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Supplementary Documentation for an Environmental Impact Statement Regarding the Pantex Plant

Hydrologic Study for the Iowa Army Ammunition Plant

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SUPPLEMENTARY DOCUMENTATION FOR AN ENVIRONMENTAL IMPACT STATEMENT REGARDING THE PANTEX PLANT:

HYDROLOGIC STUDY FOR THE IOWA ARMY AMMUNITION PLANT

by

N. M. Becker

ABSTRACT

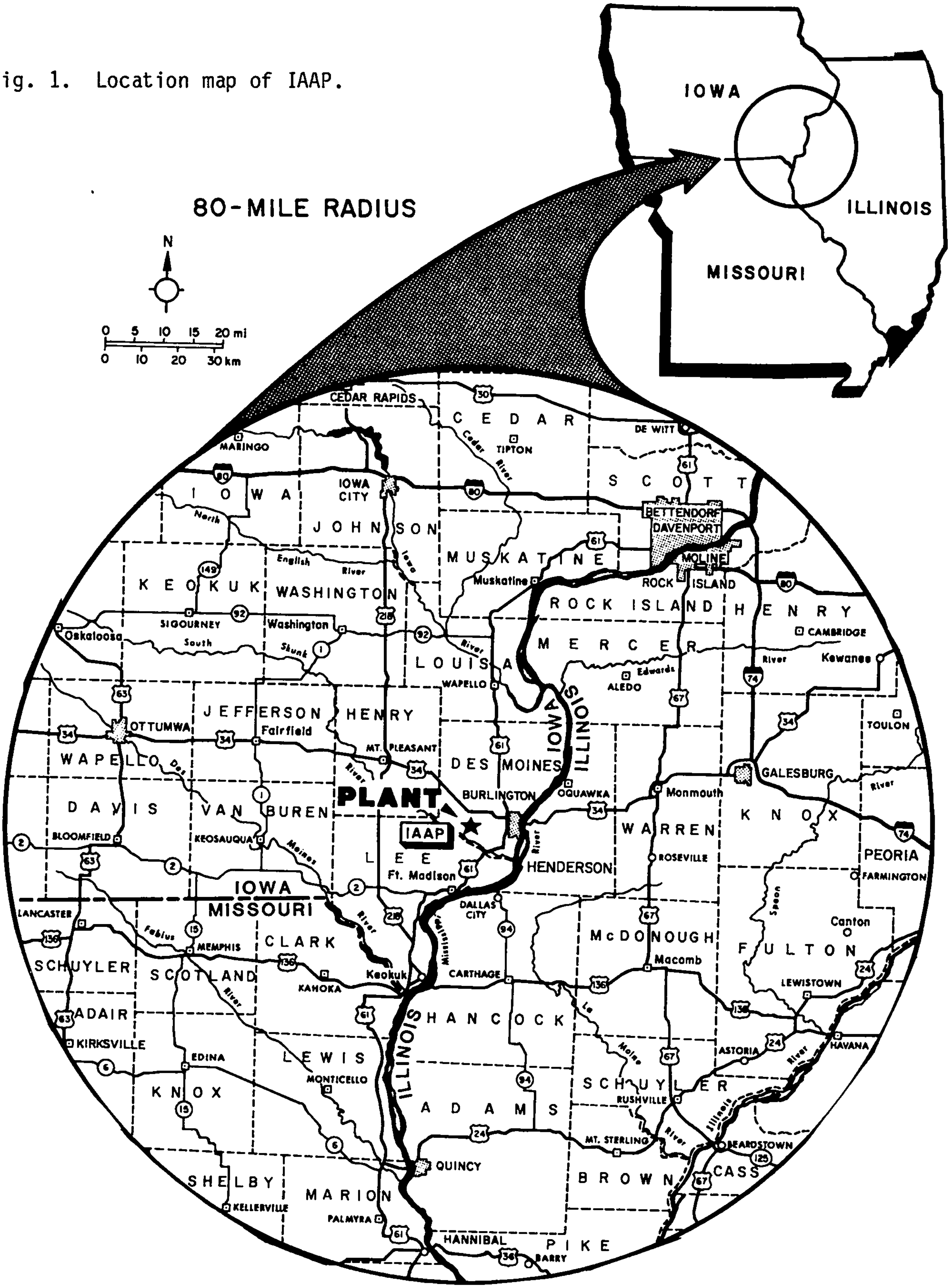
This report documents work performed in support of preparation of an Environmental Impact Statement (EIS) regarding the Department of Energy's Pantex Plant near Amarillo, Texas. A study of flooding was made for the Iowa Army Ammunition Plant near Burlington, Iowa, one of the alternative sites. A partial series-flood frequency analysis of the Skunk River, which flows along the plant's southern boundary, was examined as well as the effects of rise in river level of the Skunk River on the plant and its operations. A flood frequency analysis on Long Lake, a manmade reservoir within the plant grounds, was made. Maximum spillway capacity was computed and compared to the magnitude of floods of particular recurrence intervals.

I. INTRODUCTION

This report documents work performed in support of preparation of an Environmental Impact Statement (EIS) regarding the Department of Energy's Pantex Plant near Amarillo, Texas. This EIS addresses continuing nuclear weapons operations at Pantex and the construction of additional facilities to house those operations. The EIS was prepared in accordance with current regulations under the National Environmental Policy Act. Regulations of the Council on Environmental Quality (40 CFR 1500) require agencies to prepare concise EISs with less than 300 pages for complex projects. This report was prepared by the Los Alamos National Laboratory to document details of work performed and supplementary information considered during preparation of the Draft EIS.

This report documents surface hydrologic studies at the Iowa Army Ammunition Plant (IAAP) near Middletown, Iowa (Fig. 1). The IAAP is located

Fig. 1. Location map of IAAP.



about 10 miles west of the city of Burlington in southeastern Iowa. The Skunk River borders the southern boundary of the plant, and three small streams flow through the site. Two small reservoirs have been created onsite in addition to numerous ponds.

The climate is characterized as mid-continental, with hot, humid summers and long, cold winters. Annual rainfall is about 35 in. with 26 in. of snow. Average annual Class A pan evaporation is about 47 in. Record high and low temperatures recorded at Burlington are 111°F in 1936 and -27°F in 1905.

Onsite topography consists of upland divides and youthful drainage systems. Upland divides are gently rolling surfaces representing glacial drift that has been slightly modified by loess. Youthful drainage systems characteristically have high relief, with steep slopes and youthful streams. The underlying geologic structure of Paleozoic age is due to the tectonic development of the Forest City Basin, a structural basin centered about southwestern Iowa, eastern Kansas, and northwestern Missouri. The IAAP is located on the eastern flank in an outcrop area of Mississippian-age rocks. The rocks are progressively older with depth (layercake strata) and are chiefly composed of limestones, sandstones, dolomites, shales, and siltstones, reflecting marine sediment origins. Although no wells completely penetrate the sedimentary sequence, igneous and metamorphic basement rocks are presumed to underlie these Paleozoic rocks at depths greater than 2500 feet (Campbell 1966).

Throughout this report English units are used, reflecting the unit systems in which the data were reported. To convert to metric units, use the following conversions.

To convert	Multiply by	To obtain
ft	0.3048	m
mi	1.609	km
mi^2	2.590	km^2
ft^3/s	0.0283	m^3/s

II. FLOOD FREQUENCY OF THE SKUNK RIVER

The Skunk River, a tributary to the Mississippi River, flows southeasterly along the southern border of the IAAP (Fig. 2). The US Geological Survey (USGS) has maintained stream gauging on the Skunk River at Augusta since 1915. Augusta is a small community located south of the IAAP on the north banks of the Skunk River (Fig. 2).

Peak flood discharges at Augusta have been measured since 1915 (Fig. 3). These discharges are determined through direct measurements and development

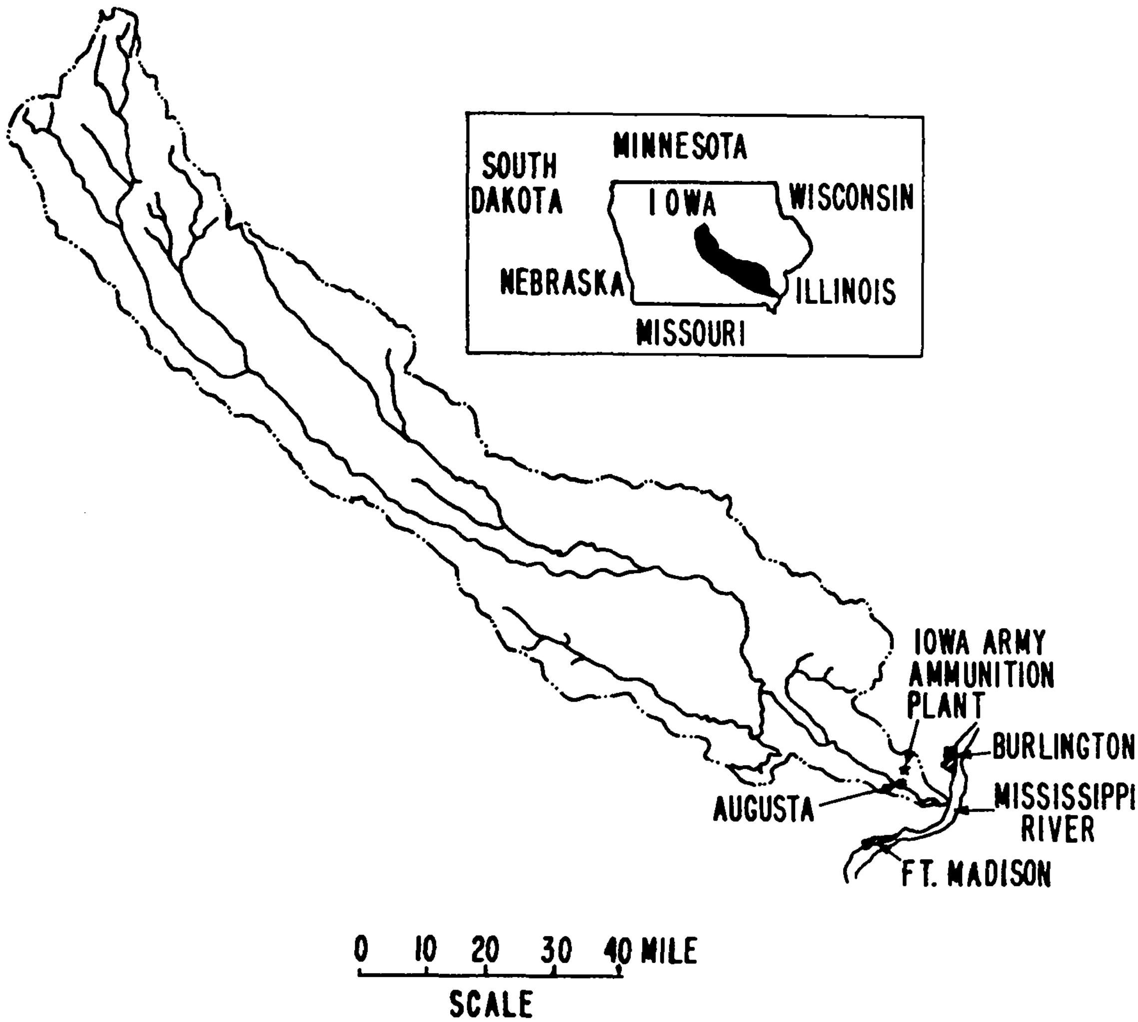


Fig. 2. Skunk River watershed.

of stage-discharge relationships (Fig. 4). The stage-discharge relationship correlates, on the average, the elevation of the river with the discharge.

The peak flood discharge data can be used to develop a partial-series flood frequency distribution to predict floods of various recurrence intervals. [A recurrence interval of 100 years refers to the discharge, which has a probability of occurrence of 1/100 in any given year (0.01 probability).] This has been developed by Heinitz (1978) (Fig. 5). Combining this information with the stage-discharge relationship and the known drainage basin area at Augusta, which is 4303 sq mi, leads to a relationship between river elevation and recurrence intervals (Table I).

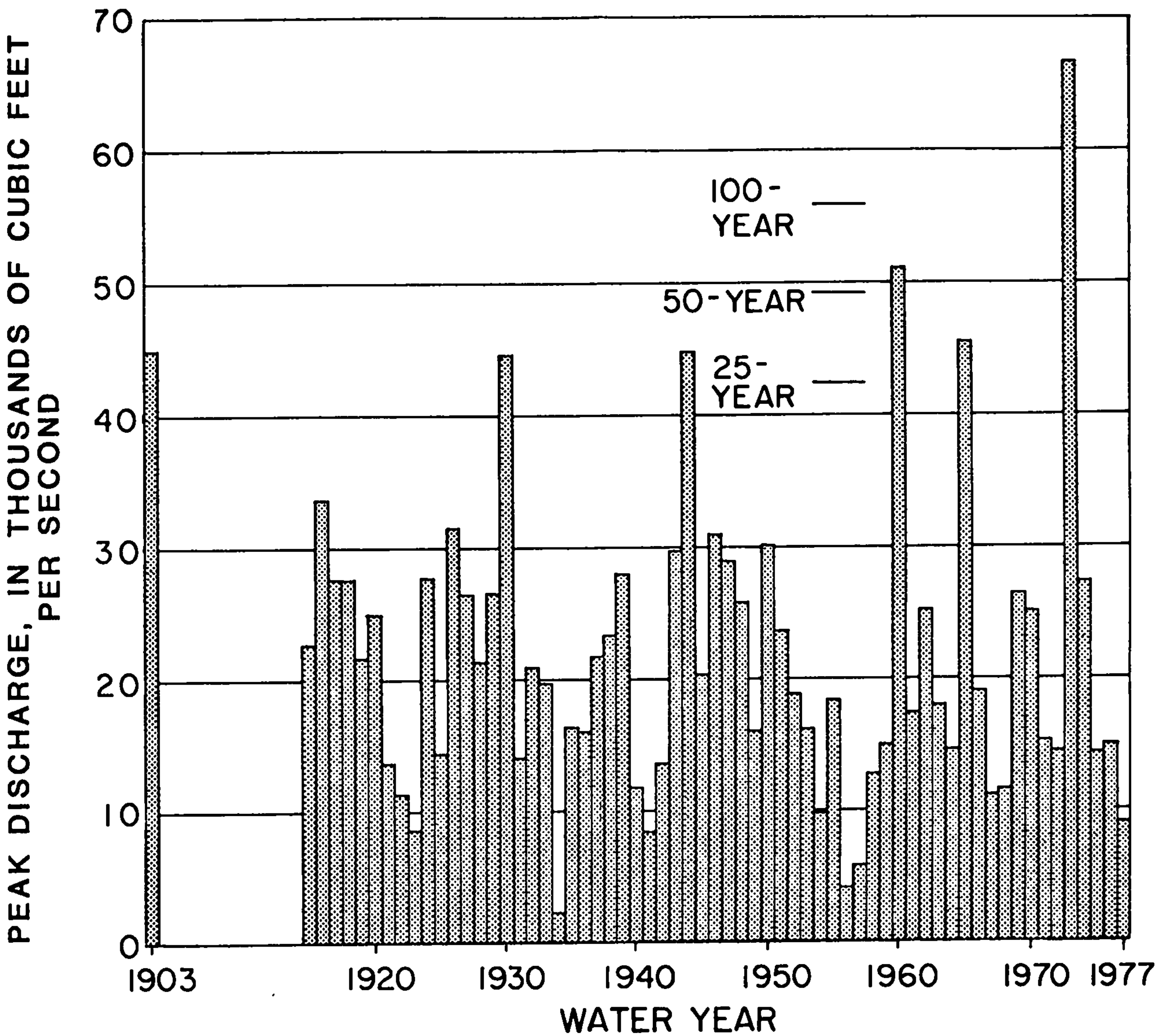


Fig. 3. Peak flood discharge history of the Skunk River.

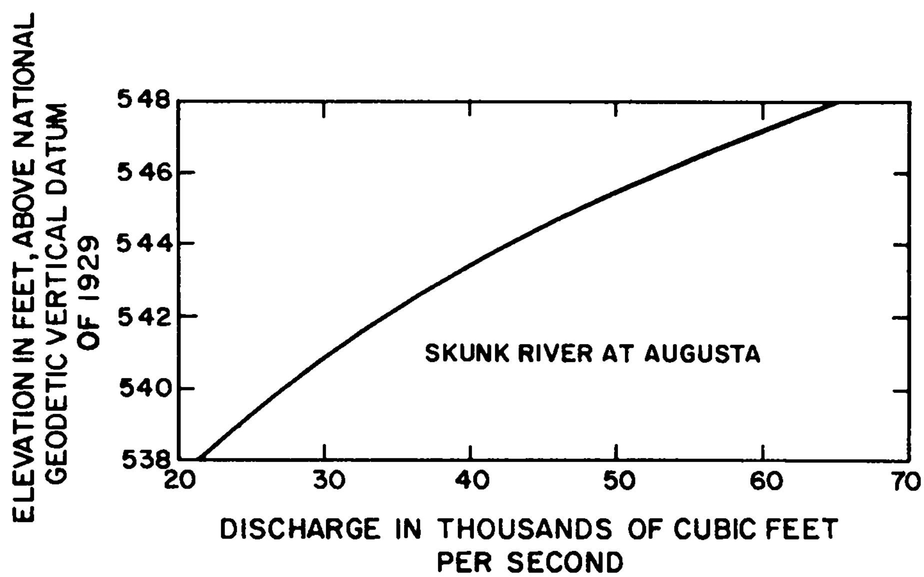


Fig. 4. Stage-discharge relationship of the Skunk River at Augusta.

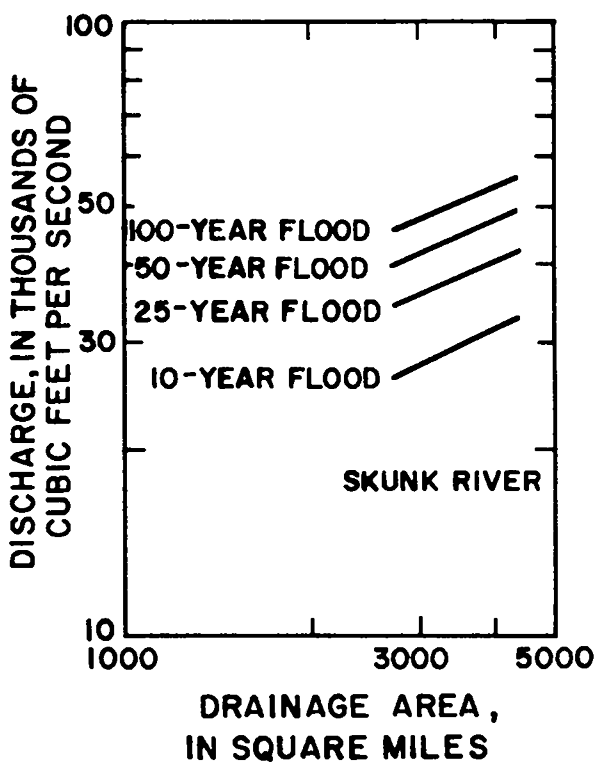


Fig. 5. Peak discharge as a function of drainage area.

TABLE I

FLOOD ELEVATION OF THE SKUNK RIVER AT AUGUSTA, IOWA,
AS A FUNCTION OF RECURRENCE INTERVAL*

Recurrence Interval (yr)	Flood Discharge (ft^3/s)	Elevation Above MSL (ft)
10	33 000	540.7
25	43 000	542.9
50	50 000	544.7
100	56 000	546.2

* Drainage area 4303 mi^2.

Discussion

By using the US Geological Survey Contour Map of the area, the effects of flooding of the Skunk River on the IAAP can be investigated (Fig. 6). The 550-ft elevation contour is shown. Table I shows that for all floods, including the 100-yr flood, the river elevation will be below this contour. This elevation must be qualified because heavy bank foliage, debris, and winter ice jams can cause dramatic temporary changes in the stage-discharge relationship.

The 550-ft elevation contour generally runs along the south fence boundary of the IAAP. The contour extends into the plant site at a number of locations: approximately 1500 ft along an intermittent stream southwest of Line 3A, approximately 800 ft along an intermittent stream west of the demolition area, approximately 700 ft along an intermittent stream southwest of the demolition area, 400 ft along an intermittent stream north of the village of Augusta, and approximately 1 mi into the plant along Long Creek (Fig. 6). Figure 6 shows that the 100-yr flood might cause some flooding in Augusta.

Of all these locations, the only possible onsite area that could be affected by flooding is along the channel of Long Creek. All other locations are in undeveloped woodlands.

Along Long Creek, the 550-ft elevation contour line crosses Road K and a road within Yard G. It appears that, in addition to washing over these roads, a building or two on the Pistol Range along Road K would be flooded by the 100-yr flood. However, this minor flooding is not expected to affect any of the operations at the IAAP nor cause severe damage. The flooding of the

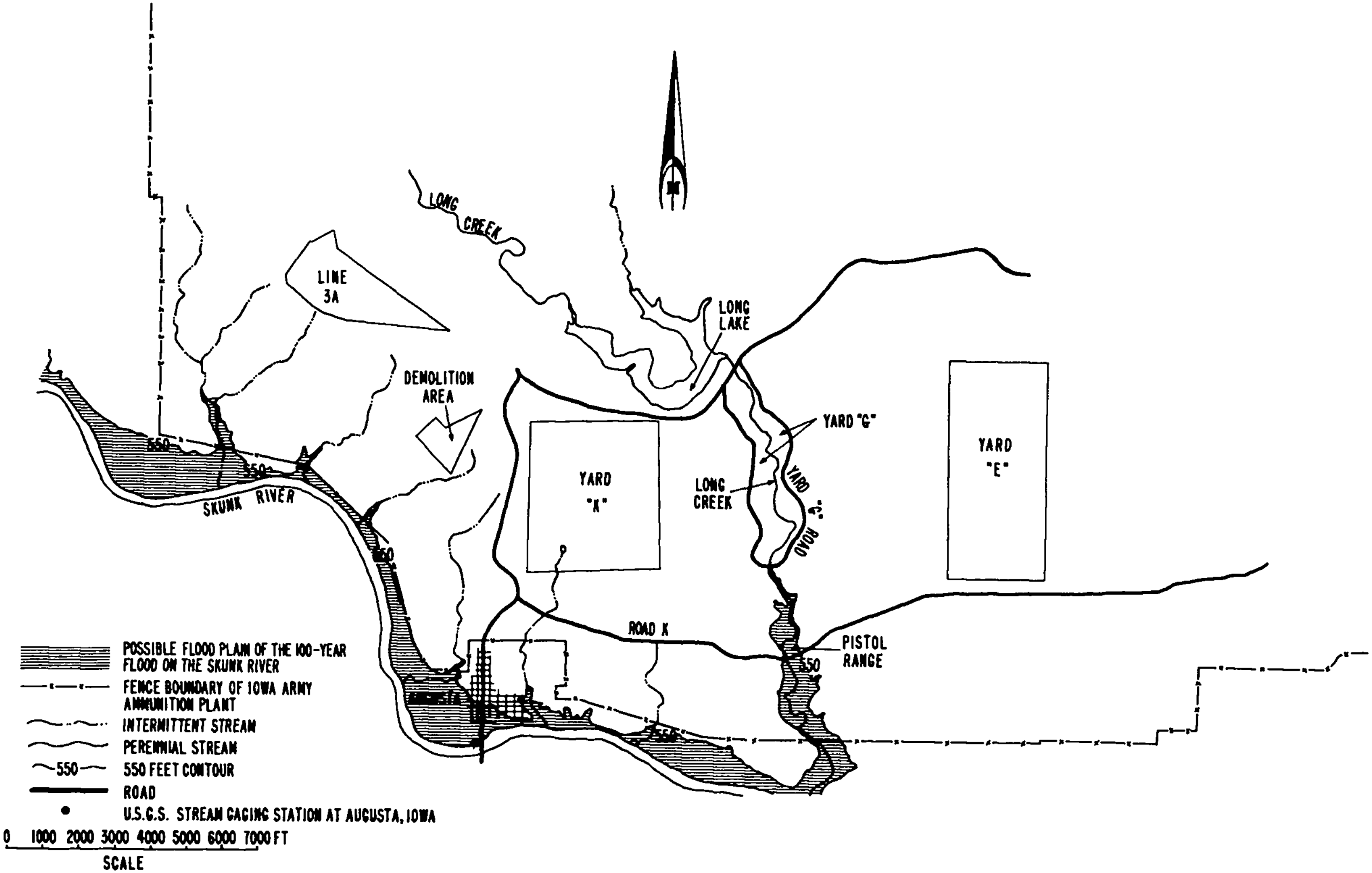


Fig. 6. Location of the 550-ft contour at the IAAP.

Skunk River will not affect relocated Pantex operations, should they relocate to the IAAP.

III. FLOOD FREQUENCY ANALYSIS OF LONG LAKE

A flood frequency analysis was generated for Long Lake, a manmade reservoir on the plant grounds (Fig. 6). Long Lake was created in 1941 by the US Army by damming Long Creek to provide a water supply for the then new munitions plant. Since 1977, the IAAP has purchased water from the city of Burlington (Mississippi River water), and so the lake is now used for recreation and conservation purposes only.

The earthfill dam is 1130 ft wide from abutment to abutment and is equipped with a 75-ft-wide concrete ogee spillway. The height of the dam has been increased over the original elevation 610 ft above mean sea level (MSL) by a railroad grade that runs along the dam crest. A railroad bridge crosses over the spillway; at this location the dam/railroad grade crest attains its lowest elevation (628.5 above MSL). The spillway empties out onto a limestone apron and then flows under a highway bridge and/or into two culverts before reentering the main channel.

This portion of the study investigates the maximum discharge capacity of the spillway, the magnitudes of particular floods into Long Lake, and the ensuing rise in reservoir level in response to these floods.

A. Maximum Discharge Capacity of the Spillway

The spillway is an ogee-type, concrete spillway 75 ft wide. The crest of the spillway is at elevation 605 ft above MSL. To gain additional capacity, 3-ft-high wooden flashboards were added at the time of construction (Holmberg' 1982). Therefore, the spillway now behaves as a sharp-crested weir.

The general equation to calculate discharge over the spillway is

$$Q = CLH_e^{3/2} ,$$

where

Q = discharge in cubic feet per second (cfs),
C = discharge coefficient,
L = length of the crest in feet, and
H_e = total head on the crest in feet

(Bureau of Reclamation 1977). The limiting factor on the total head on the spillway was assumed to be the bottom of the railroad bridge that runs across the spillway at elevation 628.5 above MSL. Therefore, H_e maximum is 20.5 ft. The bottom of the dam is assumed to be at elevation 578 (Day and Zimmerman 1941). By using this information and an upstream dam slope of 1.5:1, a discharge coefficient of 3.90 was selected. The length of the crest was adjusted to 66.8 ft to account for the concrete retaining walls upstream of the spillway. Substituting, Q maximum equals 24 181 cfs, the maximum discharge the spillway can pass before overtopping the dam at the railroad bridge.

B. Floods on Long Lake

Magnitudes of floods on Long Lake were computed using regression equations developed specifically for Iowa (Lara 1973). Regional relations between floods of specific return periods and basin characteristics were used in developing the equations. Regression equations developed for Region I (that part of Iowa not included in the Des Moines lobe, a glacial feature), which covers 68% of Iowa, and model II, which considers both the watershed area and slope, were used.

The equation for computing the flood is of the general form

$$Q_t = c_t \, A(t)^x \, S(t)^y ,$$

where

A = drainage area in square miles,
S = main channel slope in feet per mile,
Q_t = discharge for a t-recurrence interval in cubic feet per second, and
c_t,x,y = regression coefficients for a given t-recurrence interval.

The regression coefficients are found in Table II. Computed peak discharges for a drainage area of 19.53 mi^2 and a channel slope of 10.74 ft/mi are found in Table III. These figures for watershed area and slope were measured from USGS topographic maps of the area.

C. Resultant Reservoir Rise from Flooding - Discussion

As stated in Section A, the maximum flow the spillway can pass is slightly greater than 24 000 cfs. Comparing this number to the peak discharges in Table III indicates that the spillway will be able to accommodate even the 100-yr flood.

The head on the spillway can be computed by the spillway discharge equation (Sec. A) given a known discharge. This head can be summed to the elevation of the crest of the flashboards (El. 608) to determine a reservoir elevation associated with each recurrence interval flood (Table IV). The

TABLE II

REGRESSION COEFFICIENTS FOR CALCULATING PEAK DISCHARGES*

t (yr)	c_t	x_t	y_t
2	31.2	0.701	0.490
5	82.5	0.651	0.445
10	143	0.618	0.410
25	262	0.579	0.367
50	394	0.551	0.355
100	571	0.524	0.305

*Lara 1973.

TABLE III

PEAK DISCHARGES ON LONG LAKE

Recurrence Interval (yr)	Peak Discharge (cfs)
2	802
5	1643
10	2375
25	3500
50	4488
100	5590

TABLE IV

ELEVATION OF RESERVOIR AS A FUNCTION OF FLOOD FREQUENCY

Flood Recurrence Interval (yr)	Head on Crest of Flashboards (ft)	Elevation above MSL (ft)
2	2.12	610.12
5	3.41	611.41
10	4.36	612.36
25	5.65	613.65
50	6.67	614.67
100	7.72	615.72

reservoir level associated with the 100-yr flood will probably not exceed elevation 616. The most damage that would occur would be the flooding of some gravel roads. It is likely that the elevation would never be as great as elevation 616 due to leakage through the limestone abutments whenever the reservoir elevation exceeds elevation 608 (Holmberg 1982).

Downstream (from the dam) flood damage would include the possible washing out of two gravel roads, K Road and the Road in Yard G, and flooding of some structures on the Pistol Range (Fig. 5). However, this damage would not be severe nor would it affect plant operations. This flooding will not affect relocated Pantex operations, should they occur, as long as the relocation is situated at least 50 ft above Long Lake's present shoreline.

IV. SUMMARY AND CONCLUSIONS

An analysis was made of the possible deleterious effects of flooding of the Skunk River. By using a partial series-flood frequency analysis, it was determined that the 100-yr flood would raise the Skunk River up to elevation 550 ft, resulting in some flooding on the IAAP over woodlands, two roads, and possibly some buildings on the Pistol Range. In general, flooding would not cause any serious or major damage to the IAAP and would not affect relocated Pantex operations.

A flood frequency analysis of the Long Lake reservoir was made. The reservoir was created in 1941 by damming Long Creek with an earthfill dam. The dam is equipped with a concrete ogee spillway. The crest of the spillway was raised 3 ft during construction through the addition of timber splashboards. Thus, this spillway behaves like a sharp-crested weir. A railroad grade constructed on the dam crest has further raised the level of the dam, the top of the grade ranging in elevation from 650 to 636 ft.

The maximum discharge the spillway can accommodate is slightly greater than 24000 cfs. This spillway will easily accommodate floods through the 100-yr flood discharge, as computed through regression equations. Downstream (from the dam) damage would include possible washing out of two gravel roads, K Road and the road in Yard G, and flooding of some structures on the Pistol Range. However, flooding would not be severe nor would it affect plant operations. It will not affect relocated Pantex operations, as long as the relocation is situated at least 50 ft above Long Lake's present shoreline.

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