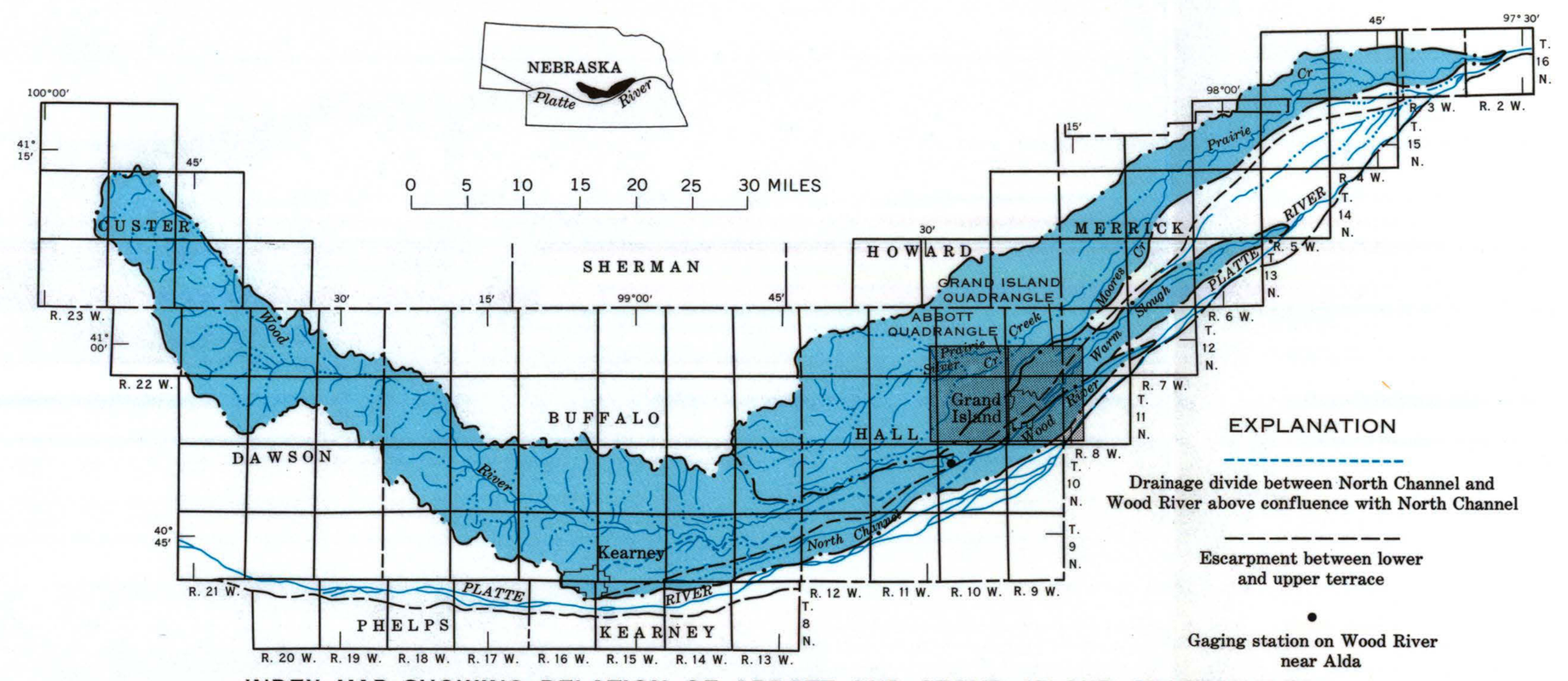
Photograph by Don Bartlett Studio, Grand Island, Nebraska

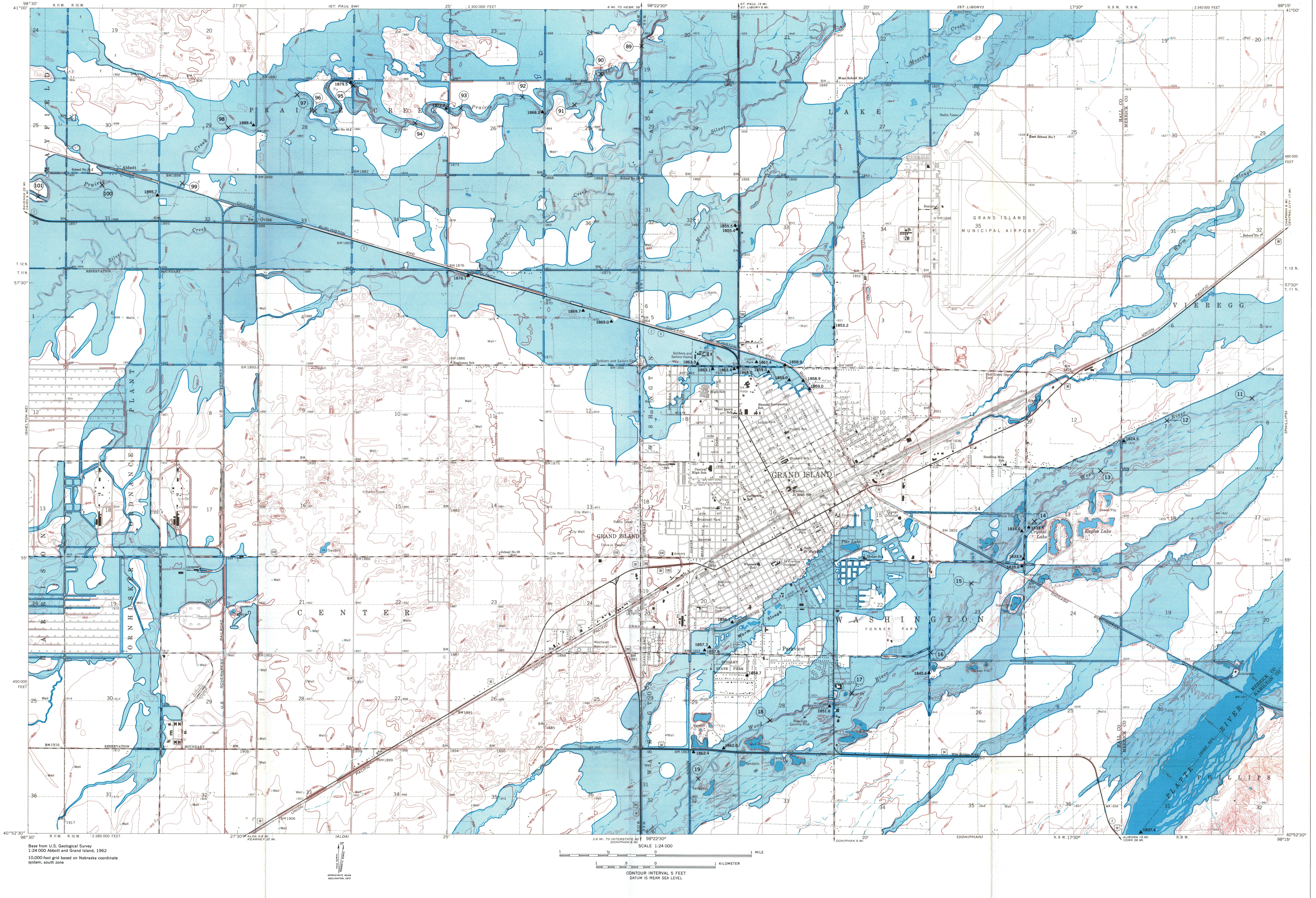
RESIDENTIAL AREA DIRECTLY SOUTH OF SOLDIERS AND SAILORS HOME IN NORTHWESTERN GRAND ISLAND.

Photograph by Lincoln State Journal Newspaper, Lincoln, Nebraska

NEW RESIDENTIAL HOUSING AREA IN SOUTHWESTERN GRAND ISLAND.



INDEX MAP SHOWING RELATION OF ABBOTT AND GRAND ISLAND QUADRANGLES TO DRAINAGE BASINS OF WOOD RIVER, WARM SLOUGH, AND PRAIRIE CREEK



FLOOD OF JUNE 1967 AT GRAND ISLAND, NEBRASKA

Rain on June 13–15, 1967, was the immediate cause of widespread flooding in northeastern Hall and western Merrick Counties, Nebr. The inundated areas included the northernmost and southernmost parts of the city of Grand Island, (population, 30,675), part of the government reservation occupied by the Cornhusker Ordnance Plant, and extensive tracts of rich agricultural land. Shown on the accompanying map is the areal extent of flooding within the Abbott and Grand Island 7 1/2-minute quadrangles; about 42 square miles, or 37 percent of the two-quadrangle area, was under water. As only minor flooding resulted in June 1968 after a rain of nearly the same magnitude on about the same area, the factors that combined to result in the disastrous June 1967 flood merit examination. By documenting those factors, this report provides some of the information that is needed for formulation of plans to lessen damages from future floods in Grand Island and vicinity and to guide development of those areas subject to inundation.

Geographic and hydrologic setting.—The Abbott and Grand Island quadrangles lie almost wholly on the broad, nearly flat floor of the Platte River valley. Although the entire two-quadrangle area is within the drainage basin of the Platte River, none of the flooding with which this report is concerned was due to overflow of, or diversion from, the Platte River. Instead, the flooding occurred in the drainage basins of Wood River, Warm Slough, and Prairie Creek, each of which is tributary to the Platte River downstream from the two-quadrangle area. The relation of the Abbott and Grand Island quadrangles to those three drainage basins is shown by the index map.

Wood River heads about 80 miles west and 20 miles north of the point where it enters the two-quadrangle area. Its drainage area upgradient from that point is about 715 square miles, and within the two-quadrangle area is about 17 square miles. Wood River flows most of the year throughout its course from the eastern part of R. 18 W. to the central part of R. 15 W., then flows only intermittently until joined by North Channel 1.75 miles south of the midpoint of the Abbott quadrangle. Below the confluence, Wood River flows continuously in some years but only intermittently in others. North Channel is so named because it originally was the northernmost channel in an anastomosing network of channels constituting the Platte River in mid-Nebraska. Virtually cut off from the Platte by construction of Interstate Highway 80 in the vicinity of Kearney, Nebr., it no longer derives any of its flow from that source.

The Warm Slough drainage basin includes about 9 square miles south of the Abbott quadrangle and about 39 square miles within the two-quadrangle area. Formerly, the natural head of the stream was about 1.5 miles southeast of the southwest corner of the Abbott quadrangle, whereas now the head of the stream is near the center of the Grand Island quadrangle. This northeastward transfer of the originating point of through flow resulted from construction of cross-drainage embankments for railroads, highways, and other roads south of Grand Island and urbanization of large parts of the areas between the cross-drainage structures. Although most of the city of Grand Island is within the Warm Slough drainage basin, no natural drainageways tributary to Warm Slough exist within the city. Most of the precipitation on rooftops and paved areas enters storm sewers and that on lawns and gardens enters the soil. Some of the outflow from the storm sewers is conveyed northward by open ditch to Moores Creek (a tributary of Prairie Creek), some empties into a lagoon at the north edge of town, and some is conveyed eastward by two open ditches that empty into Wood River. As the system of storm sewers is not adequate at times of heavy precipitation, plans for its expansion are now in preparation.

Prairie Creek heads about 17 miles west of the southwest corner of the Abbott quadrangle and together with its tributaries drains an area of about 187 square miles west of the two-quadrangle area and about 50 square miles within it. All are ephemeral streams, flowing only in response to overland runoff. The reservation containing the Cornhusker Ordnance Plant is drained by tributaries of Silver Creek which, in turn, is tributary to Prairie Creek. Embankments of the railroad spurline into the ordnance plant and of the railroad and highway that extend west-northwestward from the northwestern part of Grand Island are obstructions to drainage at times of excess runoff.

Trending northeastward across the two-quadrangle area from a point 4.3 miles east of its southwest corner to its northeast corner is a low escarpment (see index map) that separates a lower terrace on the southeast from a higher terrace on the northwest. On the average, the lower terrace is about 5 feet higher than the Platte River and the upper terrace is 15 to 20 feet higher than the lower. Both terraces slope toward the northeast, as does the flood plain of the Platte River.

The part of the two-quadrangle area that is drained by Wood River is wholly on the lower terrace; the part drained by Warm Slough includes some of the lower and some of the upper terrace; and the part drained by Prairie Creek is wholly on the upper terrace. The divides separating the three drainage basins within the two-quadrangle area are so topographically indistinct that they cannot be located precisely. In fact, the divide separating the Wood River drainage area from that of Warm Slough has been breached in several places by ditches that border the embankments of roads and railroads crossing the divide. As the terrain is so nearly level, virtually all the precipitation is absorbed by the soil. Consequently, overland runoff rarely occurs.

Generally speaking, the soils and subsoils in those parts of the two-quadrangle area that are drained by the Wood River and Warm Slough absorb precipitation readily and transmit it to the water table. Throughout much of the part drained by Prairie Creek the soils absorb precipitation readily but have a high water-holding capacity; furthermore, the subsoils tend to retard infiltration to the water table.

The entire two-quadrangle area is underlain by water-bearing sand and gravel, and the zone of saturation is hydraulically continuous with the Platte River. Under equilibrium conditions, the slope of the water table is the same as that of the river and in the same direction. Thus, the depth to water below the lower terrace area ordinarily is no more than 5 feet (somewhat less in the topographically lower places) and below the upper terrace is generally between 15 and 25 feet. Infiltration of precipitation and pumping for irrigation temporarily cause the water table to be higher or lower, respectively, than it is under equilibrium conditions. Streams on the lower terrace flow whenever the water table rises above the channel bottom, whereas streams on the upper terrace are separated from the water table by several feet of fine-grained sediments, which in some places include some virtually impermeable clay, and so flow only in response to overland runoff.

Moisture conditions prior to the flood.—Between the beginning of 1967 and the last week of May, precipitation on the area draining toward the two-quadrangle area had been exceedingly small. Instead of the 7 1/2 to 8 inches of precipitation considered to be normal for that period, only 2 1/2 to 3 inches had fallen. However, during the period May 26 to June 12, a succession of almost daily rains totaling 7 to 10 1/2 inches fell in the area. Although some of the moisture was returned to the atmosphere within a short time, virtually all the remainder was absorbed by the terrain.

That a large quantity of water (about 6 inches) had infiltrated to the water table beneath part of the upper terrace by midnight of June 12 is evidenced by a water-level rise of 2 1/2 feet in an observation well located in the SW1/2SW1/4 sec. 25, T. 11 N., R. 11 W. That relatively little water (only about 1/6 inch) had run off from a large part of that same terrace is indicated by the discharge record of the gaging station on Wood River near Alda, a short distance upstream from the confluence of the Wood River with North Channel. Presumably, by June 12, the soil and subsoil throughout the drainage basin above the gaging station were so thoroughly wetted as to have little additional water-holding capacity. Similar conditions probably characterized that part of the upper terrace within the Warm Slough drainage basin. However, in the part of the upper terrace that is drained by Prairie Creek, the quantity of water that had infiltrated to the underlying aquifer may have been much less. There, because extensive layers of nearly impermeable clay above the zone of saturation retard downward movement of water, temporary zones of saturation built up in the sediments above the clay layers. Such zones of saturation together with the high moisture content of the nonsaturated sediments reduced the capacity of that part of the terrain to absorb additional water.

The generally greater permeability of the soils on the lower terrace undoubtedly resulted in more water infilitrating to the zone of saturation there than on the upper terrace. Consequently, the normally shallow water table was raised to or a little above the bottom of the natural drainageways and to within a foot or two of the land surface elsewhere. Thus, all along North Channel, along Wood River below the confluence with North Channel, and along Warm Slough (including the disconnected segments upgradient from the present head of that stream), the absorptive capacity of the terrain was reduced to zero. Although the soils on other parts of the lower terrace had no more capacity to hold water, they still could transmit moisture to the underlying zone of saturation.

If not for the antecedent moisture, the rain of June 13–15 would have resulted in only minor flooding.

Flooding due to the rain of June 13–15.—It was on the thoroughly soaked terrane with little capacity to absorb additional water that 2 to more than 6 inches of rain fell on June 13–15. Under ordinary circumstances, the runoff from that amount of rain would not be likely to cause the natural drainage channels to overflow; but the conditions were far from ordinary, and extensive flooding, especially in and near Grand Island, was the unfortunate result. The inundated areas were partly on the lower and partly on the upper terrace.

North Channel and Wood River below its confluence with North Channel are incised less than 5 feet below the land surface. Because the antecedent precipitation had raised the water table to or above their channel floors, runoff from the additional rain soon had both streams overflowing. The discharge of North Channel was not measured but near the confluence is estimated to have been considerably greater than at the gaging station on Wood River 1 mile upstream from the confluence. At that gaging station, the average discharge June 14–18 inclusive was more than twice the previous maximum 5-day average discharge in a 14-year period of record. The addition of this unprecedented discharge to the already overflowing reach below the confluence broadened that reach to as much as 1 mile south of Grand Island. Included in the inundated area was part of the Parkview housing area and the Woodland and Riverside country clubs.

Meanwhile, water was ponding in low places in the urbanized area situated on the lower terrace. When the flooding Wood River reached a sufficiently high stage, it began to spill into the Warm Slough drainage basin through the breaches in the low divide. The spillage caused the ponded areas to enlarge and finally merge into a broad, shallow lake that inundated part of Stolley State Park and more than a square mile of housing and industrial developments. Instead of overflowing into the lower part of the Warm Slough drainage basin, the floodwaters spilled back into the Wood River drainage basin, mostly through a naturally low place in the divide but partly through the drainage ditch extending eastward from the Grand Island sewage disposal plant. Several high-lying tracts along the Wood River-Warm Slough divide—including part of the Parkview subdivision and much of Fonner Park—became temporary islands during the flood.

As shown by the map of the two-quadrangle area, flooding on the upper terrace was more extensive than on the lower. Included among inundated areas were parts of the Cornhusker Ordnance Plant, the northernmost part of Grand Island, and thousands of acres of cropland.

Flooding within the ordnance plant reservation was due largely to precipitation on the reservation and to runoff from the relatively small upgradient area. If not for the soils in that area being highly retentive of water and already thoroughly wetted, most of the June 13–15 precipitation would have been absorbed, and runoff from it almost negligible. Instead, runoff was greater than could be accommodated by the existing drainage channels even though the principal natural drainage channel had been straightened and several drains had been excavated to facilitate runoff. The limits of the areas of inundation within the reservation were determined largely by the embankments of the railroad spur and other roads.

Flooding elsewhere on the upper terrace was due to runoff from local precipitation plus runoff from precipitation on that part of the Prairie Creek drainage basin upgradient from the two-quadrangle area. Here, too, the reduced absorptive capacity of the soils, very low topographic relief, extremely low gradients, and manmade obstructions were factors favoring ponding of runoff. Although designed to be adequate for most flood conditions, the culverts under State Highway 2 and the railroad parallel to it northwest from Grand Island proved too small to convey water as fast as it accumulated on the south side of the highway. The ponded water finally overtopped both the highway and the railroad in sec. 1, T. 11 N., R. 10 W., but before overflow occurred the ponded water had backed over the low divide into the Warm Slough drainage basin, completely covering the grounds of the Soldiers and Sailors Home, Lincoln Park, and about 20 blocks of residential property in the northern part of Grand Island. Situated as it is, this part of Grand Island previously had been considered immune from the possibility of flooding.

Although the embankments for the highway and railroad caused ponding on the one side, they served as levees protecting some tracts on the other side. Nevertheless, precipitation on the north side of the highway and railroad, together with the water that flowed through culverts or overtopped the highway and railroad was enough to inundate wide tracts along Prairie Creek, Silver Creek, and Moores Creek, as well as much land between them. In several places north of the highway and railroad, the embankments of section-line roads caused ponding on the upgradient side while protecting land on the downgradient side. Thus, the limits of inundation were only partly determined by the natural contours of the land surface.

Of the 42 square miles inundated in the two-quadrangle area, 13.8 square miles were on the lower terrace and 25.8 square miles were on the upper terrace. The remaining 2.4 square miles consisted of the Platte River and the part of its flood plain that was inundated. No information is available for determination of the recurrence interval of a flood of this magnitude. The only streamflow measurements pertinent to this flood are those made on Wood River at the gage near Alda, and there the peak discharge of 1,630 cubic feet per second on June 16 was the greatest in the 14-year period of record at that station.

Shown on the map are the elevations, as determined by leveling, of high-water marks at several points within the two-quadrangle area. These elevations and several high-water marks outside the area were used in constructing flood-crest profiles for Wood River and Prairie Creek. Low-flow profiles also were constructed for these streams and are shown with the flood-crest profiles in figures 1 and 2. The lesser gradient of the profiles for Prairie Creek reflects the greater sinuosity of that stream compared to Wood River; actually, the land-surface slope along Prairie Creek (7.3 feet per mile) is slightly greater than that along Wood River (6.7 feet per mile) in the reaches for which the profiles were constructed.

Flood damages.—The more costly damages were those that occurred within Grand Island. There, 1,100 residences and 39 commercial buildings in the southern part of the city and 62 residences and 7 commercial buildings in the northern part were damaged by the floodwaters, even though the greatest depth measured within the city limits was 3 feet. Total damages within the city limits were estimated at $2,280,000 for residential property, $560,000 for commercial property, and $410,000 for municipal property and utilities—a grand total of $3,250,000. Cave-ins of basement walls and backups and failure of sewers were the most common problems. Damages from the floods of June 21–22, 1947, and June 5–9, 1949, in the Grand Island area were much less than those resulting from the 1967 flood.

Flooding at the Cornhusker Ordnance Plant caused a work stoppage and necessitated some road repair. No damage to the offices, assembly-line buildings, or munitions bunkers was reported.

Damages to farms in the two-quadrangle area were estimated at $3,000,000. Crop losses were due more to prolonged inundation than to erosion or deposition of sediment. In many places, county-road embankments held water on some fields for several days after the peak of the flood because the culverts through the embankments had become plugged by trash. Several tracts that had been leveled for irrigation required releveling, and in some places large accumulations of debris had to be removed. Livestock losses were estimated at $25,000.

Throughout much of the area the water table rose 4 to 5 feet during the period of antecedent precipitation and subsequent flooding. This rise was enough to bring the water table higher than the basement floor in many residences and other buildings in Grand Island, thus causing flooding of basements that were not watertight. Pumping water out caused the walls of several basements to collapse because the pressure of the ground water on the outside of the basement walls was no longer equalized by the pressure of water on the inside. Wet basements continued to be a problem for several months after the floodwaters subsided.

Suggestions for reduction of flood damages.—Although occasional flooding in Grand Island and vicinity cannot be prevented, much could be done to facilitate overland runoff and thereby minimize the extent of an area subject to inundation. Examination of the map of areas flooded provides clues as to which cross-drainage structures caused ponding of the water and which ditches conveyed floodwater from Wood River into the Warm Slough drainage basin. Enlargement of existing openings through the cross-channel structures and creation of new openings where significant ponding occurred, construction of barriers to flow into the urbanized part of the Warm Slough drainage basin, removal of trees and shrubs that encroach on natural drainageways, and improvements to the Grand Island system of storm sewers would alleviate the flood threat. Consideration should be given to the risks involved in further urbanization of the lower terrace and to the adoption of ordinances regulating development of the flood-prone areas within and adjoining the city.

Acknowledgments.—The authors wish to express their appreciation to the following for information, both verbal and photographic, on the extent of inundation within the Abbott and Grand Island quadrangles: Director of Planning for the City of Grand Island; the Hall County Engineer; personnel of the Nebraska Air Guard, Cornhusker Ordnance Plant, Nebraska Soil and Water Conservation Commission, U.S. Corps of Engineers, and U.S. Bureau of Reclamation; and many residents of the area.

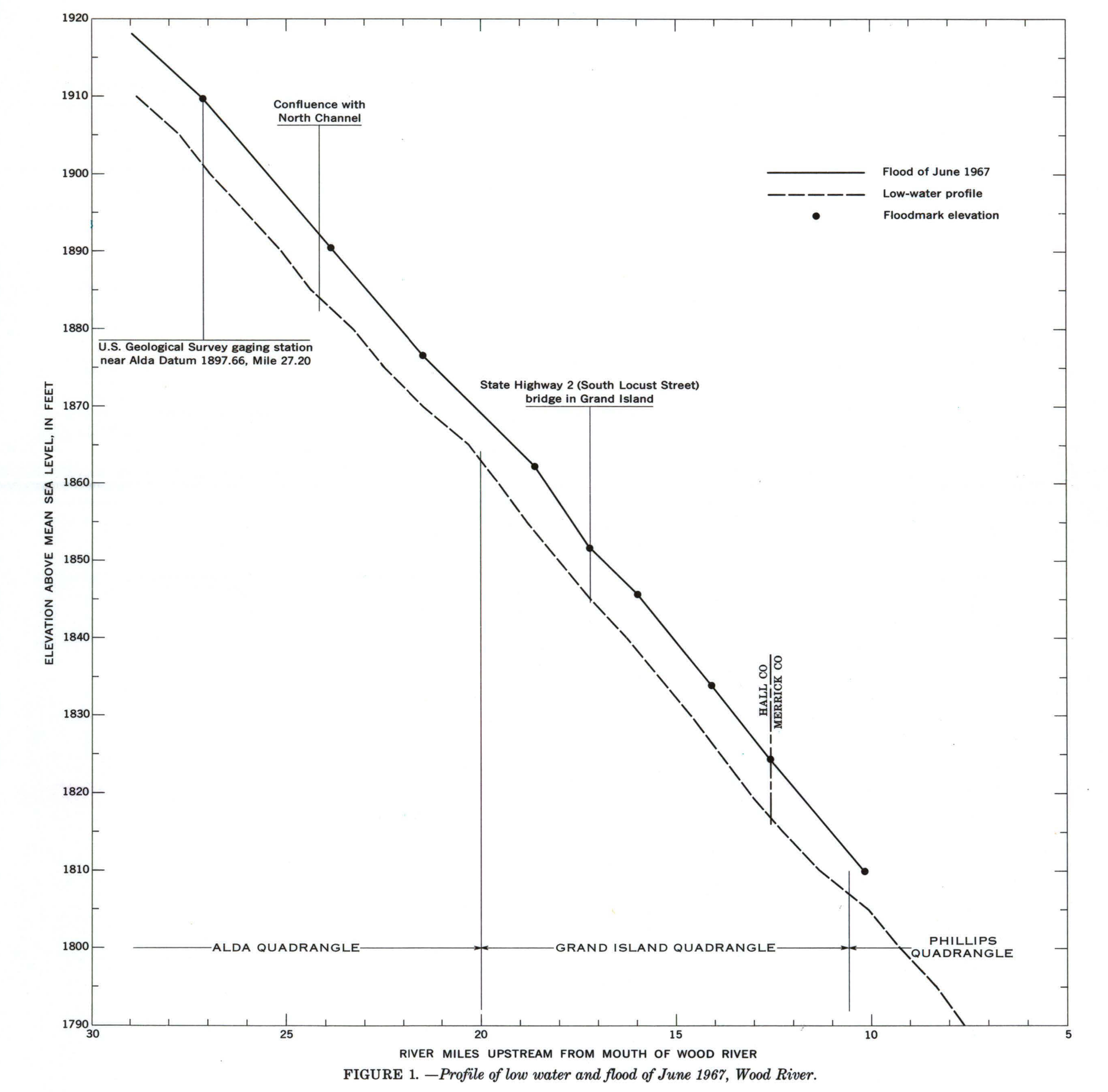


FIGURE 1.—*Profile of low water and flood of June 1967, Wood River.*

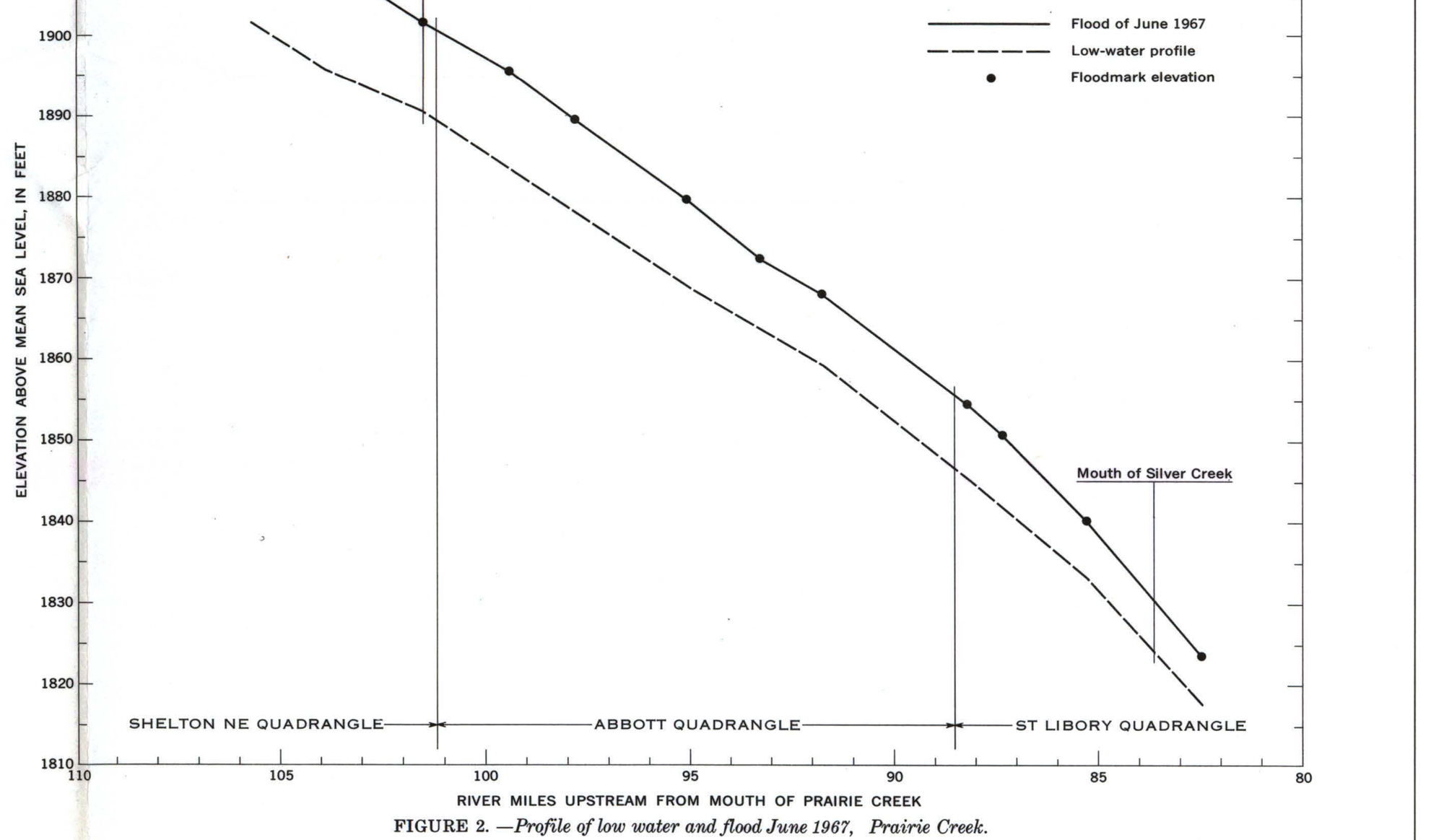


FIGURE 2.—*Profile of low water and flood June 1967, Prairie Creek.*

FLOOD OF JUNE 1967 AT GRAND ISLAND, NEBRASKA

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1970

For sale by U.S. Geological Survey, price 75 cents