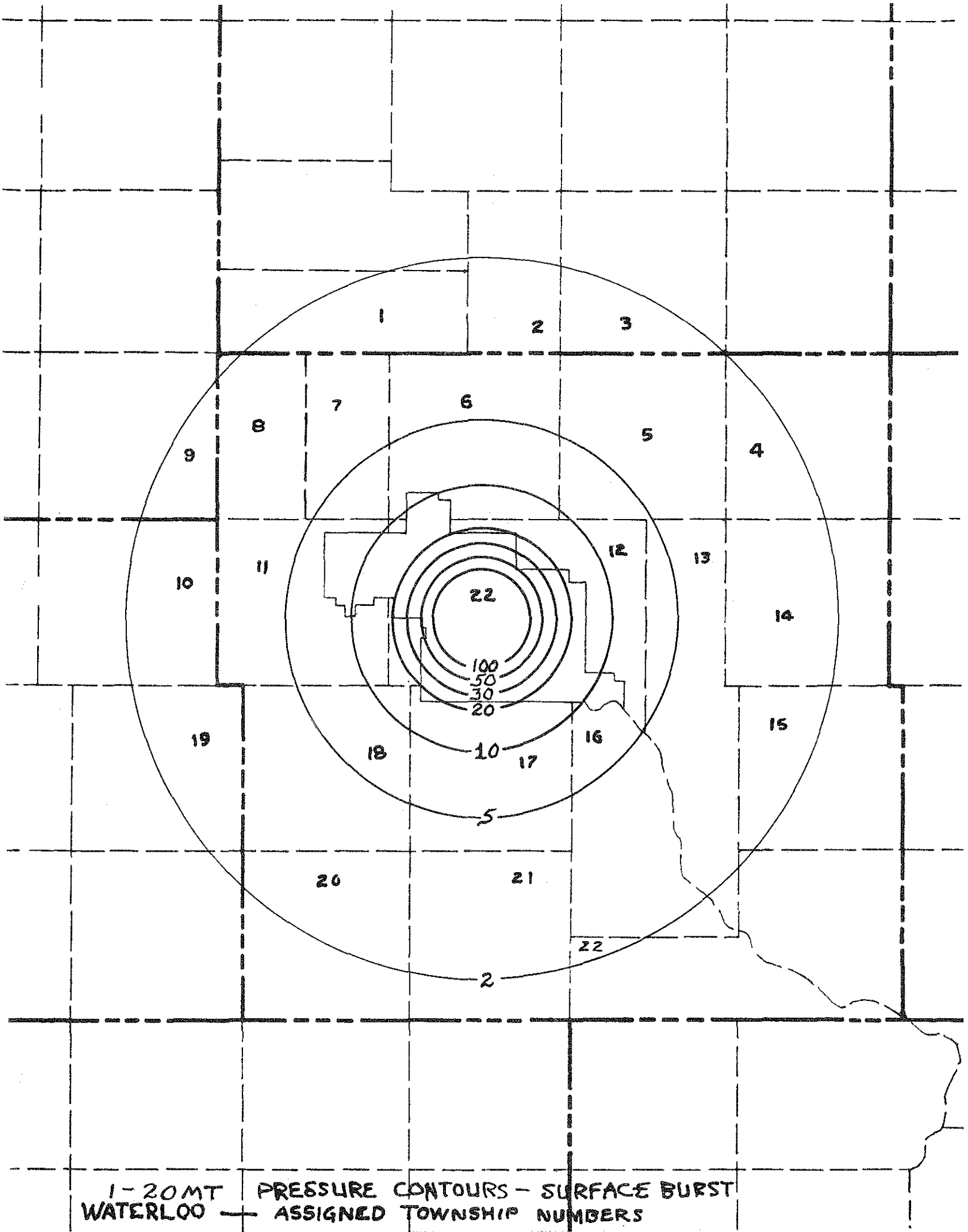


1 – 20MT PRESSURE CONTOURS – SURFACE BURST

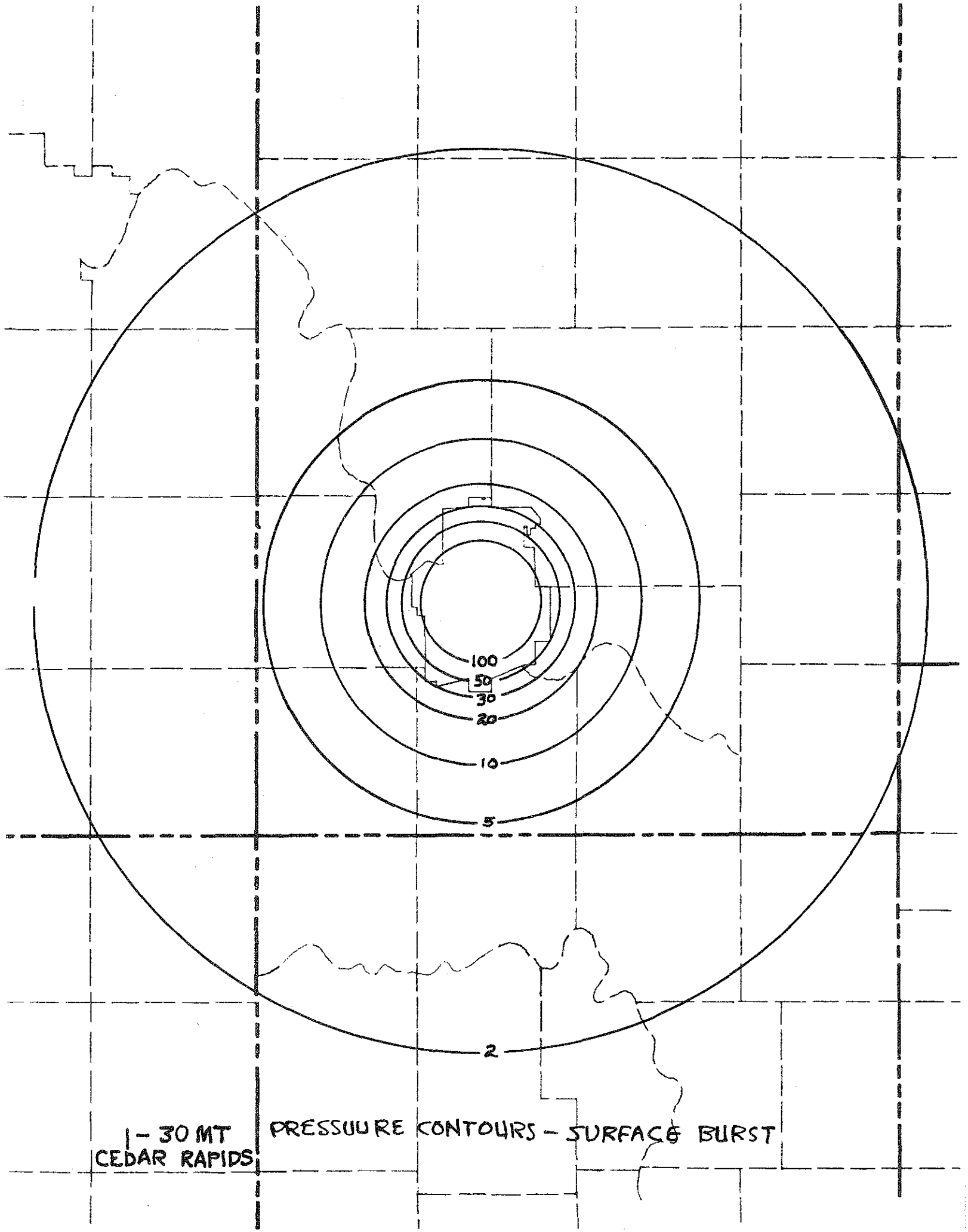
DUBUQUE – ASSIGNED TOWNSHIP NUMBERS



1 - 20MT PRESSURE CONTOURS — SURFACE BURST
Sioux City — ASSIGNED TOWNSHIP NUMBERS

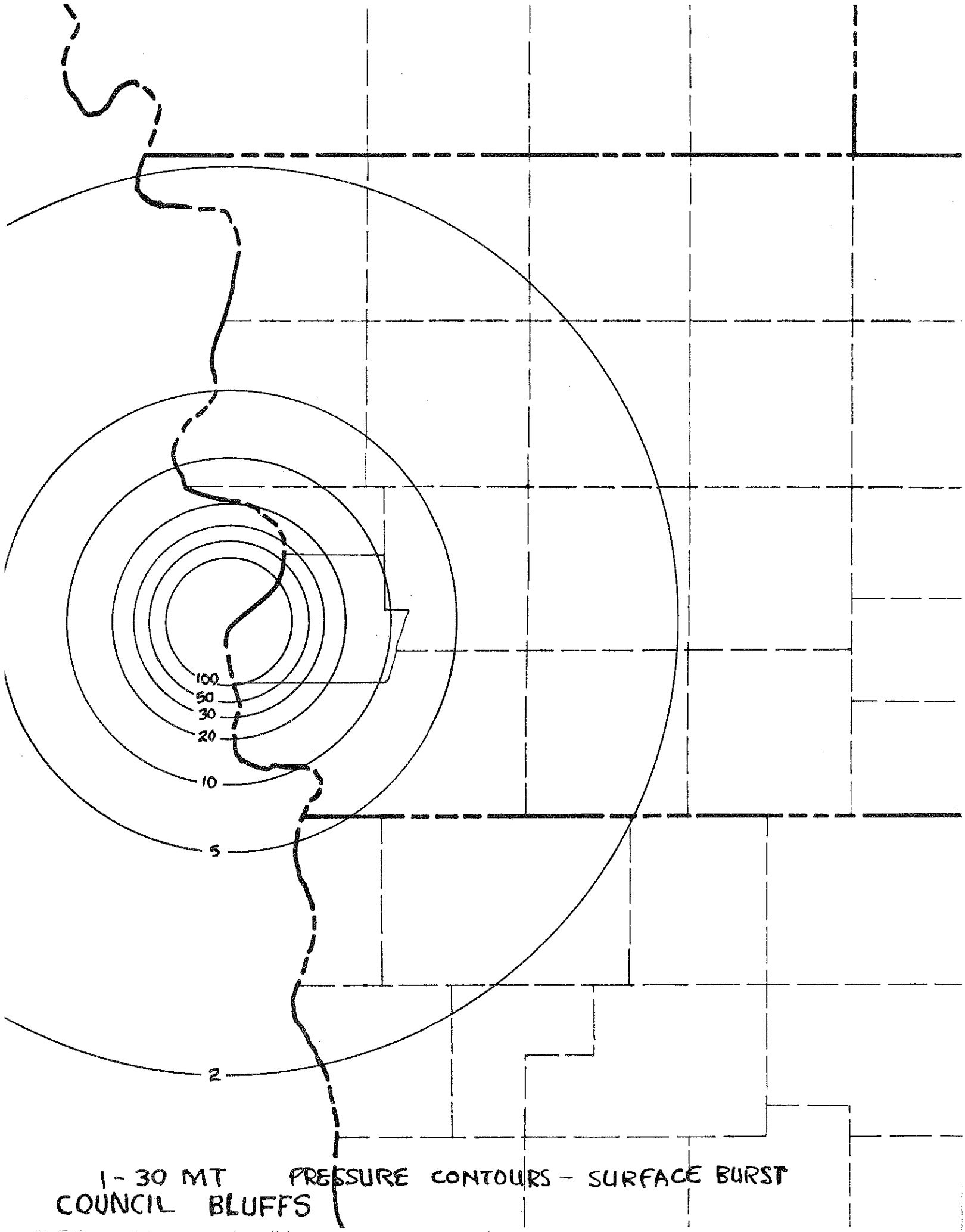


1-20MT PRESSURE CONTOURS - SURFACE BURST
WATERLOO — ASSIGNED TOWNSHIP NUMBERS

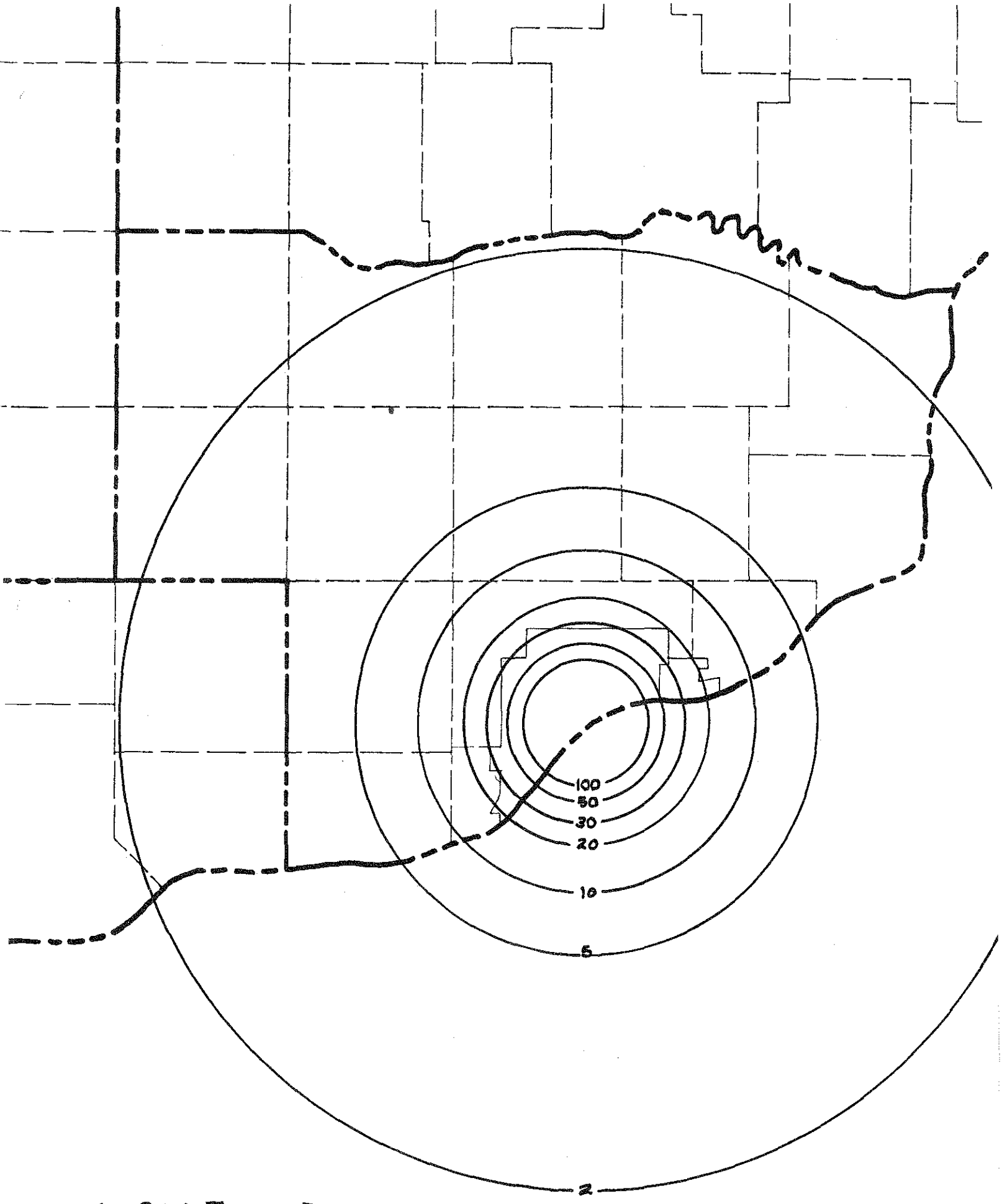


1 - 30 MT
CEDAR RAPIDS

PRESSUURE CONTOURS - SURFACE BURST

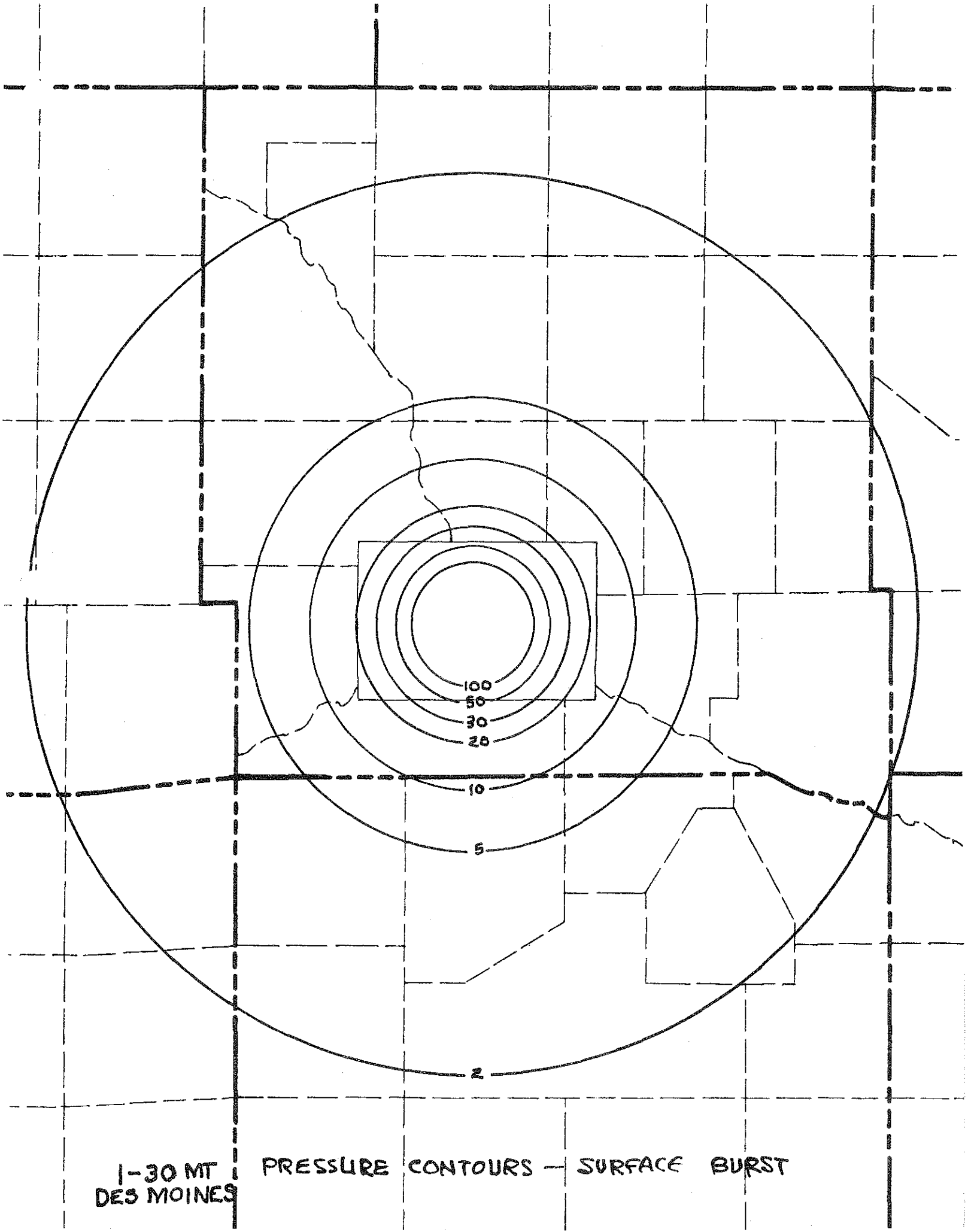


1 - 30 MT PRESSURE CONTOURS - SURFACE BURST
COUNCIL BLUFFS



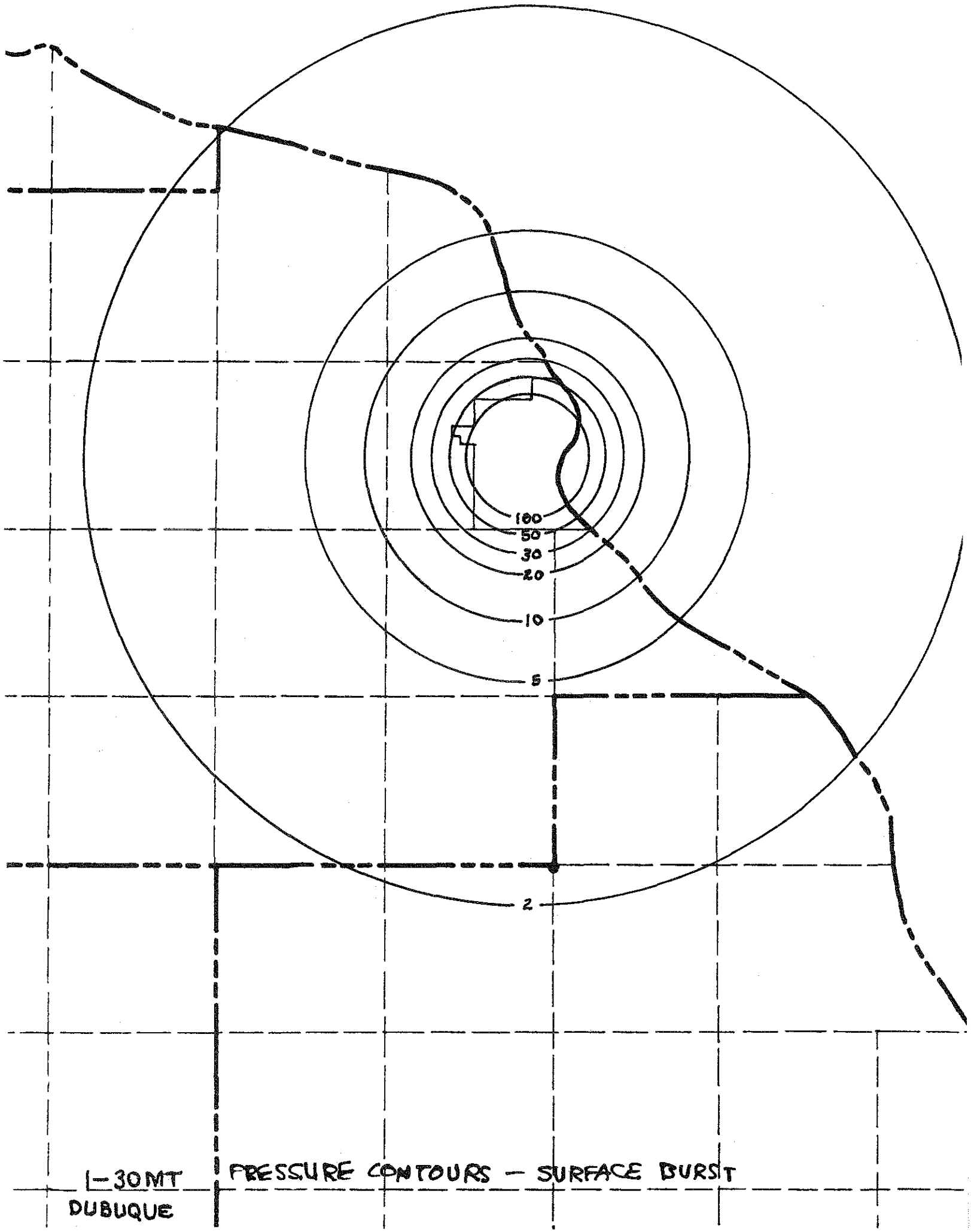
1-30 MT
DAVENPORT

PRESSURE CONTOURS — SURFACE BURST



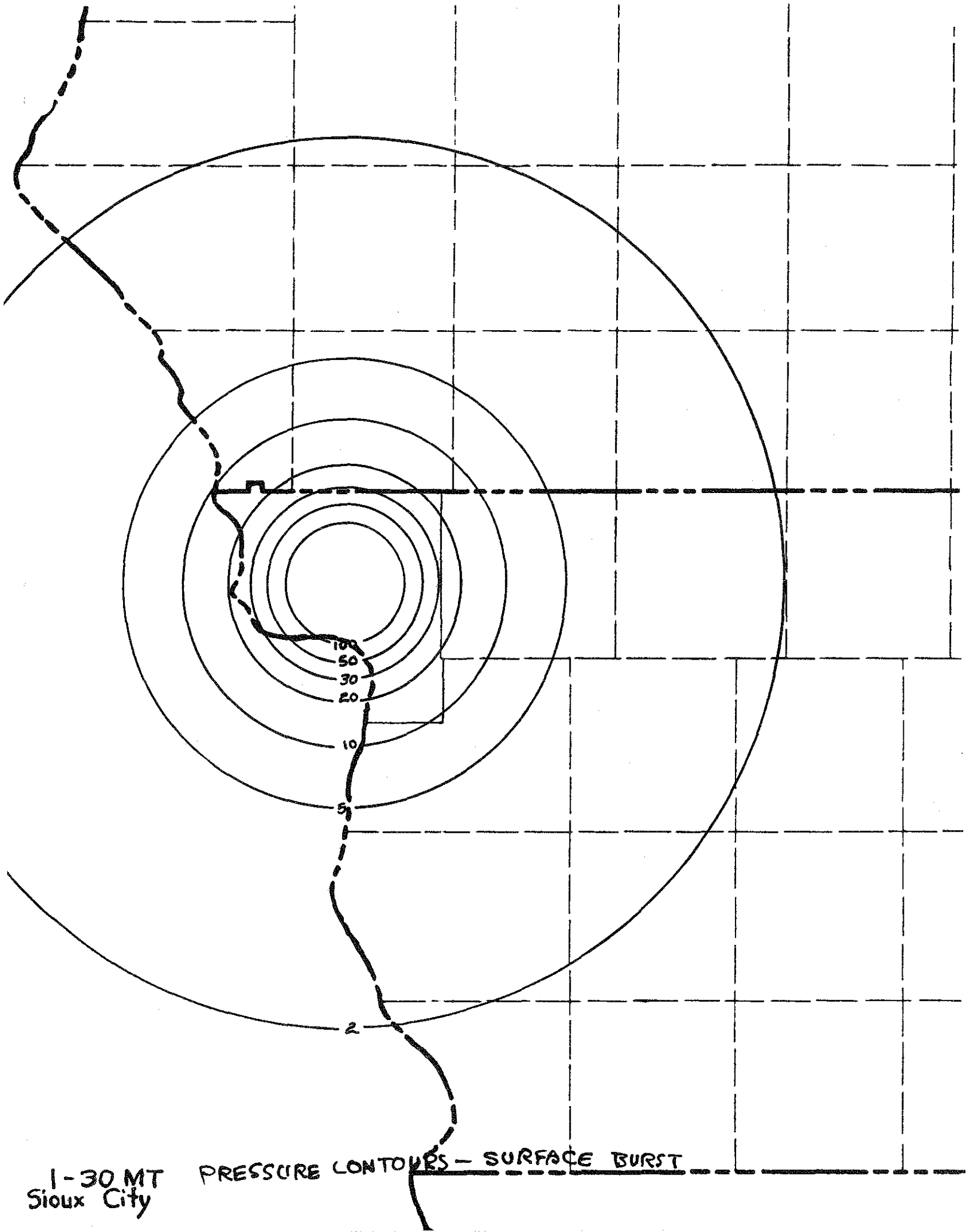
1-30 MT
DES MOINES

PRESSURE CONTOURS — SURFACE BURST



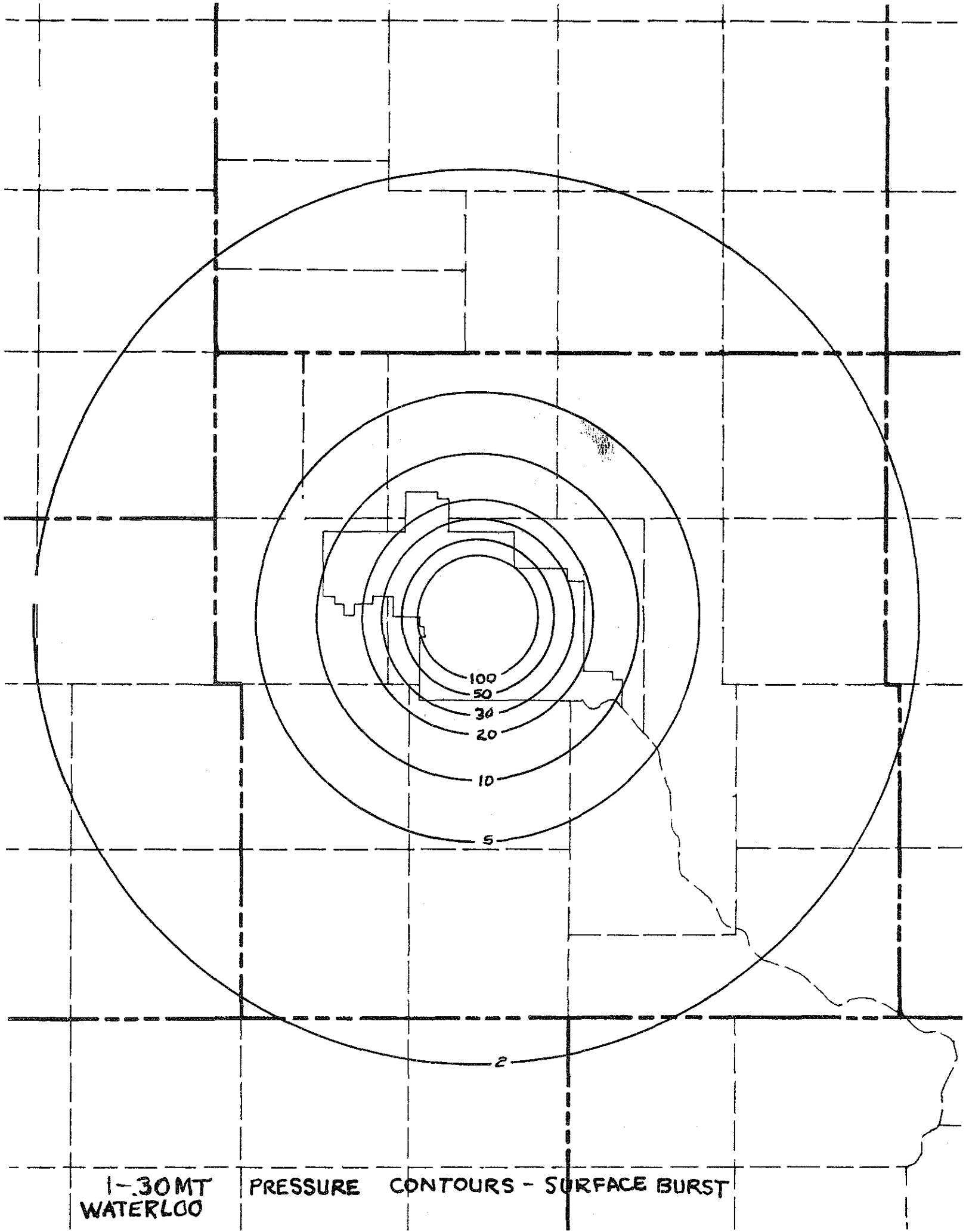
1-30 MT
DUBUQUE

PRESSURE CONTOURS — SURFACE BURST



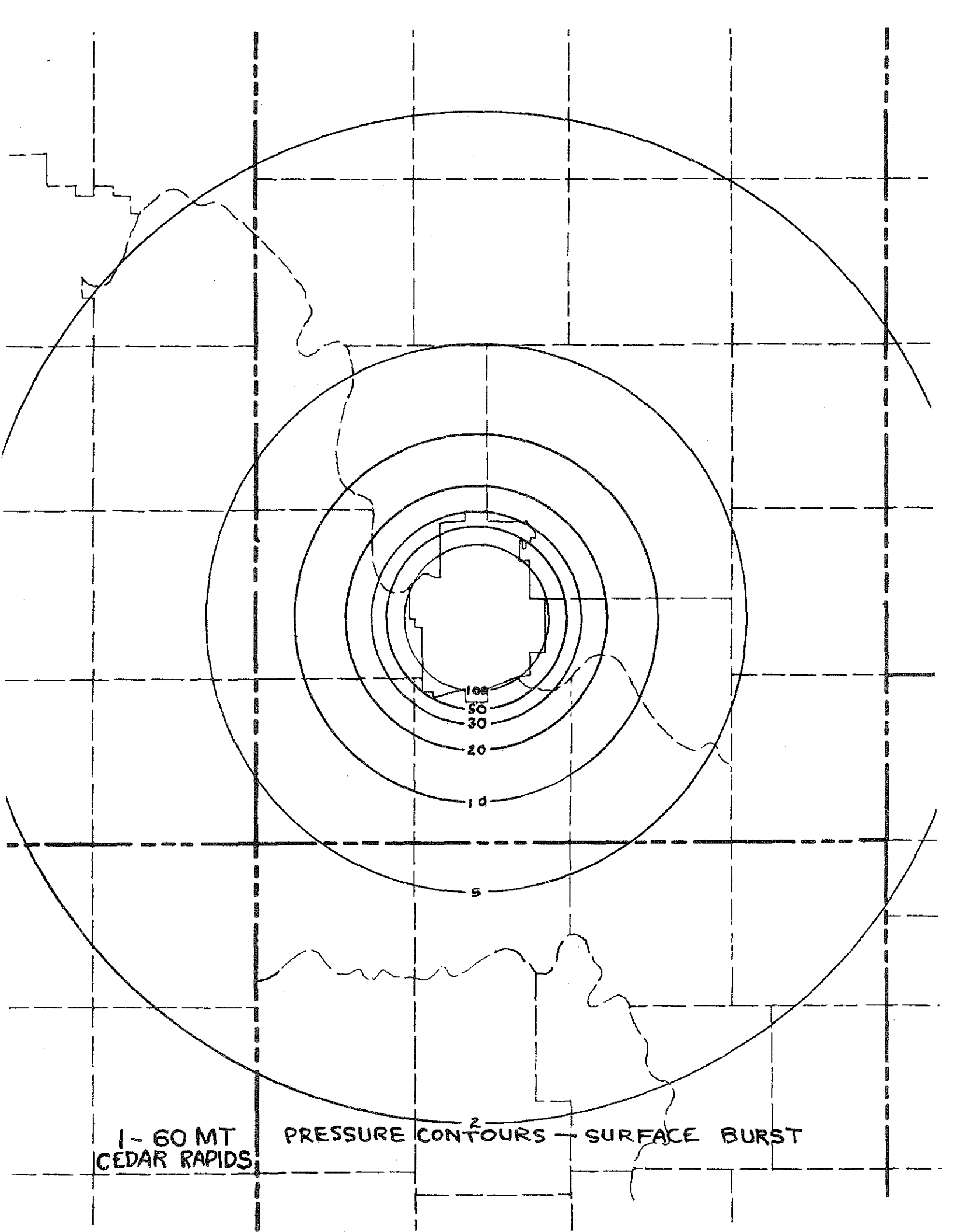
1-30 MT
Sioux City

PRESSURE CONTOURS — SURFACE BURST



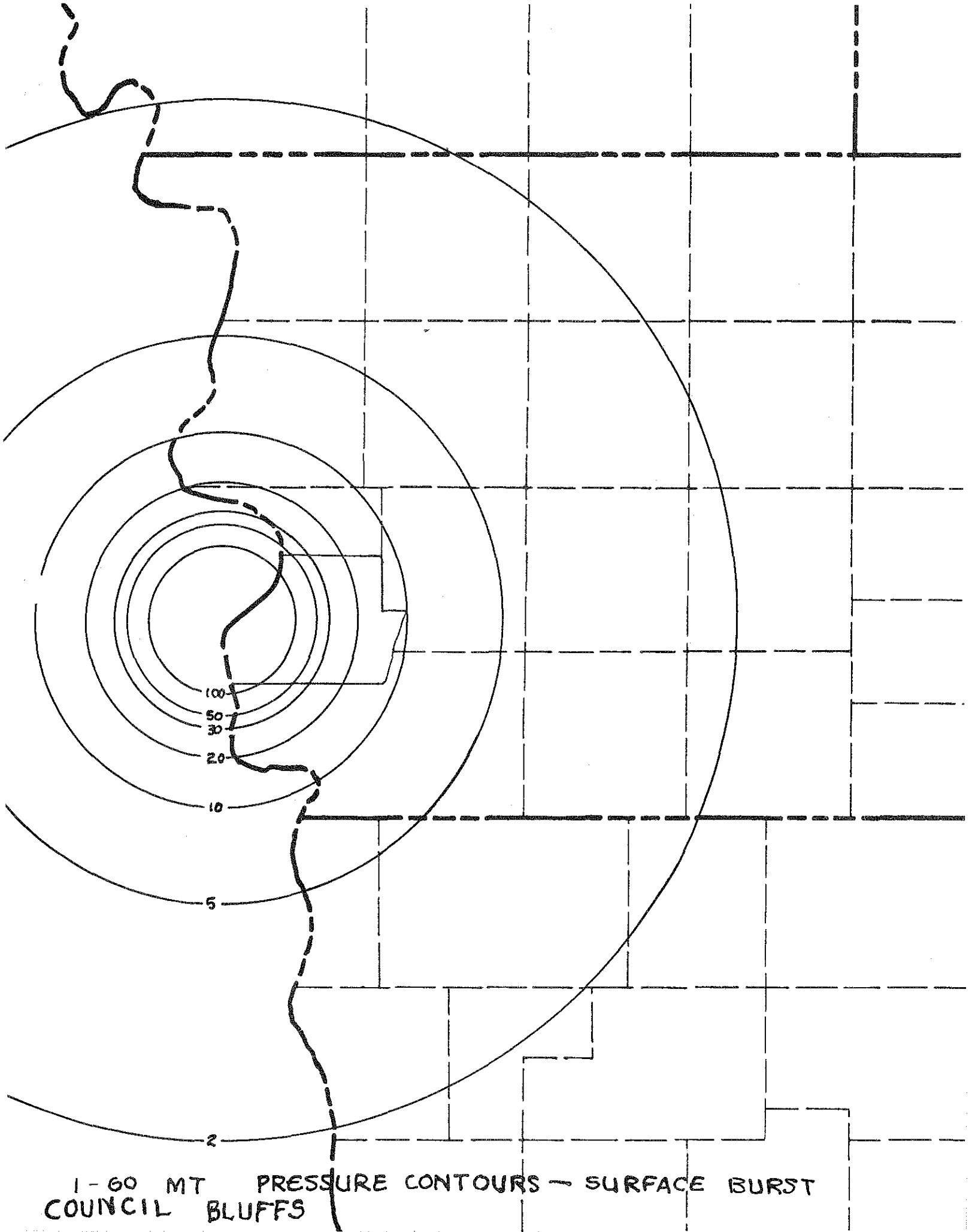
1-30 MT
WATERLOO

PRESSURE CONTOURS - SURFACE BURST

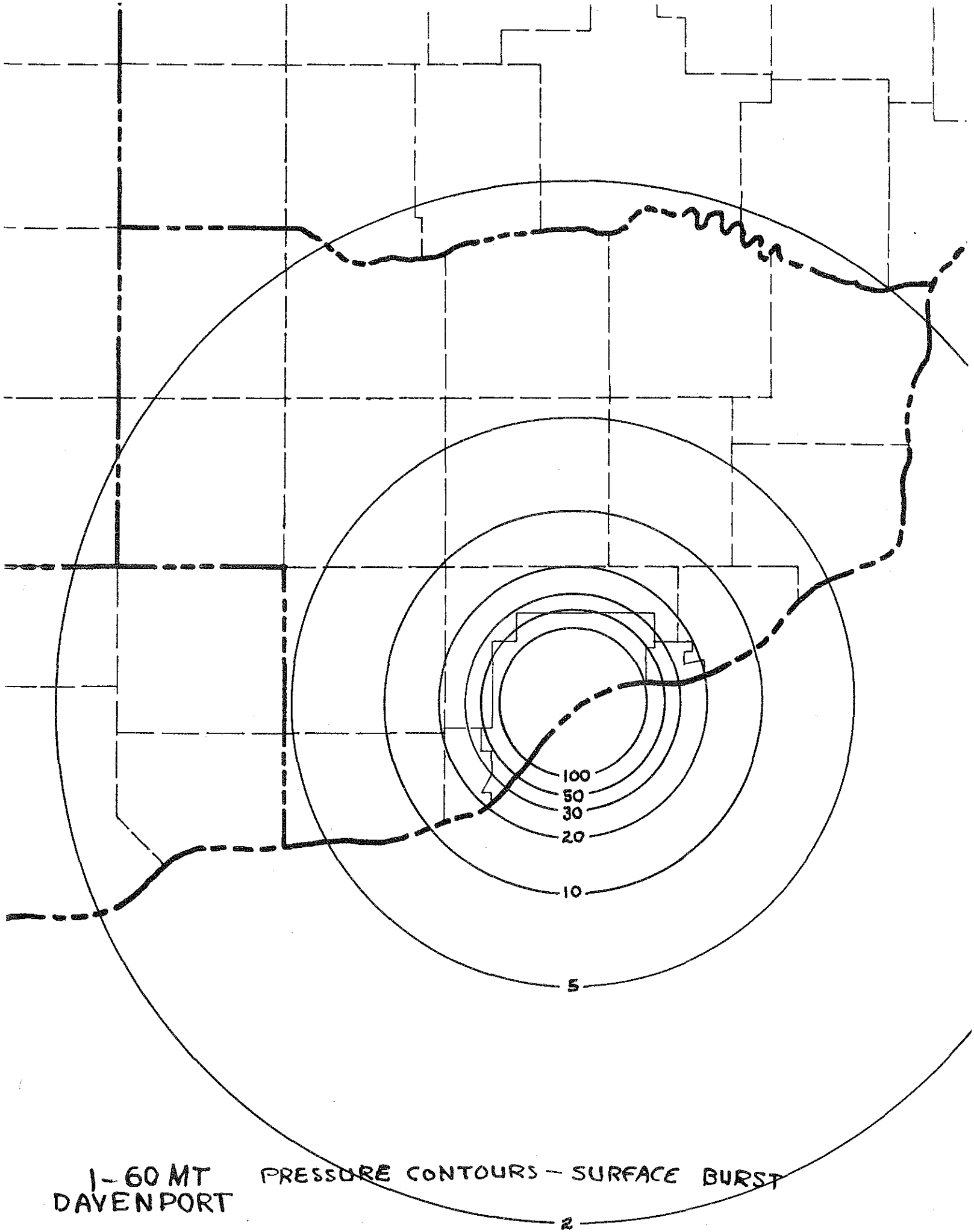


1 - 60 MT
CEDAR RAPIDS

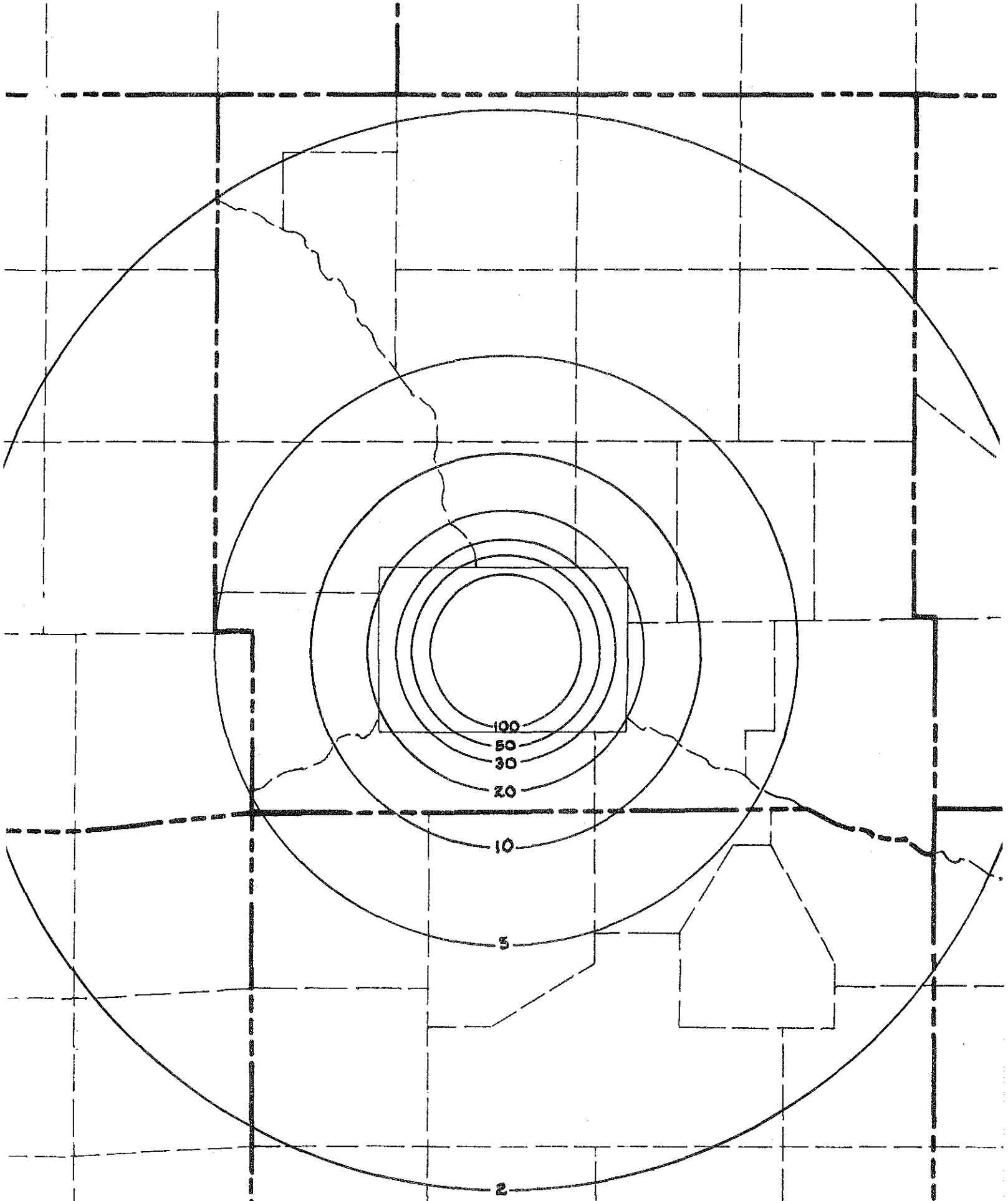
PRESSURE CONTOURS — SURFACE BURST



1-60 MT PRESSURE CONTOURS — SURFACE BURST
COUNCIL BLUFFS

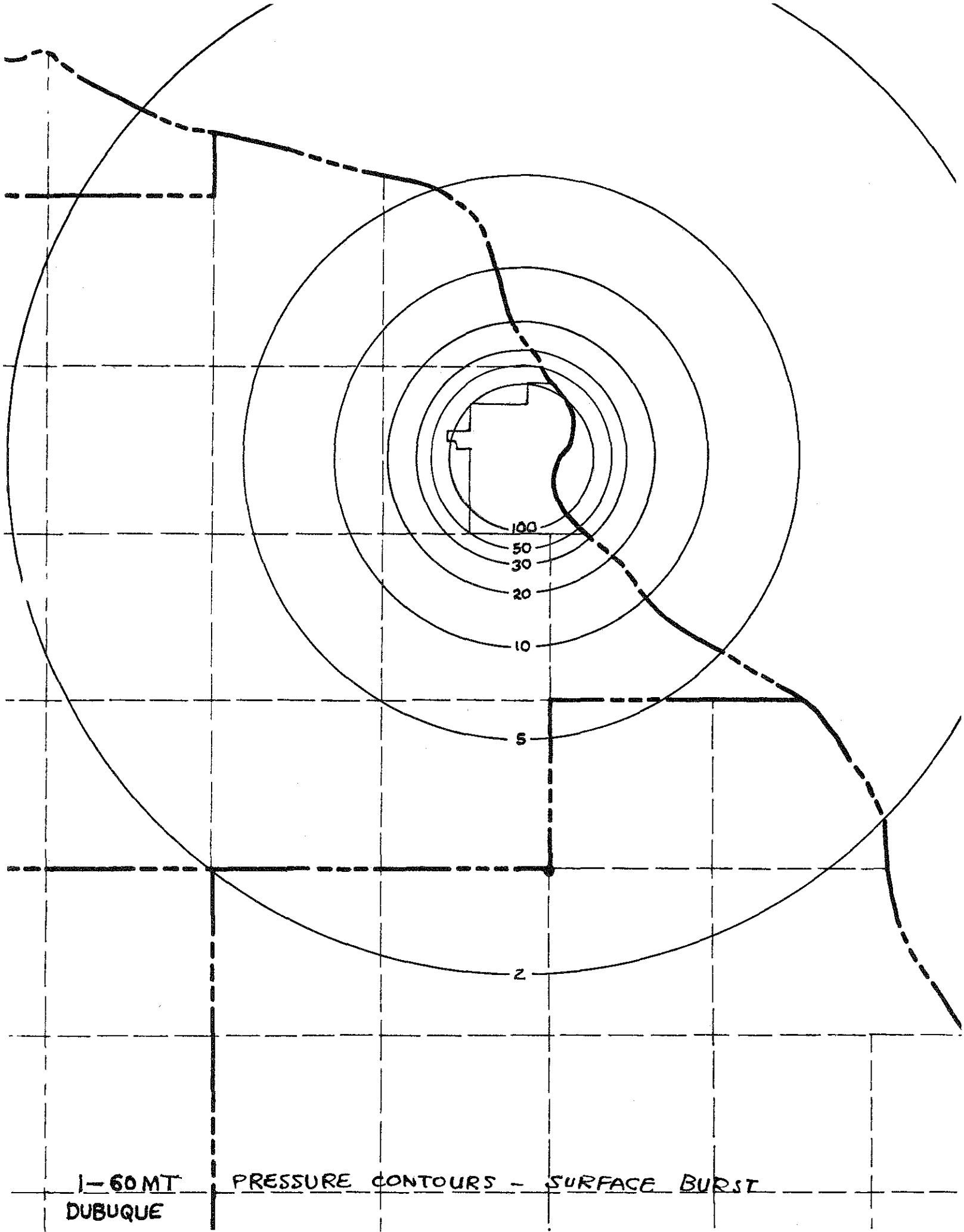


1-60 MT PRESSURE CONTOURS – SURFACE BURST
DAVENPORT

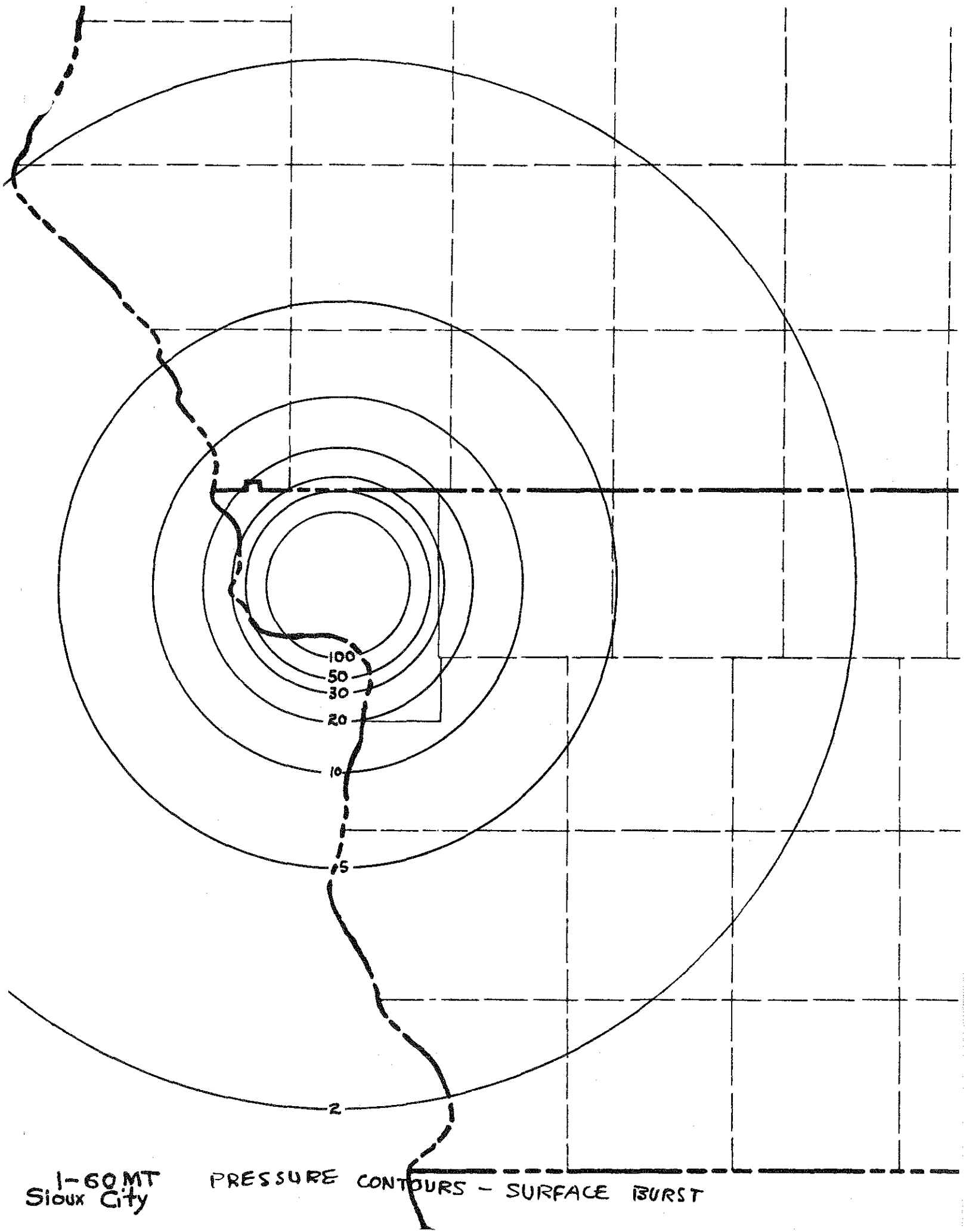


1-60MT
DES MOINES

PRESSURE CONTOURS - SURFACE BURST

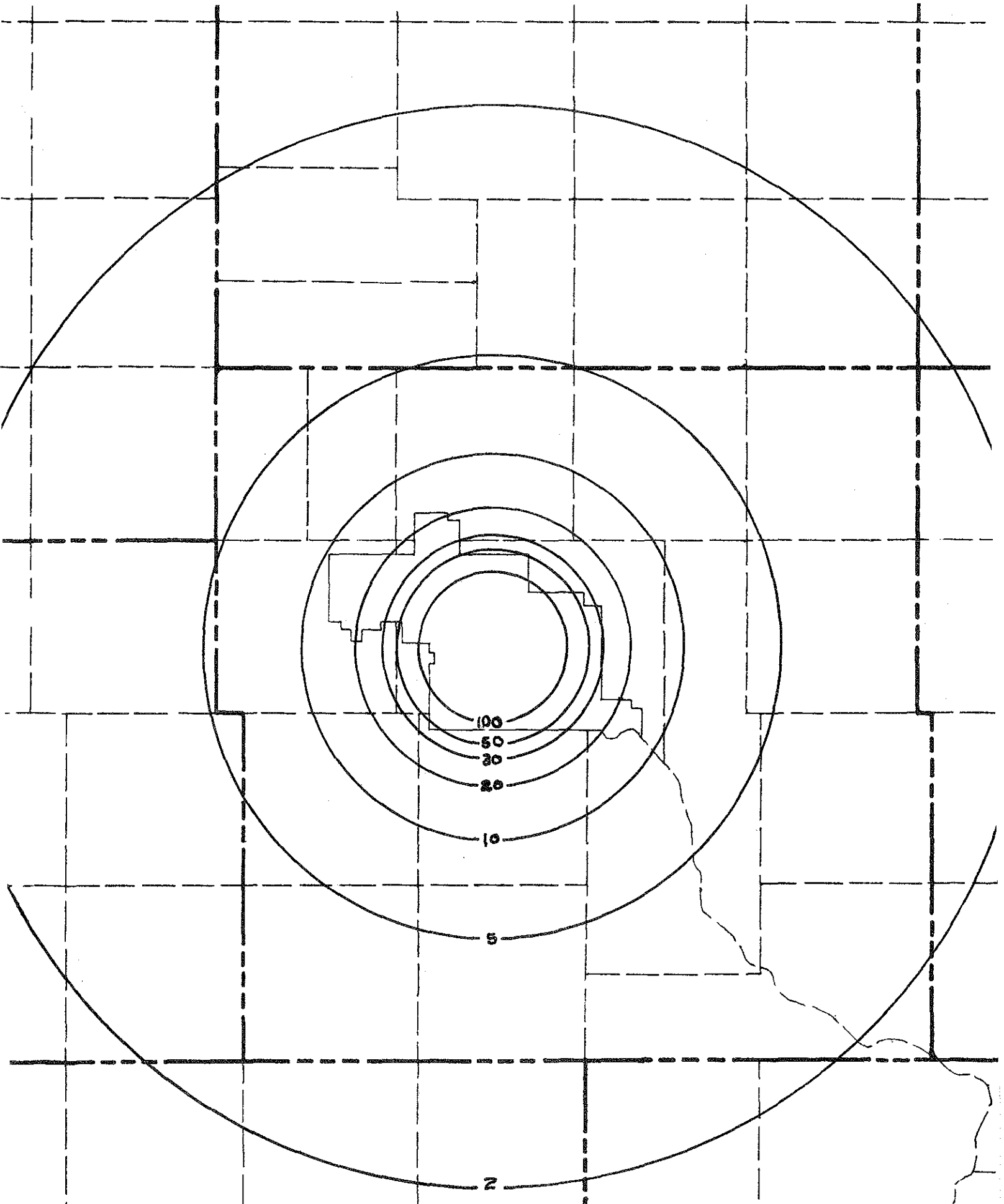


1-60 MT PRESSURE CONTOURS - SURFACE BURST
DUBUQUE



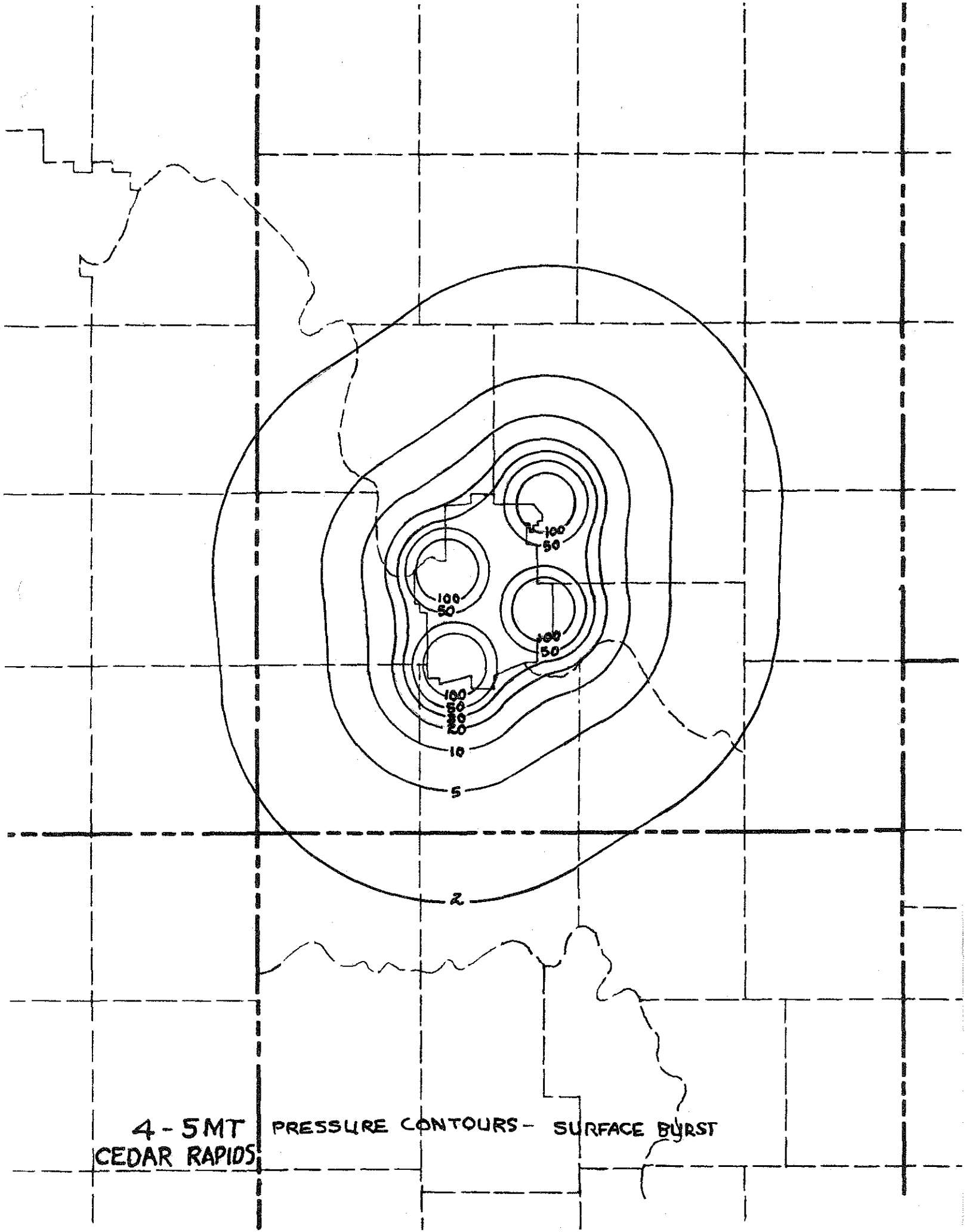
1-60 MT
Sioux City

PRESSURE CONTOURS - SURFACE BURST

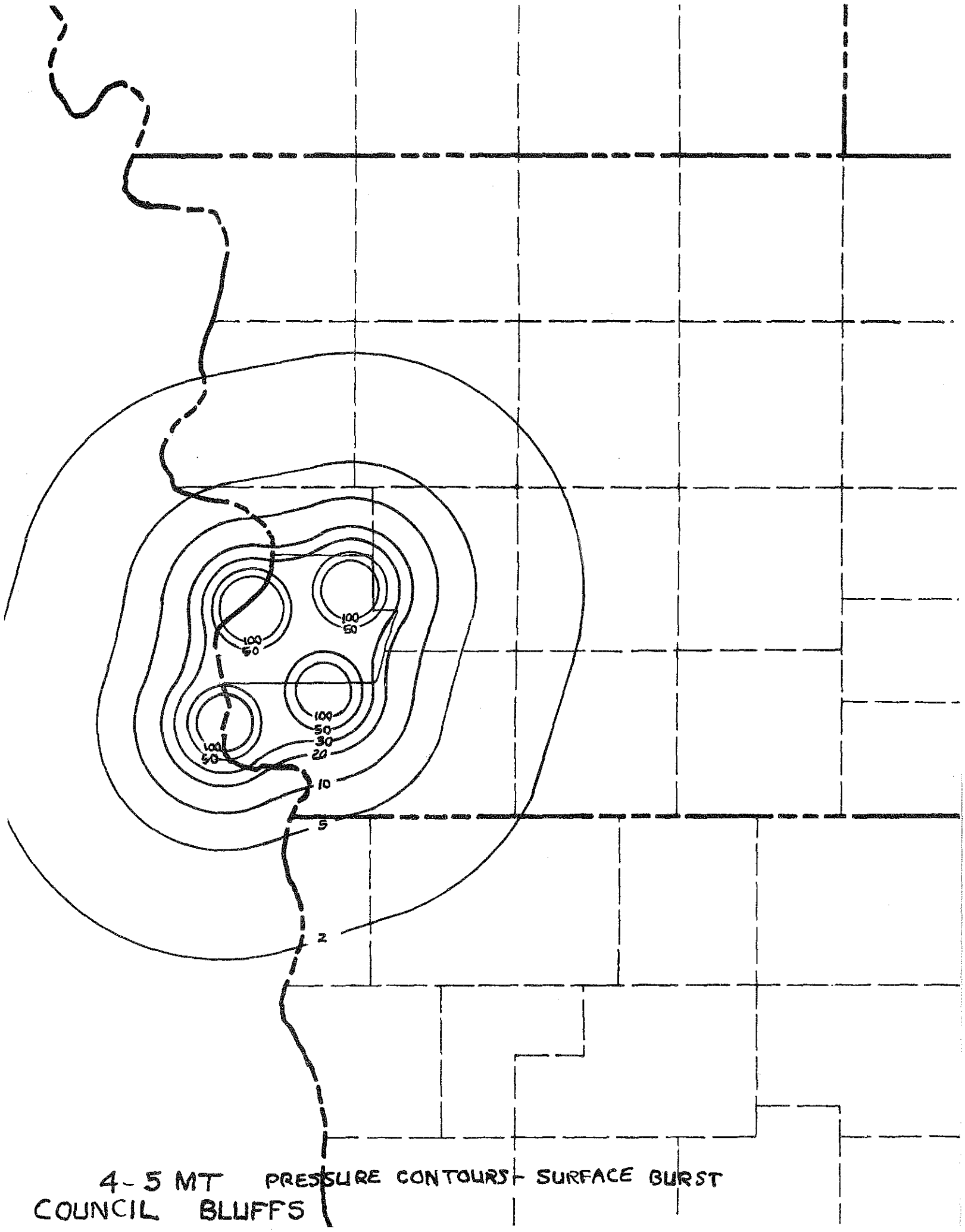


1-60MT
WATERLOO

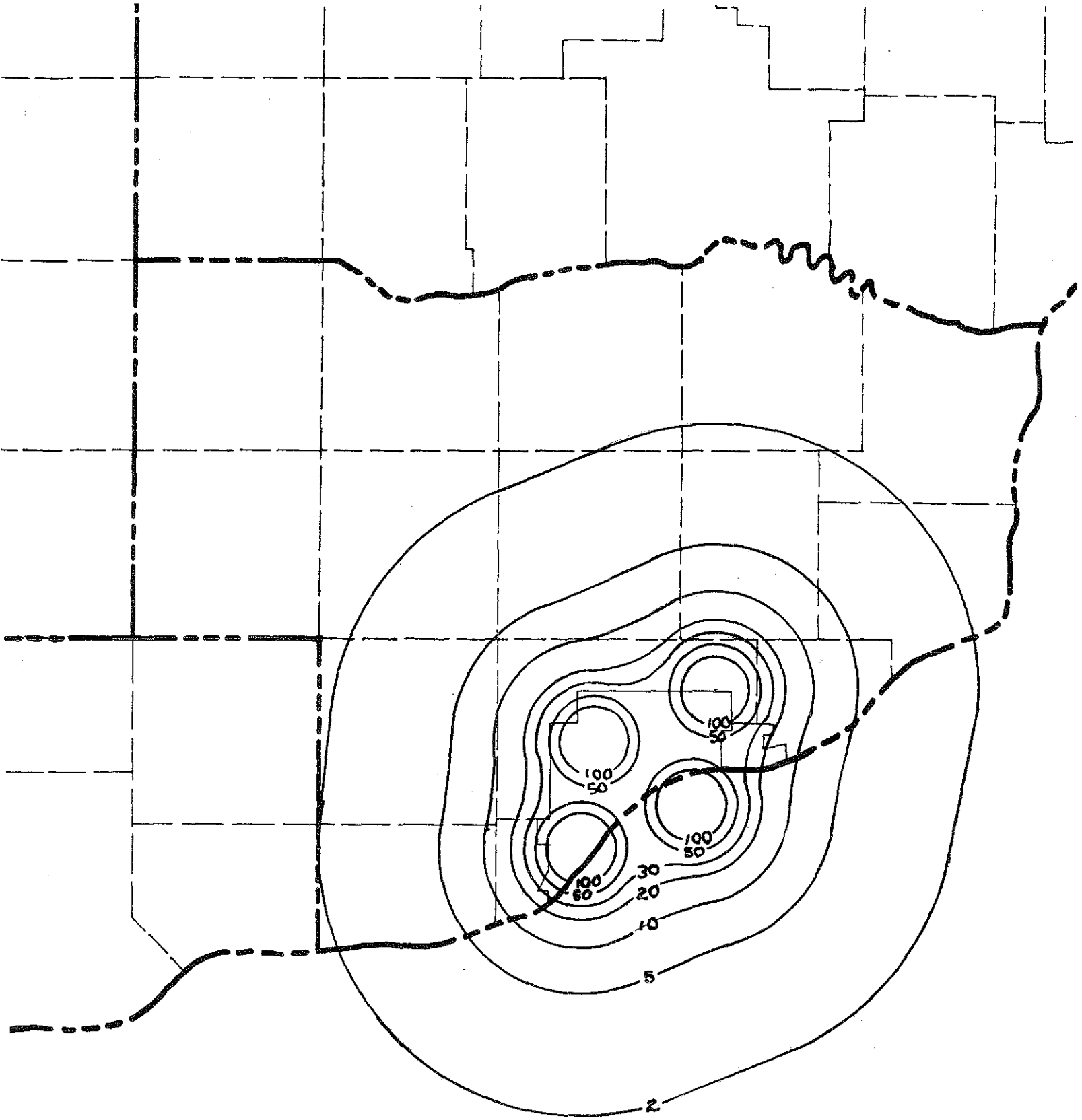
PRESSURE CONTOURS — SURFACE BURST



4 - 5MT PRESSURE CONTOURS - SURFACE BURST
CEDAR RAPIDS

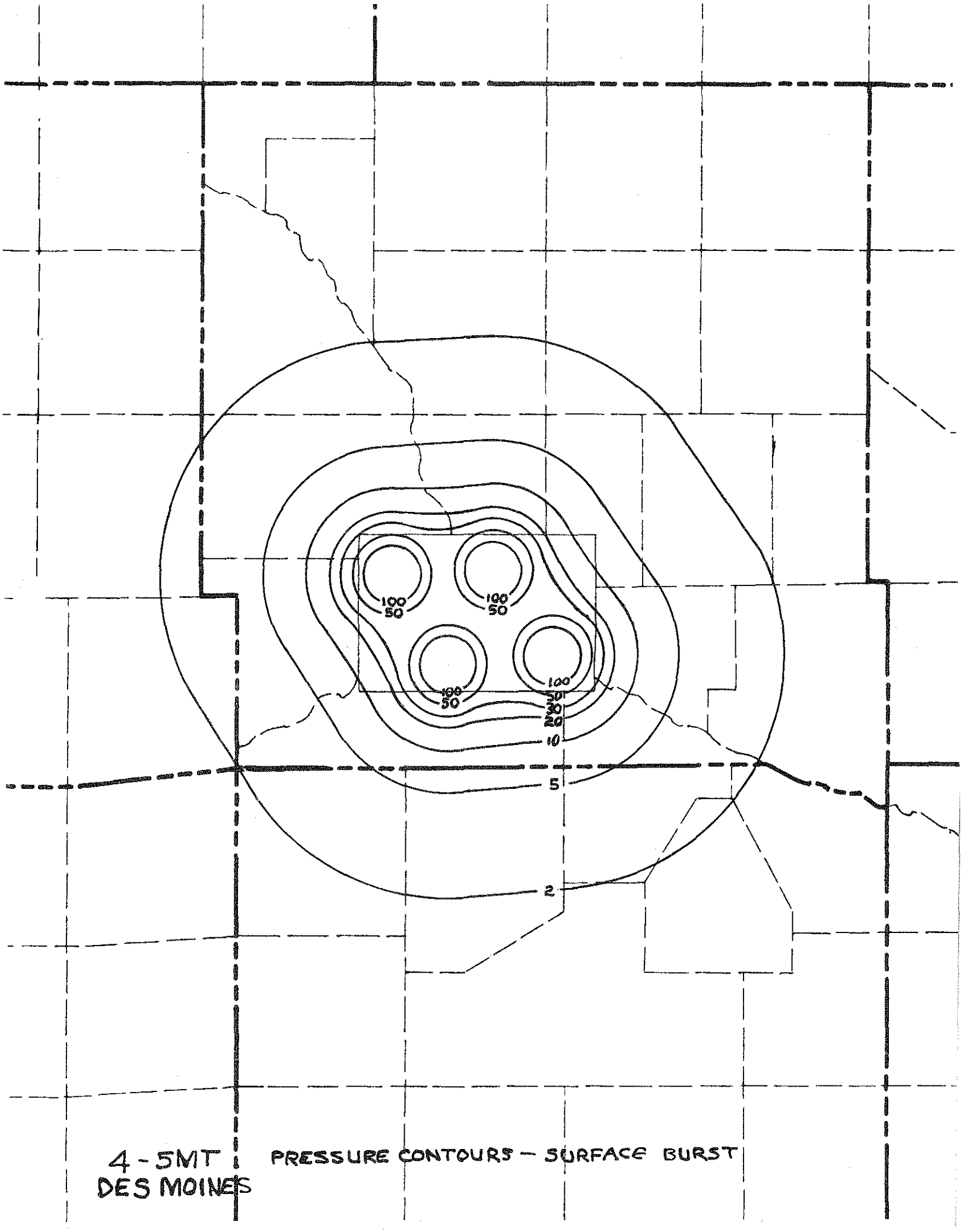


4-5 MT PRESSURE CONTOURS - SURFACE BURST
COUNCIL BLUFFS



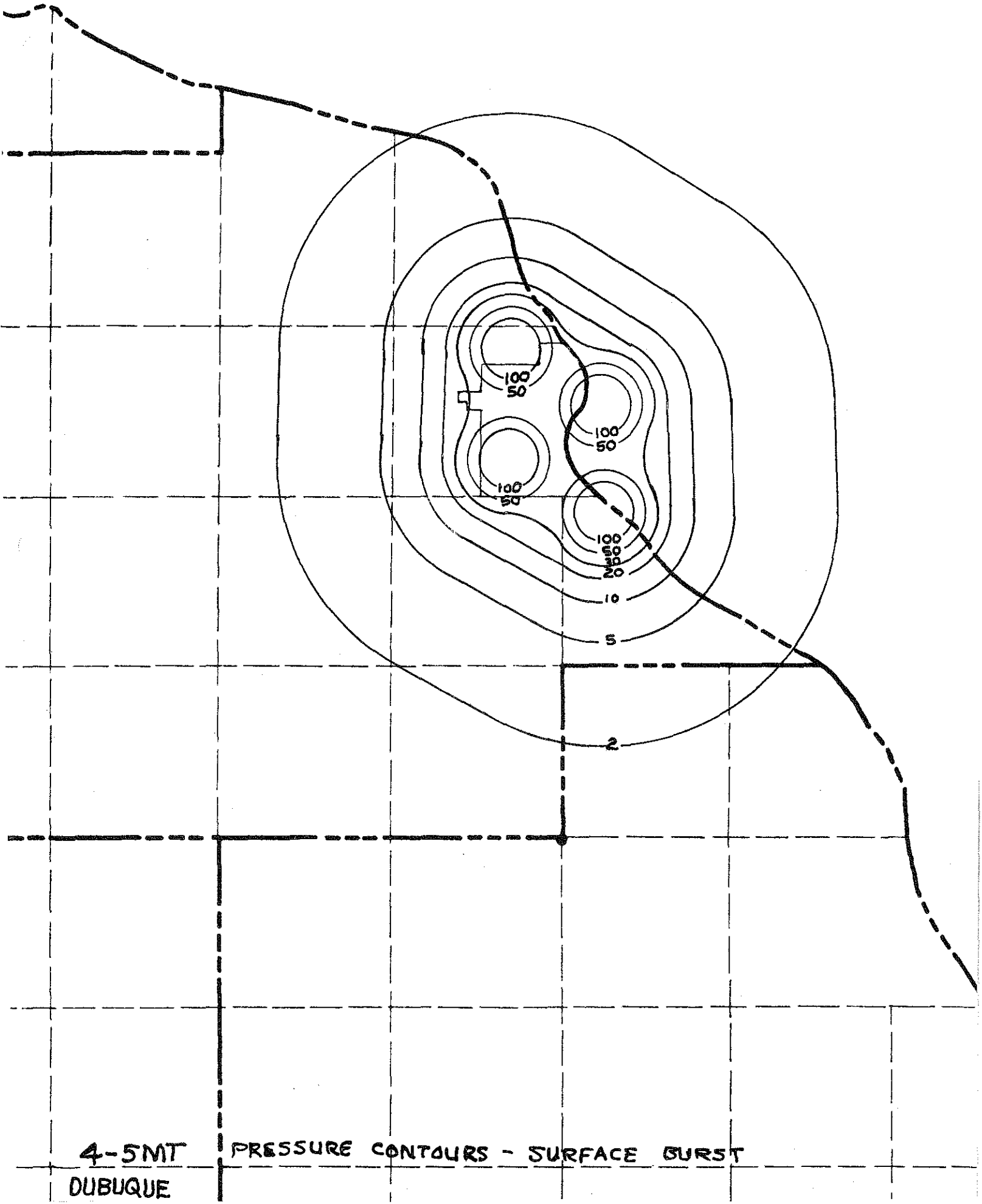
4-5 MT
DAVENPORT

PRESSURE CONTOURS — SURFACE BURST



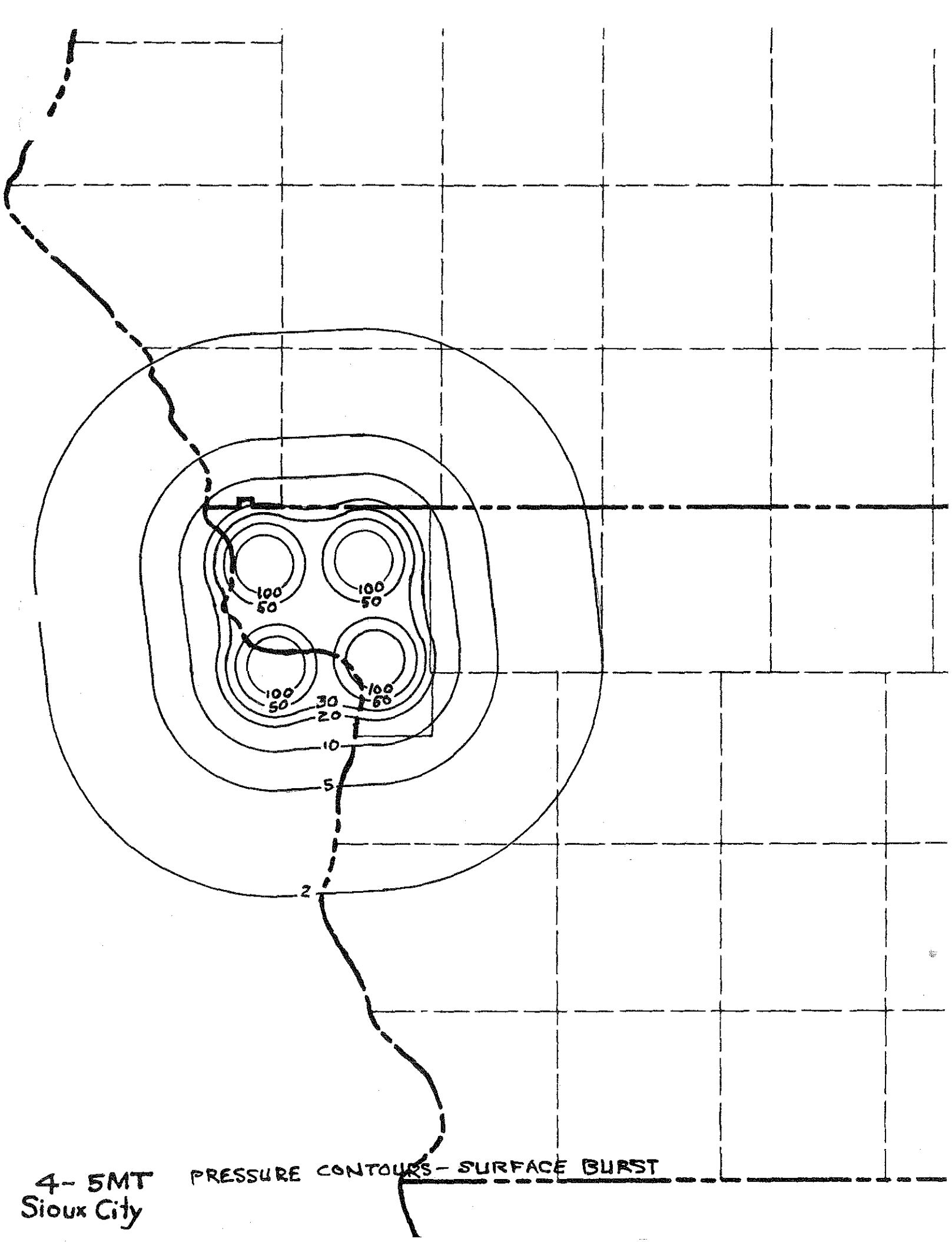
4 - 5MT
DES MOINES

PRESSURE CONTOURS — SURFACE BURST

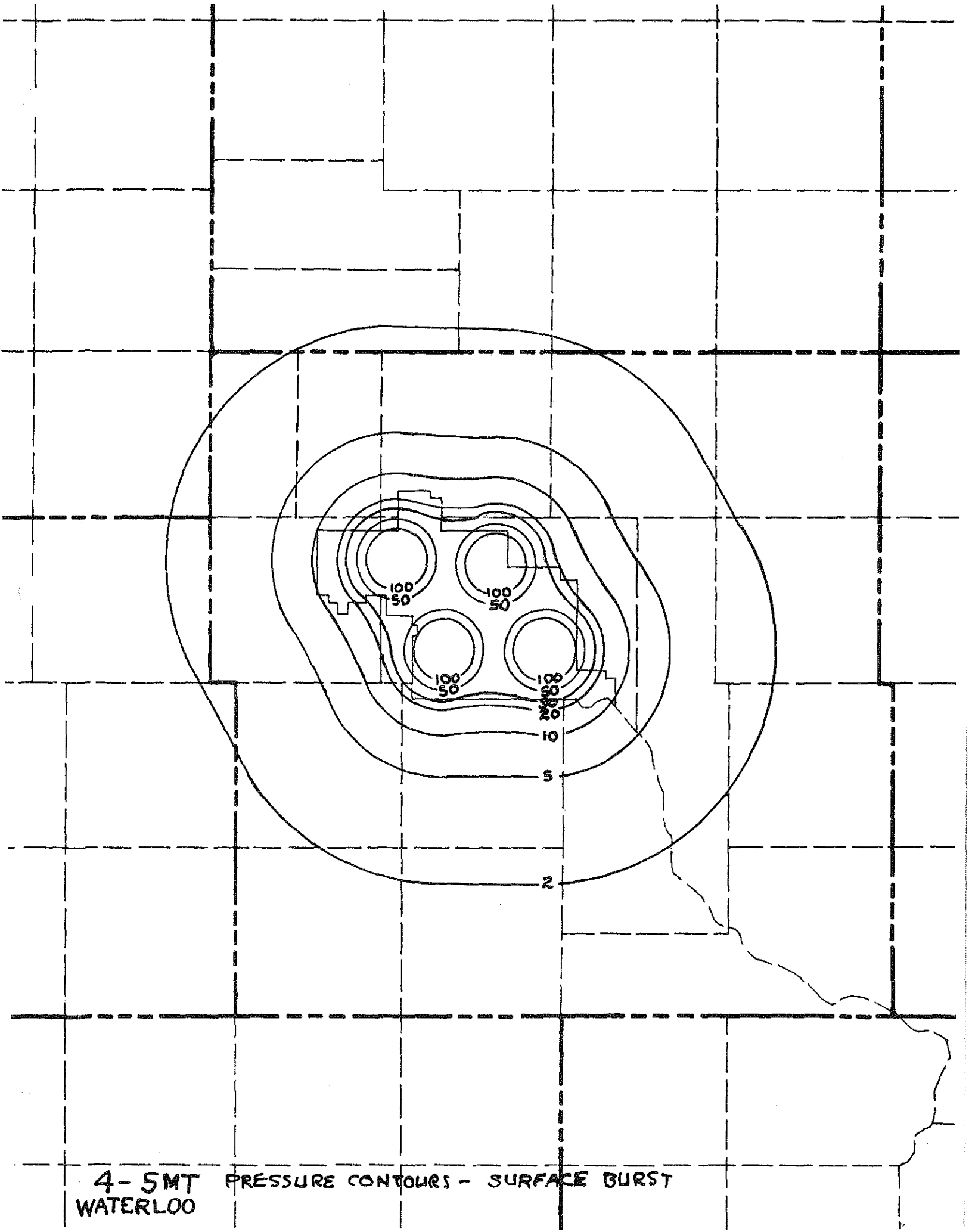


4-5MT PRESSURE CONTOURS - SURFACE BURST

DUBUQUE



4- 5MT PRESSURE CONTOURS - SURFACE BURST
Sioux City



4-5MT PRESSURE CONTOURS - SURFACE BURST
WATERLOO