HYDROMETEOROLOGICAL INFORMATION CENTER

OFFICE OF HYDROLOGY
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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

NATIONAL HYDROLOGIC OUTLOOK

SPRING FLOOD POTENTIAL AND WATER SUPPLY

NHO 94/1
February 28, 1994

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February 28, 1994

ACKNOWLEDGMENTS

This report is the culmination of the efforts of many people from a number of Federal Agencies. Frequently these Federal Agencies rely on state and regional sources for additional information, such as the collaboration between the California Department of Water Resources and the River Forecast Center in Sacramento. We are indebted to each one for their contributions. We relied heavily on the work of the NWS' River Forecast Centers (see opposite page) and Forecast Offices throughout the Nation. We also want to express special appreciation to the Soil Conservation Service, and in particular to the staff of the Snow Survey Program located in Portland, Oregon. Their network of snow measuring platforms was especially important in defining the snow cover conditions in the Western United States. These snow data were supplemented by satellite information and airborne surveys conducted by the NWS' National Operational Hydrologic Remote Sensing Center, headquartered in Minneapolis, Minnesota.

LIST OF CONTRIBUTING FEDERAL AGENCIES

NATIONAL WEATHER SERVICE
- River Forecast Centers throughout the Nation
- Weather Service Offices throughout the Nation
- National Operational Hydrologic Remote Sensing Center
- Climate Analysis Center

SOIL CONSERVATION SERVICE

U.S. GEOLOGICAL SURVEY

U.S. ARMY CORPS OF ENGINEERS

BUREAU OF RECLAMATION

ADDITIONAL INFORMATION

This Report is intended to provide a summary of conditions throughout the Nation. More detailed information can be obtained from local National Weather Service offices or from the following National Weather Service Regional Hydrologists:

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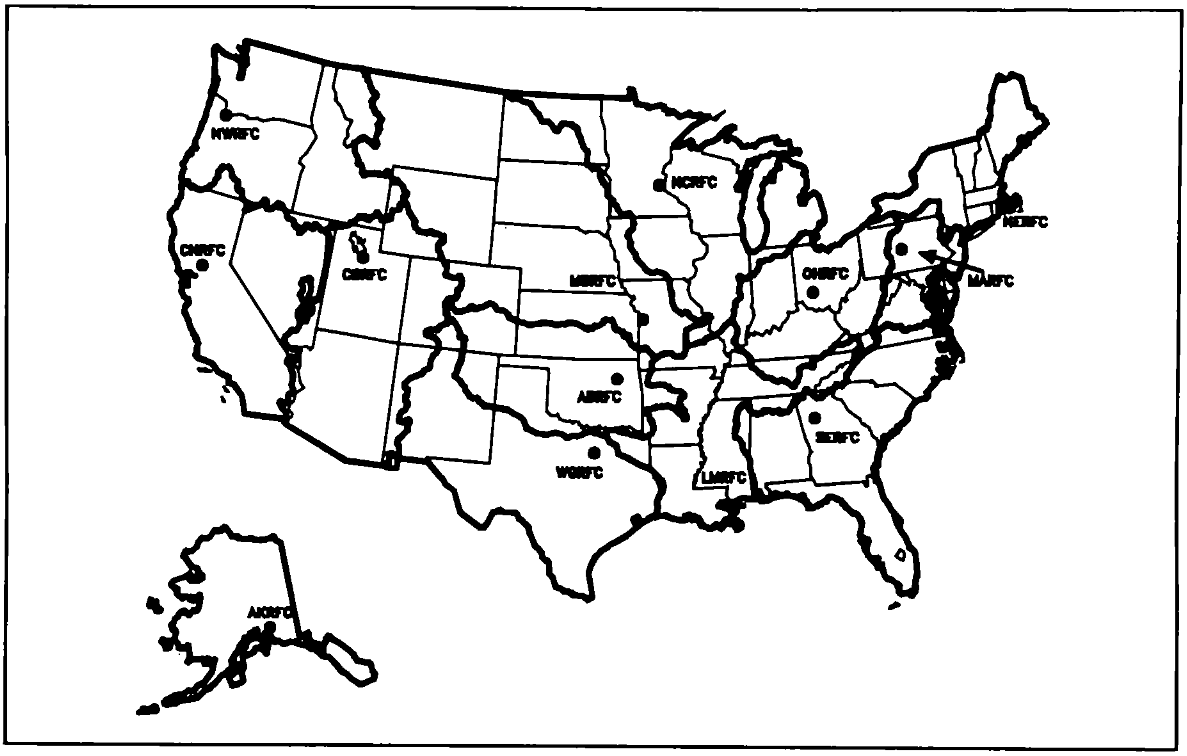


The 13 National Weather Service (NWS) River Forecast Centers (RFCs) are responsible for production of operational hydrologic forecasts and guidance for the Nation's rivers. These products cover a wide span of forecast periods, ranging from the next few days to upcoming multi-month periods. The RFCs prepare a variety of forecast products for almost 4,000 river locations throughout the 50 states. RFCs cover multiple state areas that are generally defined by major river basin boundaries; they work closely with NWS Forecast Offices within their areas of responsibility (shown above). The Forecast Offices use RFC products to prepare outlooks, forecasts and warnings issued to the public.

Acronym Used in Figure	Name	Location
ABRFC	Arkansas-Red Basin	Tulsa, OK
AKRFC	Alaska	Anchorage, AK
CBRFC	Colorado Basin	Salt Lake City, UT
CNRFC	California-Nevada	Sacramento, CA
LMRFC	Lower Mississippi	Slidell, LA
MARFC	Mid-Atlantic	State College, PA
MBRFC	Missouri Basin	Kansas City, MO
NCRFC	North-Central	Minneapolis, MN
NERFC	North-East	Taunton, MA
NWRFC	North-West	Portland, OR
OHRFC	Ohio	Cincinnati, OH
SERFC	South-East	Atlanta, GA
WGRFC	West Gulf	Fort Worth, TX

PREFACE

The maps in this Outlook are intended to depict general hydrometeorological conditions related to water supply and potential flooding. It is possible that local conditions could vary from those shown on these maps. National Weather Service offices in the area of interest should be consulted for more detailed or specific information on local conditions (see Acknowledgements).

In the discussions that follow, it should be noted that the outlooks are based on evaluation and extension of existing conditions. The areas identified as either having a high risk of flooding or water supply problems assume generally normal future conditions. Extreme future precipitation could cause flooding in an area not identified as being flood prone. In fact, flooding can occur in areas of severe water supply shortages. Furthermore, if moisture deficits are of longstanding duration, even short-term, intense rainfall may not be sufficient to eliminate water supply shortages.

The factors which lead to flooding differ across the country. Flooding can and does occur in all states at all times of the year. Still, flood potential for any given area may be higher at certain times of the year than at others. In some areas of the country flood potential is highest in spring because of the contribution of melting snow. In these areas the flood potential is largely determined by how much snow accumulates over the winter and by how fast it melts in the spring, as well as whether it is accompanied by significant rainfall. For example, the Northern Plains of the United States are especially susceptible to this type of flooding, called spring snowmelt flooding. Conversely, flooding along the Pacific Coast typically occurs in winter as a result of heavy rain, with snowmelt only occasionally acting as a contributing factor. In a third example, flood potential is highest in Florida and along the eastern Gulf Coast during the autumn, when tropical cyclones and their associated rains are most likely to impact the area. However, for much of the country, flood potential is high in the spring due to the possible contributions from snowmelt, ice jams, and spring weather patterns which can produce heavy rains.

It should be noted that the maps in this report depict flood potential for all parts of the country, based on the current state of all factors which can lead to flooding in that area.

The significance of a reservoir's contents, especially if specified in terms of a percentage of its average storage or total capacity, depends on the size of the reservoir, the average content at a given time of the year, the local climate and the purpose of the reservoir (e.g., power generation, flood control, water supply). Larger reservoirs are often designed to withstand droughts of more than one year's duration and, therefore, to hold water over a multi-year period. Care should be used in interpreting capacity percentages. A large reservoir can have a storage which is 60 percent of capacity, yet that might correspond to 100 percent of average storage for a particular time of year and may provide ample water supply. Conversely, a smaller reservoir may contain 60 percent of average, but, under normal demand conditions, may experience delivery problems without normal to above normal precipitation because its lower storage capacity provides limited reserves.

SPRING FLOOD POTENTIAL AND WATER SUPPLY OUTLOOK
February 28, 1994

EXECUTIVE SUMMARY

Current hydrometeorological conditions across the area impacted by The Great Flood of 1993 suggest that some spring flooding could occur, even with just normal future precipitation. In fact, an area which encompasses portions of the eastern Dakotas, western Minnesota and northwestern Iowa is one of two areas across the Nation that are presently of greatest concern to the National Weather Service with respect to spring flood potential. The main factors contributing to this elevated flood risk are a much above average snow pack in this area, high streamflows, and residual moisture from The Great Flood of 1993, now held captive in the soils, streams and reservoirs of the area. The key unknowns are the nature of the spring melt and how much rain will fall this spring and summer. Clearly, though, unless extreme precipitation amounts such as that which fell last year are repeated, widespread disastrous flooding is unlikely.

The second area of considerable concern for spring flooding is located in the Northeast and includes portions of southern and western New England, most of New York, most of Pennsylvania and western New Jersey. Much above average snow cover is again a major contributing factor to the flood threat in this region.

Given the cold temperatures which have prevailed across much of the northern tier of states to the east of the Rockies this winter, it is not surprising that many rivers are more choked with ice and snow than usual. As such, local flooding due to ice jams is a real possibility during the next few weeks.

However, in spite of the above average flood potential which now exists over nearly the entire eastern half of the Nation, future hydrometeorological conditions during the next several weeks will be key in determining how much of this potential translates into actual flooding. Similarly, excessive rainfall can cause flooding in areas without current high flood potential.

Meanwhile, most of the West has experienced an unimpressive winter so far. Precipitation, especially in the form of mountain snowfall, so critical to western water supply, has once again fallen short of normal so far during Water Year 1994. A series of storm systems during the second and third weeks of February have mitigated an otherwise dismal snow season, but some interior sections of the West face what seems to be an omnipresent threat of water supply shortages during upcoming months.

INTRODUCTION

The National Hydrologic Outlook provides a general assessment of hydrometeorological conditions across the Nation, focusing on problem areas relative to spring flood potential and water supply shortages. Hydrometeorological conditions addressed in the reports include precipitation, temperature, snow cover, streamflow, soil moisture, river ice and others. General national meteorological and hydrologic overviews are followed by brief descriptions of conditions in each of the areas serviced by the 13 National Weather Service (NWS) River Forecast Centers (RFCs).

METEOROLOGICAL OVERVIEW

This section reviews the weather conditions across the Nation since the start of Water Year 1994 (October 1, 1993) to the present (February 26, 1994).

Few people need to be reminded of The Great Flood of 1993 which devastated a nine-state area last summer across the upper Mississippi River Valley. Excessive rainfall resulted in the wettest summer (June-August) on record across most of the north-central United States. The heaviest rains were centered over Iowa, where as much as 37 inches fell during the three-month period. The resulting floods were disastrous, taking dozens of lives and causing billions of dollars in damage. It seemed to many midwestern residents that the rains would never end, but the most welcome feature of the weather of autumn 1993 (September-November) was, in fact, much drier conditions over most of the area impacted by the flood. For example, while North Dakota observed its wettest summer since records began in 1895, the three autumn months were the ninth driest on record.

Still, not everyone was so fortunate. After experiencing its sixth wettest summer ever recorded, flood-weary Missouri then had its second wettest autumn. Indeed, the precipitation did not end, it simply shifted southeastward into another region: autumn 1993 proved to be abnormally wet across the mid-Mississippi and Ohio River Valleys.

In spite of the excessive precipitation over some regions, the Nation as a whole experienced a slightly drier than normal autumn, influenced to a large extent by very dry conditions across most of the far West. Excluding the dry far West and the wet middle-Mississippi and Ohio River Valleys, most of the rest of the country had nearly normal autumn precipitation.

With respect to temperatures, autumn 1993 was exceptionally cool. The three month period (September-November) was the coolest such period since 1976, and the third coolest since records began in 1895. Save for the western and eastern peripheries, most of the country was dominated by submedian temperatures. Coolest temperatures were observed across the central part of the country, where 17 states experienced one of their ten coolest autumns in recorded history. Only small portions of the far West and Southeast observed a warmer than normal autumn.

Continuing the dry trend established during the autumn, December 1993 was a dry month for the Nation, on average. The majority of the country was dominated by normal or below normal precipitation. Even the rain-soaked mid-Mississippi and Ohio River Valleys observed below normal precipitation. Following a very dry autumn, unusually dry weather continued across all of the West. Nation-wide, only small pockets of above normal precipitation occurred, limited to portions of the north-central states, the central plains, south Texas, the Appalachians, and the Northeast.

Meanwhile, December temperatures reversed the cold trend established during the autumn months. The Nation as a whole recorded a significantly warmer than normal December, with submedian temperatures limited only to portions of the southwestern and eastern states. Warm temperatures were most evident across the central states.

January 1994 saw exceptionally dry weather continue across all of the West. Indeed, many states from the Rockies westward saw one of their ten driest Januaries ever recorded. The deficiency in western precipitation was great enough to influence the national mean for January, as the national average continued significantly drier than normal. Yet, the eastern two-thirds of the country observed near-normal or above-normal precipitation. Wet conditions stretched from western Texas northward across the High Plains states and into the upper Great Lakes. Heavier than normal precipitation also fell across much of the lower Mississippi and Ohio Valleys, the Northeast, and Florida.

Temperature anomalies in January split the Nation in two: the western half of the country from central Montana southeastward to western Louisiana was above normal, while the rest of the country, except for south Florida, was below normal. Most unusual was the Pacific Northwest region, which witnessed its warmest January since records began. In contrast, portions of the north-central, Great Lakes, and northeastern states observed one of their ten coldest Januaries in recorded history. Averaged together, the Nation experienced a slightly colder than normal month.

Finally, February began dry and cold across most of the country, except for portions of the Southeast. In particular, abnormally dry weather continued across the West. Then, during the second week of February, a series of wet storm systems finally crashed into the West Coast, bringing much needed precipitation to the region. After a brief respite, more storms moved across the West during the third week of February. While drier conditions have again returned to the West presently, the mid-month storminess did brighten the 1994 Water Year picture. Still, portions of the West remain vulnerable to the possibility of redeveloping drought conditions, due to long-term precipitation and reservoir storage deficits.

Meanwhile, following a dry first week, the remainder of February has proven to be quite wet across nearly all of the eastern half of the Nation. The wet weather has, until recently, been accompanied by unusually mild temperatures. As a result of the wet and mild weather, considerable flooding broke out across much of the eastern half of the Nation during mid-February.

In summary, Water Year 1994 has been characterized by a gradual but nonetheless welcome reduction in the anomalously wet conditions found across the region affected by The Great Flood of 1993. Still, enough residual moisture remains in the soils, streams and reservoirs across the region to be of concern during upcoming weeks. In fact, as the following sections will describe, most of the eastern half of the country is entering the spring with wetter than normal hydrologic conditions. Meanwhile, much of the West has observed a drier than normal water year thus far, raising concerns about redeveloping drought conditions. However, recent February storms have improved conditions substantially across much of the far West. Water year temperatures have been variable, though much of the eastern half of the country has suffered through a miserably cold winter, especially across the northeastern quarter of the Nation. Finally, in contrast to several recent winters, Alaska has experienced a milder and drier winter thus far. However, portions of interior Alaska have an above average snowpack at this early date.

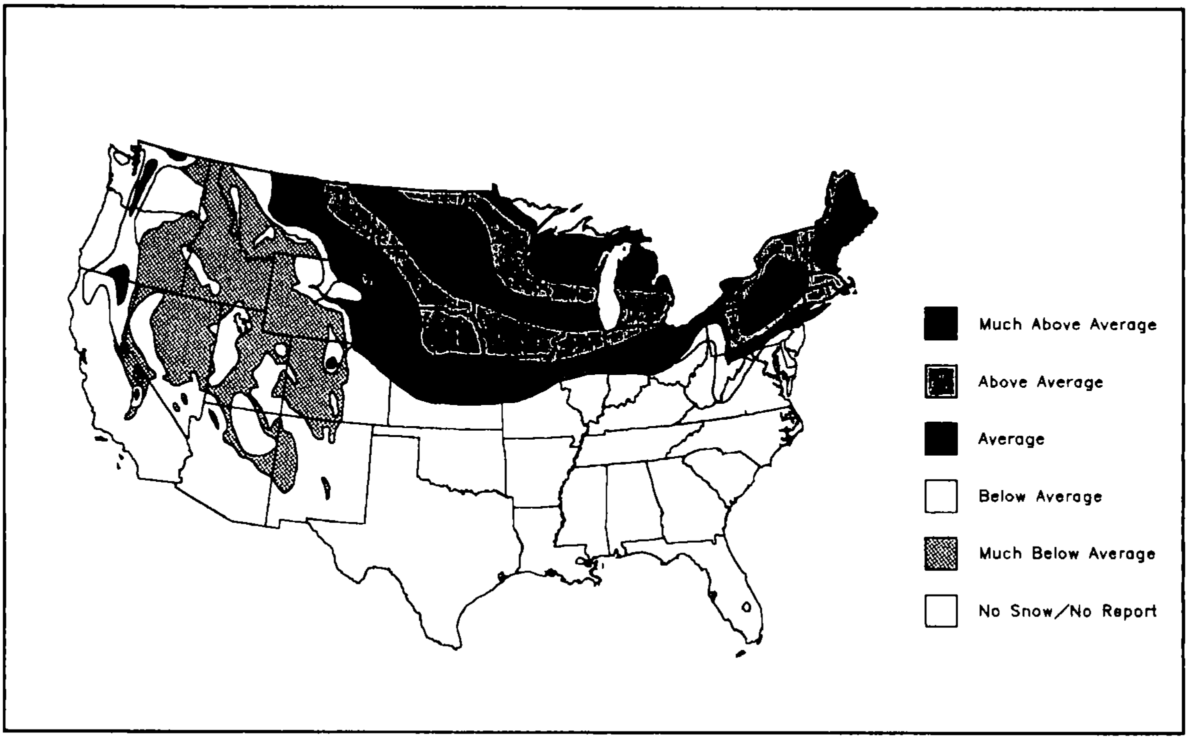


Figure 1. *Snow cover conditions as of February 26, 1994.*

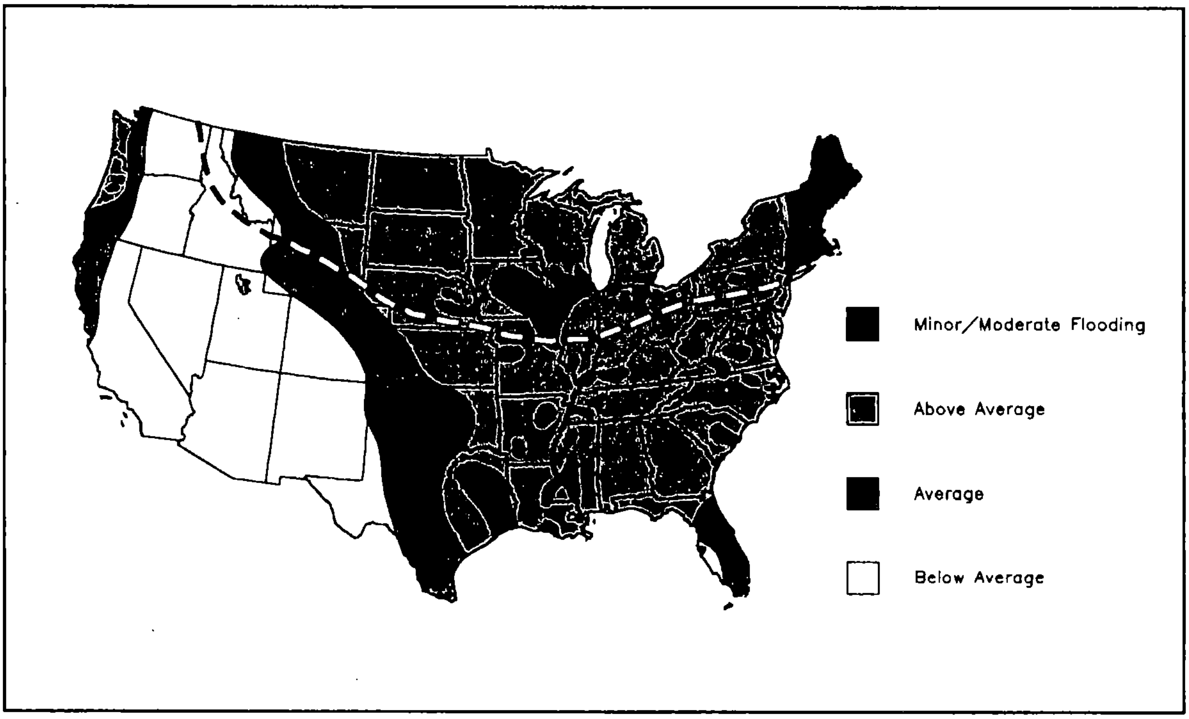


Figure 2. *Streamflow conditions for February 26, 1994. Ice jam flooding is possible north of the dashed line where some rivers are frozen.*

HYDROLOGIC CONDITIONS

As indicated above, this winter has been one of contrasts. Until recently, the West had been unusually dry, while the East received copious precipitation, with snow in the north and considerable rainfall to the south. The dividing line, this year, was marked by a number of severe ice storms. Much of the northern tier of states also experienced prolonged cold weather throughout much of the winter. This resulted in significant build-up of river ice. It also produced areas with deeply frozen soils.

This pattern was interrupted by a late January/early February thaw which was accompanied by rain and raised water levels underneath the ice, forcing the ice to break up. This led to ice jam flooding in Ohio, Pennsylvania, New York and Vermont.

Within the last 2-3 weeks, significant changes in the meteorological flow patterns have emerged: many areas in the West experienced major storms, in some cases, raising their paltry winter precipitation totals to within hailing distance of normal seasonal levels. In much of the northeastern quadrant of the United States, from Nebraska through the Mid-Atlantic region, another warm and rainy period recently occurred. This resulted in flooding from rain, melting snows and river ice jams in Ohio, Indiana, Kentucky and Tennessee. The most severe flooding occurred in West Virginia, where locally heavy rainfall resulted in some of the worst flooding in nearly a decade. Flooding also led to some evacuations in northern Illinois.

The net result of these ups and downs is reflected in the snow cover map shown in Figure 1. Much of the Intermountain region shows much below average snow cover. There are pockets of average snow amounts in the Cascades and Sierras in the western part of the Nation. This is due to a doubling of the snow pack within the past two weeks. The dearth of snow in the West seems to be balanced by a current substantial snow cover east of the Rockies. This eastern snow cover is all the more remarkable, considering the significant melt of snow during both the late January/early February thaw and the very warm weather around Presidents' Day weekend.

Over the long term, the melt-related flood events already experienced may come to be seen as the lesser of two evils. Although a considerable number of individuals did have their lives disrupted by flooding during these warm episodes, without them, the snow cover would have been much deeper, greatly increasing the possibility of much more severe flooding later.

A band of significant snow cover extends from extreme northeast Montana, southeastward into the Dakotas, Minnesota, northern Iowa, and along the Wisconsin-Illinois state line to Lake Michigan. Much of the rest of the High Plains-Midwest region also currently has substantial amounts of snow on the ground. Much of the snow in the area around northern Illinois is the result of a recent storm, replenishing a snow pack depleted by previous warm, wet weather.

The upper portions of the Ohio Valley (eastern Ohio, western Pennsylvania and most of West Virginia) have had limited snow since the flooding associated with the late January/early February thaw. To the east, substantial amounts of snow remain on the ground in the eastern two-thirds of Pennsylvania, much of New York, and much of New England.

The meteorological patterns described in the previous section and above have resulted in generally high streamflows in the eastern two-thirds of the United States, as well as in limited portions along the coast in the Pacific Northwest (Figure 2). Much of the Intermountain region has below normal river

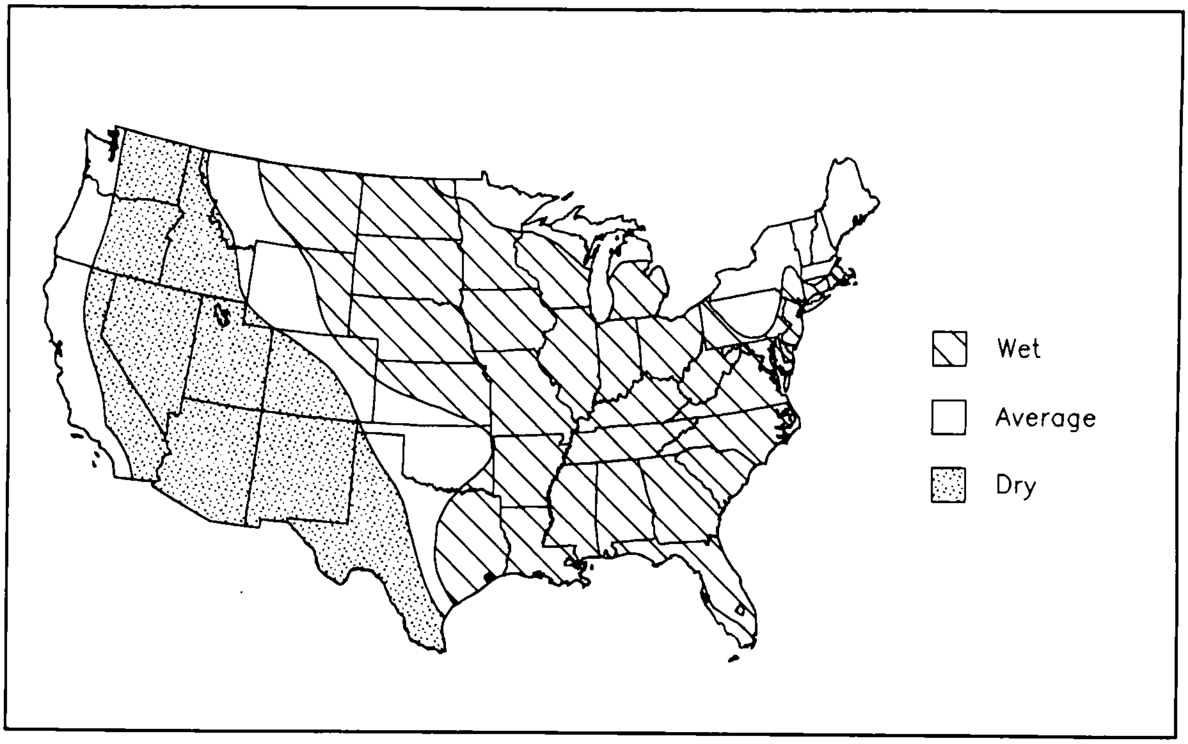


Figure 3. *Soil moisture conditions as of February 26, 1994.*

and stream levels, with transition zones of generally average flows between the two extremes. There are numerous pockets of minor-to-moderate flooding in the eastern United States. In the southern areas, they are the result of substantial rainfall. The flooding in the northern areas is generally residual flooding from the recent rain/melt conditions.

The soil moisture conditions shown in Figure 3 mirror quite closely the pattern shown in the streamflow map (Fig. 2). Obviously, the same conditions leading to high streamflows moistened the soils in the affected drainage basins; low flows are indicative of recent dry conditions and are associated with low soil moisture.

While emergency management agencies continue to vigilantly watch conditions in the Midwest, where flooding devastated a nine-state area for most of last summer, conditions in other parts of the eastern two-thirds of the United States are also of considerable concern. Much of the area ravaged by last summer's flooding has had a relatively dry fall and winter, thus far. This has helped to moderate the flood threat in that area.

Identifying areas of above average flood potential include consideration of the factors included in the sidebar on page 10. By far the most uncertain factor is both the amount and distribution of future precipitation and temperatures. Figure 4 shows the 30-day precipitation (Fig. 4(a)) and temperature (Fig. 4(b)) outlooks prepared by the NWS' Climate Analysis Center.

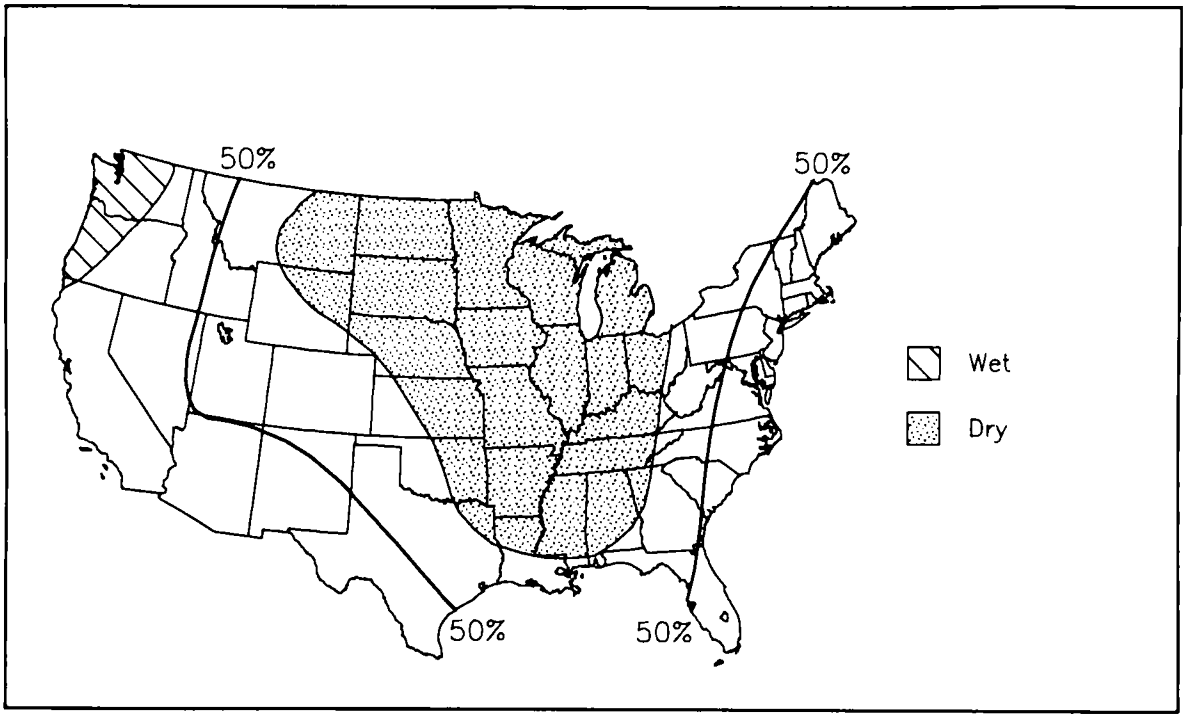


Figure 4(a). *30-day precipitation outlook for March 1994 (prepared by the Climate Analysis Center).*

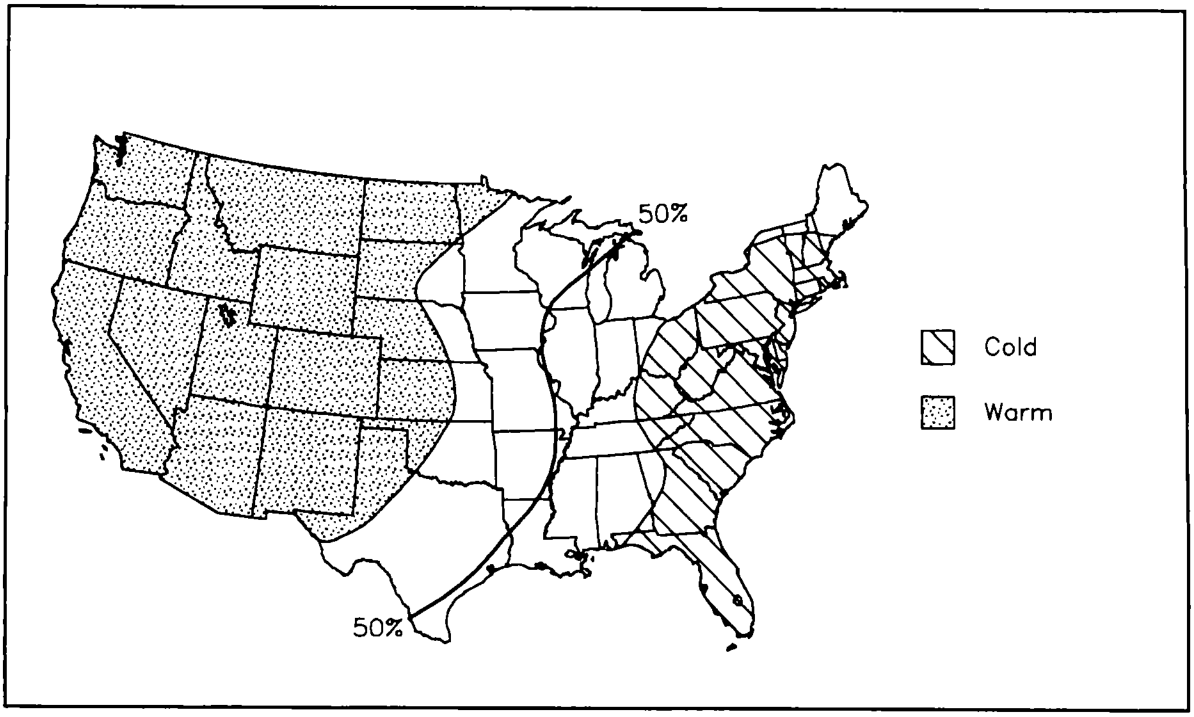


Figure 4(b). *30-day temperature outlook for March 1994 (prepared by the Climate Analysis Center).*

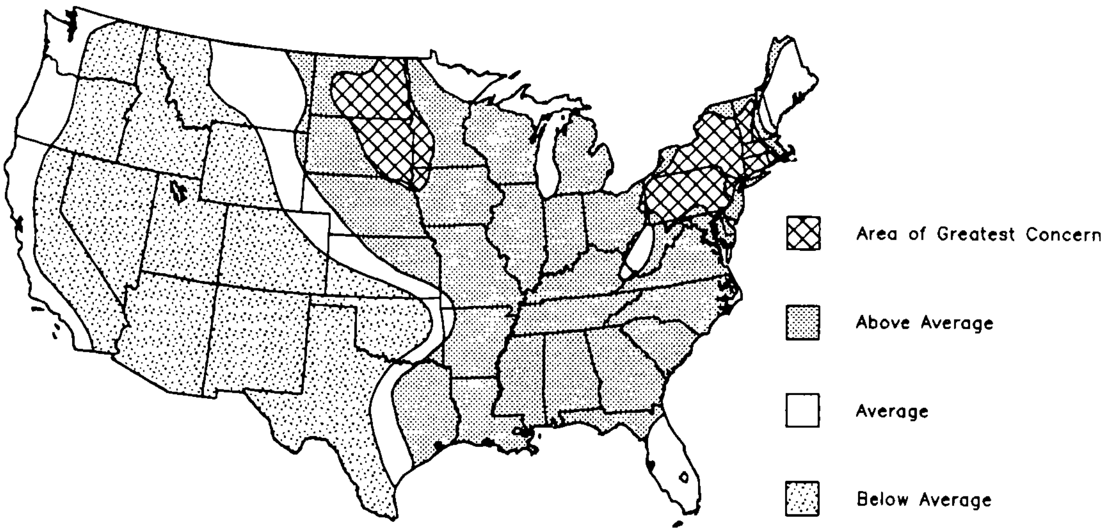


Figure 5. *Flood potential as of February 26, 1994.*

The flood potential map shown in Figure 5 is the result of consideration of all the elements discussed above. Most striking is that much of the United States, east of the Rockies, has above average flood potential. An area of considerable concern extends from northwestern Iowa, westward and northward to the Canadian border. This is the result of deep snow cover (Fig. 1) in an area with high streamflow (Fig. 2) and on soils that generally remained moist following summer flooding (see Fig. 3). Another area of concern includes much of Pennsylvania, New York, and southern and western New England. The concern is based on deep snow containing significant amounts of water. In addition, cold temperatures have frozen many rivers in this area with ice in excess of two feet thick in some places. As the snow melts, and if the melt is accompanied by rain, the ice will break up and jam at constrictions in the rivers.

In fact, to the north of the dashed line shown on Figure 2, many streams are ice covered. River rises associated with spring rains and snow melt can cause this ice to break up. While short-term temperature and precipitation forecasts can identify periods when ice jam flooding is likely, at this time there is no way to forecast the precise nature of the break up and the complex interaction between the ice floes and the rivers. However, ice jams do tend to form in preferred locations. NWS offices throughout the country continuously monitor for ice jam flooding and are able to provide effective short-term forecasts.

While snow and ice is not a problem in the South, continuing moist conditions also indicate elevated flood potential in areas from the Atlantic coast westward to eastern Texas, Arkansas, and eastern Kansas and Nebraska. Exceptions to these above average flood potential conditions in the East

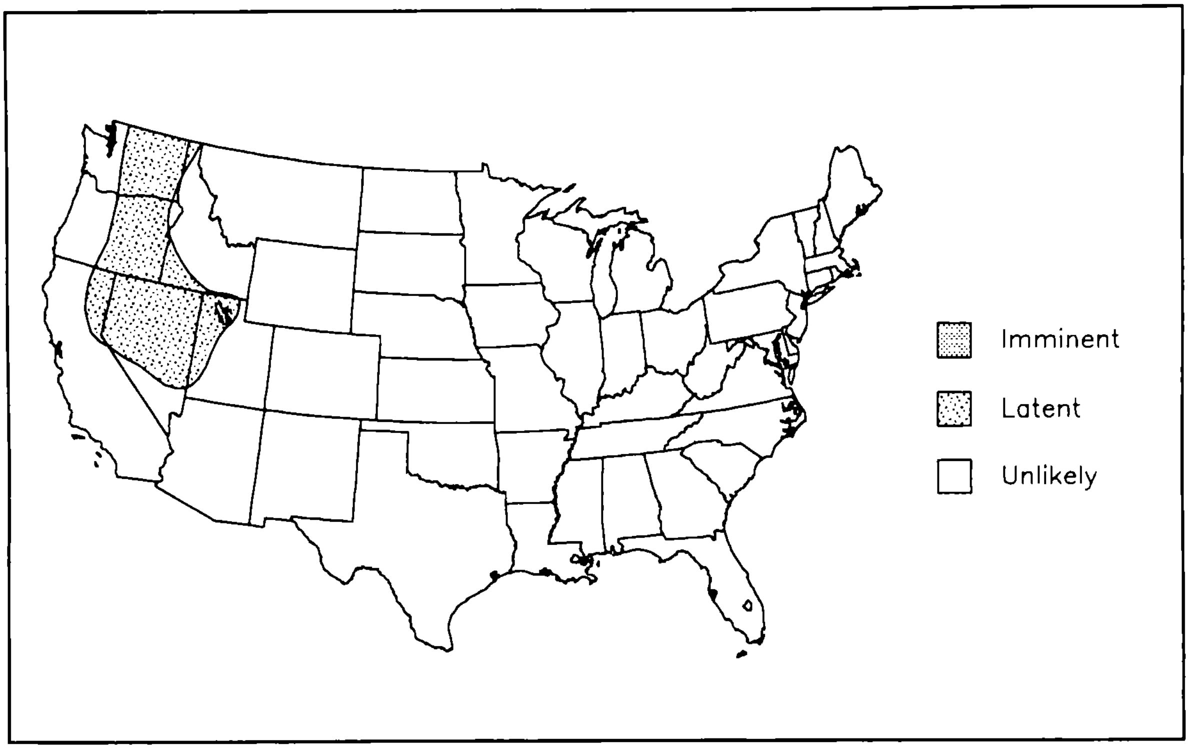


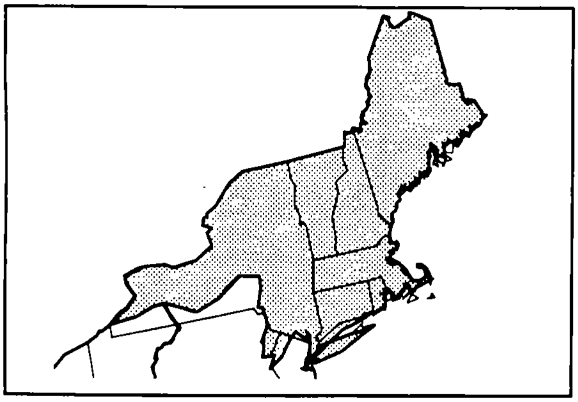
Figure 6. *Areas of potential water supply shortages as of February 26, 1994.*

include an average likelihood of flooding in Maine, eastern New Hampshire, parts of western West Virginia, and southern Florida.

The wet conditions in the eastern portion of the nation are in sharp contrast to those in the West, where snowfall has been much less than normal so far this winter. The last few weeks have seen wetter weather in portions of the western United States. In spite of this, flood potential is still below average, except along the Pacific coast.

While many areas of the country presently have an elevated risk for flooding, future conditions (snow, rain and temperature patterns) will ultimately determine whether this potential will translate into flooding. Just last spring, very heavy snow cover across much of the Northeast suggested the possibility of major flooding. However, favorable meteorological conditions generally resulted in a gradual melt, with only limited flooding problems. Conditions over the next month will have a major influence on the magnitude and extent of flooding this spring.

Precipitation during the 1992-93 winter provided many western states with relief from long-standing drought conditions, but concern is again rising that nature may fail to deliver even normal snows this winter. Winter snowfall, upon melting in late spring, provides for the majority of the West's water needs during the following summer and into the next water year. As indicated above, until the last few weeks, western precipitation fell far short of average. Figure 6 shows that eastern Washington, Oregon, much of Nevada, and smaller portions of California, Utah and Idaho may have water supply problems, unless the recent wet trend continues.



FACTORS THAT INCREASE FLOOD POTENTIAL

Wet Soils
Rain and snow melt cannot be absorbed if the ground is saturated - it rapidly runs off into rivers and streams.

High Stream Levels
Little additional runoff is necessary to push streams over their banks.

Full Reservoirs
There is no ability to retain flood flows and attenuate the flood crest.

Frozen Ground
Generally has the same effect as saturated soils.

Ice-Covered Rivers
As rivers rise due to snow melt and/or rainfall, ice fractures and flows along the river until it reaches a constriction where it can jam, forming a temporary dam. Water can rapidly rise and flood behind the jam, and, if the jam suddenly breaks, water can flood downstream locations, sometimes carrying enormous ice floes that can crush anything in their path.

Deep Snow Cover
Snow melt, combined with rain can rapidly raise stream levels. Snow melt alone is not usually sufficient to cause major flooding.

Widespread, Heavy Rain
No matter how unfavorable all the above factors may be, given enough rain, flooding is inevitable.

NORTHEAST

The cold and snowy winter of 1993-94 will not be soon forgotten in many parts of the northeastern United States. For many, it was and continues to be one to tell the grandkids about. This is especially true for much of southern New England and New York where many recent winters left people subscribing to the idea of global warming. The result of this dramatic shift in climatic fortunes is that flood potential for a good portion of the Northeast is higher than it has been for quite some time - at least a decade in many places (Fig. 5).

The stage was set for the current situation by a cool, wet autumn across the Northeast, especially New York state. Much of the region had experienced a very warm, dry summer so the precipitation was very welcome. The wet fall was still not enough however, to allow for the removal of drought warnings for New York City. December was a relatively normal month in terms of precipitation and temperature, although parts of Maine were substantially warmer and wetter than normal.

An abrupt change in the atmospheric circulation patterns occurred shortly before Christmas 1993 across the United States as a strong, persistent blocking ridge at upper levels established itself just off the Pacific coast. Downstream a deep circumpolar vortex centered near Hudson's Bay took control of the weather over the eastern half of the United States. This pattern led to repeated arctic outbreaks affecting much of the east throughout January, with temperature departures of 6-12°F below normal across the entire Northeast. Both Maine and New York state experienced their coldest January on record and numerous extreme low temperature records were set. It was the coldest January in the region since 1977 and the third coldest in the past 100 years. Despite the intense cold, precipitation was well above normal, nearly all of it falling as snow and ice except for heavy rains in late January. Some flooding and ice jamming occurred in southern New England as the heavy rains unlocked some of the accumulated snow and ice. Such a situation could be a harbinger of things to come this spring.

February has seen a continuation of the wet pattern across the Northeast, although the intense cold has ameliorated somewhat. The New York City metropolitan area and southern New England built an impressive snow cover after two major snowstorms left in excess of 20 inches on the ground by mid-month. Unseasonably warm temperatures and ideal snowmelt conditions favored most of the region for several days near Presidents' Day. This resulted in a dramatic reduction and compression of the snow cover especially over the south. Moderate rises were observed on unfrozen streams and rivers but no flood stages were reached. Several smaller snow storms have affected the Northeast since this thaw period, the latest dropping from 2-6 inches across the southern New York and New England.

Current snow cover conditions (Fig. 1) indicate near average conditions throughout much of Maine and New Hampshire where snow depths are from 10 to 30 inches and snow water equivalents range from 2-9 inches from south to north. It is over much of southern New England and New York state that snow cover conditions are anomalous and remain a cause for concern in terms of flood potential. Snow water equivalents in parts of central New England and south central New York range upwards to near 7 inch amounts. For the Berkshire mountains of Massachusetts and northwest hills of Connecticut this is considerably higher than usual. Average to slightly above average snow water equivalent values are found across upstate New York and Vermont, with up to 10 inches of water equivalent in the northern Green Mountain's snowpacks.

Rivers and streams across the northern sections of the Northeast are still frozen solid and will have to be watched later in the spring for ice jam flooding. In central and southern New England and New York state there is less uniformity in terms of river ice, but ice jam flooding could occur sooner on these rivers if the proper combination of runoff and thaw takes place. At least 10 ice jams exist on various rivers and streams in Connecticut at this time, with several more reported in Massachusetts. Although favored locations do exist, it is nearly impossible to predict the exact location of ice jam flooding and it can develop rapidly. The cold temperatures that have returned this weekend should preclude any new ice jam problems as river ice now in place will show little movement. Streamflows in general are near to slightly above normal where recent snowmelt runoff has caused some rises (Fig. 2).

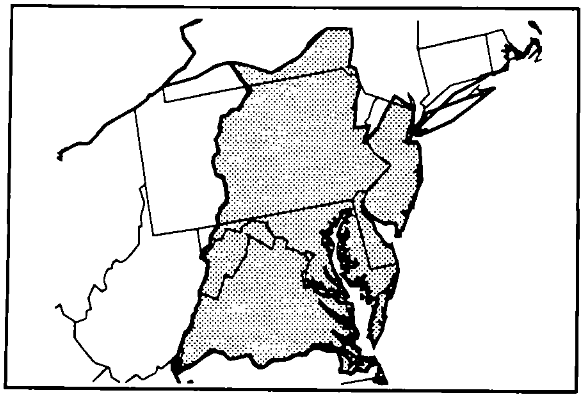
Soil moisture (Fig. 3) in the Northeast is near normal across most of the area, although the recent melt has saturated the ground over southern sections. The status of soil moisture will only become a factor after snow melt commences and the runoff attempts to infiltrate the ground. At that time the existence of frozen soils can have a significant impact on the course of any runoff event.

Regarding the water supply situation for metropolitan New York, Figure 6 does not suggest any problems are likely. Nonetheless a drought warning continues for the city and some surrounding counties. Drought management officials may well be waiting for the spring runoff to replenish the reservoirs and in all likelihood will lift the drought warning sometime this spring.

In summary, at this time, there is cause for concern over the possibility of spring flooding in New York state and New England. This is due in large measure to the existence of substantial water in the snow cover in these areas. The most vulnerable areas include southern and western

New England and much of New York state, especially the northern plateau east of Lake Ontario. There is also the possibility for ice jam flooding over nearly the entire region, although northern rivers with thicker ice appear to be more susceptible, but for later this spring. Severe flooding in the Northeast usually requires a rapid warmup combined with heavy rains. However, an orderly melt such as was experienced around Presidents' Day in February could prevent the development of anything more than minor flooding.

This flood potential outlook is necessarily based on current conditions, but it is future developments that will ultimately decide the nature and extent of any flooding. In terms of future weather, outlook certainty decreases as the time horizon increases. In the near future (the next 3-5 days), it now appears that a significant storm may affect much of the eastern United States, but primarily south of New England. Medium range forecast models cannot agree on an exact track for this storm, but it is likely that any precipitation that does fall in the Northeast would be of the frozen variety. Temperatures are expected to remain cold before and after this storm. Moving beyond the medium range into longer time frames, the Climate Analysis Center 6-10 day outlooks and 30 day outlooks (Fig. 4(a) and 4(b)) for the Northeast indicate that the generally cold and wet pattern will continue. The longer into the spring that the deep snowpack remains intact, the greater the possibility of a more rapid meltdown, so these long-range outlooks are not particularly encouraging.



MID-ATLANTIC

Western and northern portions of the Mid-Atlantic region are covered with snow (Fig. 1), while snow is presently absent across southern portions. Over the northern half of the region (north of the Mason-Dixon line), the snow on the ground is quite significant, and ranges in depth from 4-25 inches. Water equivalent of this snowpack ranges from 0.5-6.5 inches. The deepest snow and highest water equivalent amounts are found across portions of the Chemung, Chenango, Upper Susquehanna, and Upper Delaware River Basins of southern and central New York. Similarly, much above average snow conditions are found across middle portions of the Susquehanna River Basin in central and northeastern Pennsylvania.

Streamflow (Fig. 2) is currently running above average over the entire region. For example, on February 27, the Susquehanna River near Harrisburg, Pennsylvania, was flowing at 171 percent of average February flow, while the Schuylkill River at Philadelphia, Pennsylvania was flowing at 139 percent of the February average, the Delaware River at Trenton, New Jersey was also at 139 percent of its February average, and the Potomac River at Little Falls, near Washington, DC was at 497 percent of the February average. Some minor flooding is occurring along a portion of the West Branch of the Susquehanna River in Lycoming County, Pennsylvania, due to ice jams. Elsewhere in the region, some minor flooding is also occurring along portions of the James and Appomattox Rivers near Richmond, Virginia. Because of the cold winter, many streams and rivers across the northern half of the region still contain a thicker than normal layer of ice (see dashed line in Fig. 2).

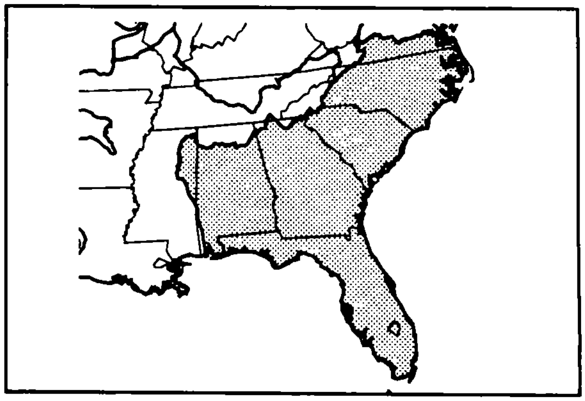
Soil moisture conditions (Fig. 3) are near normal over the extreme northern portions of the region, and wet over the remainder of the region. Additionally, the development of a significant snow cover fairly early in the winter across the northern half of the region inhibited soil frost formation. Reduced soil frost is beneficial because soils frozen and hardened by frost cause snowmelt to runoff rather than be absorbed.

The latest 30-day precipitation outlook (Fig. 4(a)), valid for March 1994, suggests precipitation will average near normal across the region. However, the 30-day temperature outlook (Fig. 4(b)) indicates that a colder than normal month is possible across the entire region. Meanwhile, closer to the present, forecast information at the time of writing (February 27) suggests the possibility of a significant precipitation event (possibly some snow) across at least southern and eastern portions of this region during the first few days of March.

When all of the above factors are taken together, the flood potential (Fig. 5) for the Mid-Atlantic region is above average. In fact, at the present time, the northern half of the region is part of an area that is of greatest concern nationally. Within the Mid-Atlantic region, this high threat area includes all of the Susquehanna River basin and a portion of the Delaware River basin. Much above average snow conditions, above average streamflow conditions, and generally high soil moisture are the primary factors resulting in this concern. Future hydrometeorological conditions over the next 2-6 weeks could greatly influence the extent to which this above average flood threat translates into actual flooding. Should a rapid melt of the snowpack combine with persistent, heavy precipitation, major flooding would likely result. Additionally, the threat of local flooding due to ice jams (see dashed line in Fig. 2) is also significant across northern portions of the region, particularly along the Chemung, Chenango and Upper Susquehanna Rivers. Already this month numerous ice jams have formed, causing high water levels and some minor flooding.

Finally, based on current conditions and normal weather in the future, no water supply shortages are anticipated anywhere in the Mid-Atlantic region during upcoming months.

SOUTHEAST



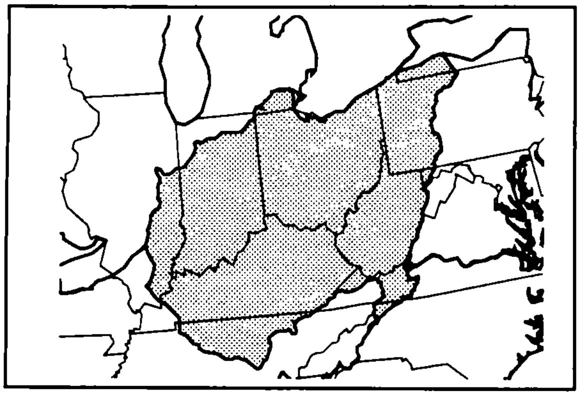
The period from spring through early winter of 1993 was unusually dry. Drought conditions were widespread across the region. This eventually came to an end as frequent periods of moderate rain have occurred over most areas since December. This rain has brought soil moisture levels to near saturation except in southwest Florida where seasonally dry conditions continue (Fig. 3).

Because of the mild climate, snowmelt is rarely a factor in causing flooding across the southeastern United States. When some unusual event occurs, the snow melts within a few days after snowfall. This year is no exception with no snow cover (Fig. 1) in the Southeast.

Spring flooding is made more likely by saturated soils and high streamflows. Because of recent rainfall events, levels rose to an above average category on rivers and streams (Fig. 2). Most rivers and streams remain below bankfull with the exception of minor flooding in progress on the Dan River in Virginia, the lower Roanoke River in North Carolina, and the extreme lower Santee River in South Carolina. However, in Florida, streamflow ranges from above average in the panhandle to below average in the southwest part of the state.

Reservoirs are near normal levels and in good shape with the exception of Lake Lanier which remains nine feet below full pool. On the other hand, the John H. Kerr reservoir on the North Carolina-Virginia state line is four feet above normal.

The flood potential (Fig. 5) for the Southeast region is mostly above average except for the southern two-thirds of Florida where it is average. There are no water supply shortages expected (Fig. 6). The precipitation outlook (Fig. 4(a)) through March indicates slightly below normal precipitation for the entire Southeast with cool temperatures (Fig. 4(b)). In the near term, a significant rainfall event will likely affect much of this region during the first couple of days in March.



OHIO RIVER BASIN

Most of the Ohio River basin currently has an above normal flood potential (Fig. 5). The area of greatest concern is in the Allegheny River basin of western Pennsylvania and New York. Extensive snow cover, elevated streamflows, and high soil moisture are present in varying degrees across the basin to produce this elevated flood potential. In addition, ice jam flooding remains a possibility in the northern half of the Ohio basin.

The precursor to these conditions was an extremely wet fall (September-November) throughout the region; Indiana had its wettest autumn in the last 100 years, and the other states were also extremely wet. Precipitation in December was much less extreme, with above normal amounts confined to southern Kentucky and West Virginia. January ushered in some of the coldest weather in over a decade in much of the Ohio Valley. An extreme outbreak of arctic air just past mid-month led to numerous monthly and all-time record low temperatures. Among the records were: Charleston, West Virginia -16°F; Cleveland, Ohio -20°F; Louisville, Kentucky -22°F; Pittsburgh, Pennsylvania -22°F; and Indianapolis, Indiana -27°F. The brutal cold was accompanied by widespread winter precipitation, even over the southern end of the basin where much of Kentucky was buried in unusually deep snow. February has been a much less extreme month, and several periods of thaw wiped out the snow cover throughout most of the southern parts of the basin.

The current map of snow cover (Fig. 1) depicts the lack of snow in the south and a transition to above average conditions in the north, especially northwest Indiana. The deep snow cover that had built up in the West Virginia mountains was almost completely melted off by warm temperatures and heavy rain (February 8-10), resulting in major flooding in that state. The snow cover was also melted off by heavy rains in much of the rest of the basin earlier in February resulting in considerable flooding in Indiana. New storms have since reestablished a significant snow cover across most of Indiana and Ohio.

Most rivers and streams in the region now have fallen below flood stage (Fig. 2), with the exception of the Green River in Kentucky, the extreme lower Ohio mainstem and several rivers in the extreme north where minor flooding is still occurring. Streamflows still remain above to well above normal throughout the basin, with the flow on Ohio River ranging from 1.5-2.5 times normal. Significant ice on rivers and streams is confined to the northern third of Ohio, Indiana and Pennsylvania, although very cold temperatures this weekend may have reformed ice in some places (the dashed line on Fig. 2 represents the approximate limit of river ice). Some ice jam flooding is always possible where thick ice has built up, although it is difficult to ascertain in advance exactly where an ice jam will form.

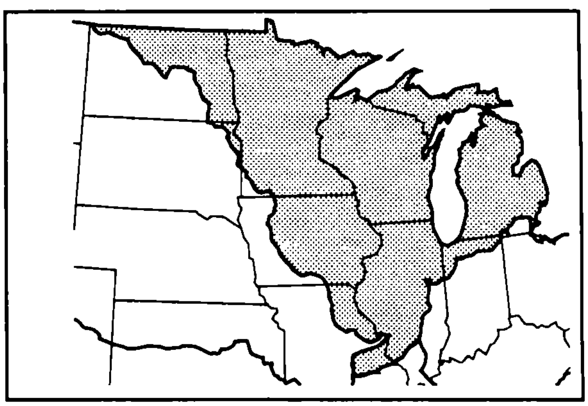
Soils throughout the basin are saturated (Fig. 3) from the abundant precipitation of the last several weeks. Guidance indicates that the relatively modest amount of 1.5 inches of rain in 12 hours could trigger flash flooding in most parts of Kentucky.

The recently enhanced snow cover, wet soils and high streamflows combine to put nearly the entire Ohio basin at some risk for flooding this spring. As noted earlier the Allegheny River, with the deep snow in its headwater basins looks most vulnerable at this time. Above normal flood potential exists for the Monongahela River basin in western Pennsylvania and the West Virginia panhandle, as well as the Licking, Kentucky and Green Rivers in Kentucky. The risk for flooding is somewhat less, but still slightly above normal on most other rivers in the Ohio River Valley.

Water supply shortages (Fig. 6) are not expected anywhere within this area at this time, as reservoirs are almost uniformly above normal levels.

The 6-10 day forecast for March 3-7 calls for continued cold, but dry weather throughout most of the region. If this prognosis verifies there is little likelihood of flooding within that time frame. Looking ahead 30 days until the end of March, the Climate Analysis Center maps (Fig. 4(a) and 4(b)) show generally cooler than normal temperatures are expected in the eastern part of the basin, with near normal precipitation. Drier weather with about average temperatures are expected in the western basin.

UPPER MISSISSIPPI/GREAT LAKES



Spring snowmelt flood potential in the NWS' North-Central River Forecast Center is considered to be above average, with the exception of northeastern Minnesota and the upper peninsula of Michigan, where an average potential exists. According to hydrologists at the NWS' North-Central River Forecast Center in Minneapolis, there are five major factors leading to spring snowmelt flooding in the upper Mississippi River basin. These are: 1) high fall soil moisture, 2) deep, hard ground frost,

3) heavy winter snow cover, 4) widespread heavy rains during the melt period, and 5) rapid melt, i.e. warm temperatures. These factors are discussed below in the context of the 1993-94 winter season.

Fall precipitation was low in the upper part of the basin and quite high in the south, especially in Illinois. However, the unprecedented summer rains in much of the upper part of the basin left soils quite moist throughout most of the region (Fig. 3). December was a relatively mild month, but the precipitation pattern was reversed with dry conditions in the south and near normal precipitation in the north. In the southern parts of the basin (Illinois and portions of Iowa) recent melting of the snow cover contributed to much above normal streamflow and saturated soils.

As noted above, the depth of frost penetration is an important factor in the spring flood outlook. Here the situation is extremely variable. In Minnesota for instance, frost depth ranges from near zero in areas that had an early snow cover to 20 inches or more in southern Minnesota. In Wisconsin the depth of frozen soil extends from about 12-36 inches, while in Michigan the range is about 12-24 inches. Even parts of North Dakota have areas with virtually no frost penetration beneath a deep snow cover.

January saw the onset of extremely cold weather over the entire region, with temperature departures of -4 to -12°F. Temperatures plunged to -33°F at Waterloo, Iowa, and -28°F at Alpena, Michigan for new monthly records. Perhaps more importantly for the spring flood outlook however, was the very heavy snowfall that fell over much of the basin. Parts of central Minnesota received up to 400 percent of normal January precipitation, virtually all of it falling as snow. The insulating effect of this snow cover prevented extremely deep frost penetration, but all this water will be available for runoff later this year.

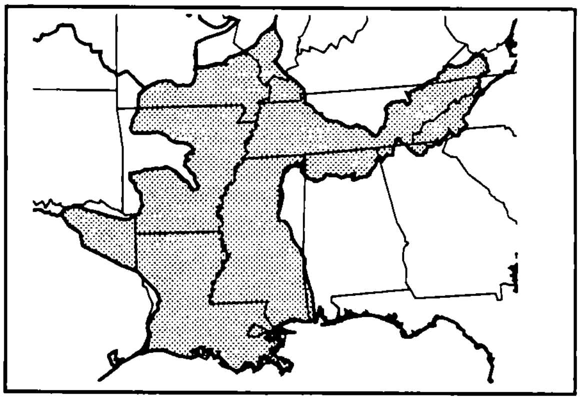
The snow cover map (Fig. 1) shows the high accumulations which have built up during the winter. The snow cover which melted from Illinois, Iowa and southern Wisconsin earlier this month has been reestablished by a series of moderate to heavy snow storms. Chicago, Illinois experienced its snowiest February ever. The critical factor in terms of snowmelt potential is the water equivalent of the snow cover. Over such a huge area there is considerable variation in snow water equivalent (SWE). No snow is currently found south of about Springfield, Illinois. Moving into northern Illinois the SWE increases to about 1.5 inches. In Iowa the SWE ranges as high as above 2 inches, while in Wisconsin SWE ranges from under 1 inch up to 3 inches. In Minnesota, SWE increases from 1.5 inches in the southeast up to 4 inches along the North Dakota state line. Up to 5 inches of SWE is contained in the Minnesota River drainage in extreme northeastern South Dakota; this is among the highest values reported in the upper Mississippi basin. From 4-6 inches of water equivalent exists in upper Michigan, but this is not extremely high for an area that normally receives substantial "lake-effect" snowfall from Lake Superior. Interestingly, the bitter winter of 1993-94 froze the entire surface of Lake Superior for the first time in over a decade, thus shutting off much of the lake-effect snowfall.

Streamflows across the basin are generally above average, and minor flooding was reported in parts of Illinois and Iowa (Fig. 2). Some of this flooding was due to ice jams and some to the recent heavy rains and snowmelt. Ice jam flooding could potentially occur over a large part of the upper Mississippi basin, as depicted by the dashed line on Figure 2. Rivers and streams north of this line remain susceptible to ice jam flooding.

As mentioned above, there are two additional factors which can contribute to spring snowmelt flooding in the upper Mississippi River basin. These are widespread heavy rain combined with warm temperatures during the melt. Of course one can only surmise whether or not these conditions will arise in any given spring. The medium range (6-10 day, March 3-7) forecast calls for above normal temperatures and near normal precipitation, which could lead to a minor reduction in the snow cover with no significant flooding. At 30 days (Figs. 4(a) and 4(b)), warmer and drier than normal conditions are indicated, which would perhaps fulfill only the final factor, rapid melt. Without some rainfall it would be unlikely that major flooding would occur from snowmelt alone.

In summation, it can be said that the three important antecedent ingredients (i.e., high soil moisture; deep, hard ground frost; and heavy snow cover) for snowmelt flooding exist to some degree over almost the entire upper Mississippi River basin. The deep snow cover extant over the northern and western end of the basin leads to high concern for this area. The Red River of the North, Minnesota River, Crow River and their tributaries are at the greatest risk for snowmelt flooding. Also at somewhat higher risk are rivers in lower Michigan, including the Muskegon, White, Manistee and Boardman Rivers. Most of the rest of the region can be characterized as having at least a moderate flood potential.

LOWER MISSISSIPPI



The Lower Mississippi River basin, stretching from extreme southern Illinois to the Gulf of Mexico, currently has an above average potential for flooding this spring (Fig. 5). Flows on this portion of the Mississippi mainstem are highly dependent on hydrologic conditions from the major river basins that feed the river. These basins include the Missouri, Arkansas, Red, White, Ohio, Tennessee and upper Mississippi. The flood potential results from inflow from these rivers as well as the lesser contribution from "local" tributaries.

Fall and winter precipitation was basically normal throughout most of the basin. Parts of Arkansas and Mississippi had very wet weather in January, with rainfall between 150-200 percent of normal. A series of storms beginning the first week of February brought heavy rainfall of 2-6 inches across most of the basin. The most recent rainfall event on February 22-23 brought moderate rainfall and some minor flooding.

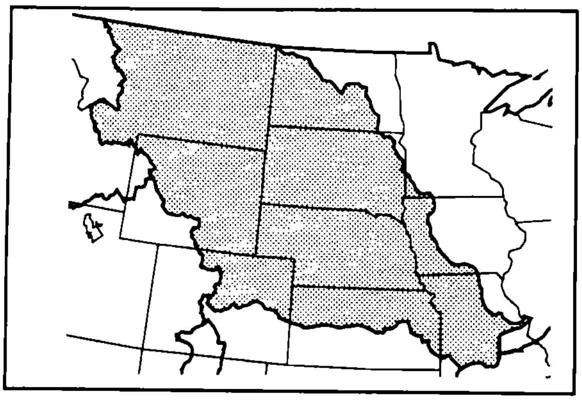
Snow cover is quite rare in the lower Mississippi basin and this year is no exception, with no snow on the ground as indicated on Figure 1. Snow cover conditions in the upper Midwest can have a sizable effect on lower Mississippi flows as the spring melt proceeds. The snowpack now in place over portions of that region will likely contribute to higher flows this spring and the deepest snow accumulation period in the upper Midwest is frequently in March.

Elevated streamflows (Fig. 2) persist throughout the lower Mississippi basin. Pockets of minor river flooding are still found in Arkansas, Tennessee, Louisiana and Mississippi. Soil moisture (Fig. 3) is wet or very wet across the entire region as well.

Based solely on current streamflow and soil moisture conditions there is already a somewhat heightened potential for flooding in this area. The development of more serious flooding this spring will depend on the nature of the spring melt to the north and the degree and intensity of rainfall over the basin itself.

Near term forecasts do indicate the development of a significant rainfall event for the lower Mississippi, which will likely maintain much of the minor flooding now seen in the basin. Medium range forecasts of 6-10 days suggest below normal rainfall which would act to alleviate the current round of flooding. The 30 day outlooks (Fig. 4(a) and 4(b)) indicate the above normal precipitation and near normal temperatures may affect this area. Again however, it is important to point out the importance of developments outside the lower Mississippi basin on the extent and nature of flooding on the big river itself.

Water supplies are expected to be adequate this summer (Fig. 6); many reservoirs are using minor portions of their flood control storage.



MISSOURI RIVER BASIN

As a result of The Great Flood of 1993 across lower portions of the Missouri River basin, there is considerable interest and concern about the possibility of a repeat performance during the upcoming spring. As will be discussed below, the bottom line is that some flooding is possible across portions of the Missouri River basin. However, unless extraordinary rainfall occurs again this year, as it did in 1993, disastrous flooding is not currently anticipated along the mainstem of the lower Missouri River.

Nearly the entire basin is covered with snow (Fig. 1); only the southern periphery of the basin is free of snow. The depth of snow increases markedly from south to north, and ranges from just a couple of inches across Missouri and Kansas to nearly three feet across portions of North Dakota. Water equivalent amounts in this snow cover range from less than 1 inch to nearly 5 inches. At the same time, with respect to normal conditions, snow decreases from east to west across the basin, with the mountainous regions located in the far western portions of the basin having a below to much below average snowpack. An exception to this patten is the northern Black Hills region of extreme northeastern Wyoming and extreme western South Dakota, where record snowpacks exist above 6,000 feet.

Streamflow conditions (Fig. 2) are generally above average across most of the basin. Only the mountainous western portions of the basin have near average streamflows for this time of year.

Across eastern portions of the basin - the area impacted by The Great Flood of 1993 - streams and rivers were still flowing at above average rates going into the winter. With the colder than usual winter, many streams are frozen. Meanwhile, reservoir levels have very gradually decreased since the summer months across eastern portions of the basin. Presently, most reservoirs have normal or slightly above normal storage.

Similar to streamflow conditions, current soil moisture conditions (Fig. 3) are generally wet across most of the Missouri River basin. Once again, the mountainous western fringes of the basin are the exception, where soil moisture conditions are basically average. Those portions of the states within the Missouri River basin which were impacted by last year's flood, mainly across the eastern half of the basin, have the wettest soils.

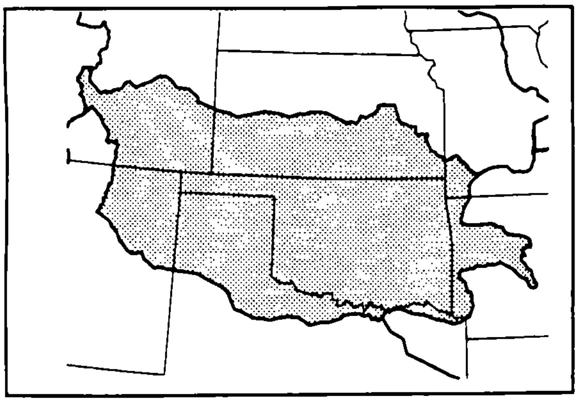
With respect to future conditions, the NWS' Climate Analysis Center's 30-day precipitation outlook (Fig. 4(a)), valid for March 1994, suggests precipitation will be normal or below normal across the entire Missouri River basin. The 30-day temperature outlook (Fig. 4(b)) for March favors normal or above normal temperatures across the region.

All factors considered, the flood potential (Fig. 5) across the Missouri River basin is quite variable, partially due to the fact that the basin is so large and has great climatic variability. Across northeastern portions of the basin, including eastern portions of the Dakotas and northwestern Iowa, the flood potential is high. In fact, based on present conditions, this area is one of two areas of greatest concern across the Nation with respect to flood potential. The primary factors contributing to this area of concern are much above average snow conditions, high soil moisture content and above average streamflows. Even with normal precipitation during the next several weeks, significant flooding could develop. Some of the major river basins likely to see flooding within this area include the smaller tributaries of the Missouri River in North Dakota (especially near Bismarck), the James River basin of eastern North and South Dakota, the Big Sioux River basin of eastern South Dakota and western Iowa, the Vermillion River basin of southeastern South Dakota, as well as portions of the Floyd, Ocheyedan, Little Sioux and Rock River basins in northwestern Iowa.

Outside of this high risk area, some flooding could occur in the northern Black Hills area due to a heavy high-elevation snowpack there. Depending on future conditions, portions of the Grand and Moreau rivers which flow out of northwestern South Dakota could also see some flooding.

As shown by the dashed line in Figure 2, ice still exists on rivers across most of the Missouri River basin, save for the extreme southern portions of the basin. As a result, there remains a possibility of ice jam flooding across much of the basin, but especially along rivers located furthest to the north, where river ice is thickest. Across southern (or lower) portions of the basin, there is little threat from flooding due to melting snow. As was shown by The Great Flood of 1993, major flooding across the southern, or lower, portions of the Missouri River basin typically develops as a result of heavy rainfall. Likewise, with less snow than normal in the mountains of the far western portions of the basin, the risk of flooding from snowmelt alone is generally small there also.

Finally, based on present conditions and near normal future conditions, water supply shortages (Fig. 6) are not anticipated within the Missouri River basin.



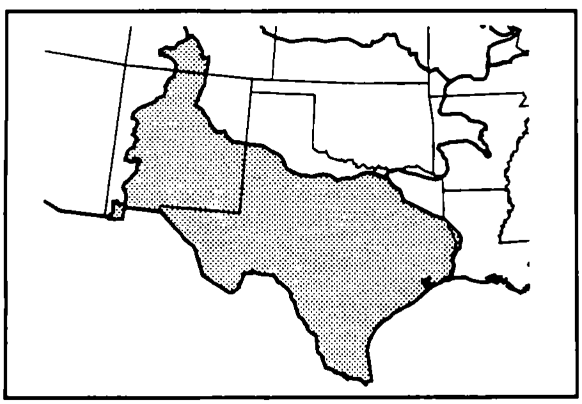
ARKANSAS-RED BASIN

Since autumn (September-November), conditions in the Arkansas basin have basically been dry and warm. In December, precipitation was normal. There were some spots of above normal precipitation in January, especially in the east. However, February precipitation returned to below normal.

There is a gradation of soil moisture conditions (Fig. 3) in this region. In the extreme east, soils are wet. Moving west, soil moisture becomes normal and eventually dry in the extreme western portions of the basin. Likewise, there is a similar variation in streamflow conditions (Fig. 2). In the eastern third of the basin, streams are running above average. In the middle of the basin, streamflows are at seasonal levels and drop to below average in the western part of the basin. Finally, there is a progression from above average flood potential in the east to below average in the middle and western portions of the region (Fig. 5).

Snow cover (Fig. 1) is nonexistent in this region. There are not likely to be any water supply problems (Fig. 6).

The outlook for precipitation (Fig. 4(a)) ranges from near normal in the west to drier than normal in the east; the temperature outlook (Fig. 4(b)) indicates near normal temperatures in the east and warmer than normal conditions in the west.



RIO GRANDE/WEST GULF

Flood potential in the area served by the West Gulf River Forecast Center ranges from below average for the western portion to above average in the east, with a narrow band of average (Fig. 5).

Western parts of the region have experienced below normal precipitation for the past several months, with most of Texas seeing near normal precipitation. The 30-day outlook for March indicates that the entire region is likely to receive near-normal precipitation amounts (Fig 4(a)).

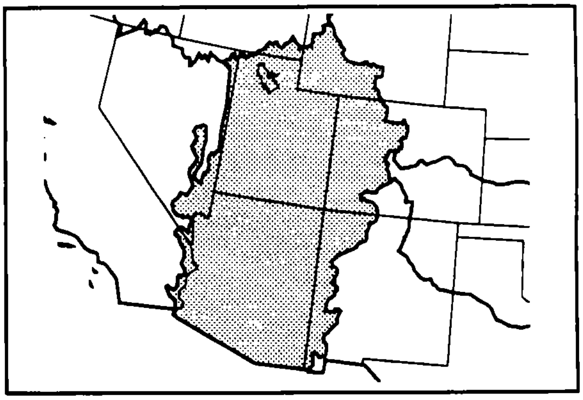
Characteristic of this region, most areas are not covered by snow (Fig. 1). The areas which do have snow cover, mountainous parts of northern and western New Mexico and southern Colorado, have reported much below average conditions due to below normal precipitation throughout the fall and continuing into the winter months. Unusually low precipitation amounts were recorded in the mountainous part of the basin during December. January ranked as the third driest month on record in New Mexico and Colorado.

Soils are dry over the western portions of the region (Fig. 3). Conversely, soils are wet over eastern Texas, with a narrow zone of normal soil moisture in central Texas.

Streamflow in the western parts of the region is below average (Fig. 2). In eastern Texas streamflow is above average with some incidents of minor to moderate flooding in eastern Texas along the Neches, Sabine and Trinity Rivers. Central Texas is experiencing average streamflow conditions.

No water supply shortages are anticipated in the region (Fig. 6). In eastern Texas reservoirs are above conservation levels, while the western reservoirs are still below conservation levels.

COLORADO RIVER BASIN



Flood potential this spring is below normal throughout the entire Colorado River basin (Fig. 5). A major factor in spring flooding in this region is mountain snowpack and this winter has been quite deficient in the building of a deep snow cover. Despite this fact, the extreme wetness of last winter combined with the impressive storage capacity of the major reservoir systems should preclude water supply shortages this summer (Fig. 6).

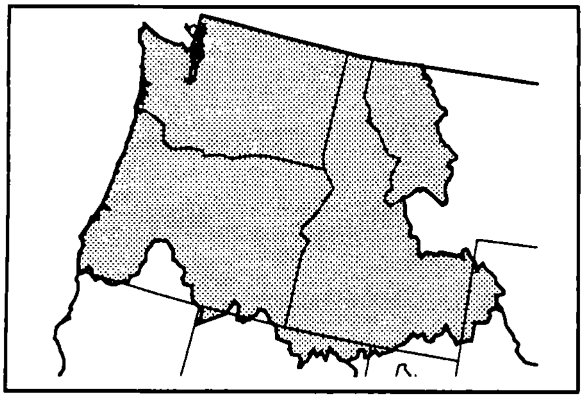
The fall and winter of 1993-94 in the Colorado River basin, as well as the rest of the western United States has been essentially a two-part story. First there was a "dry season" that extended from October (the start of the water year) through all of January. This period saw well below normal precipitation, which was especially noticeable in December and January when the region normally gets into the snow accumulation season. Arizona and parts of the central Rockies had above normal precipitation for the three autumn months, for instance, but normal in these months does not represent much actual precipitation. In the prime months of December and January, precipitation was generally only 25-50 percent of normal across the entire region. January was the fourth driest in the past 100 years in both Arizona and Utah. Fortunately the West was granted a second "season" more similar to last winter's regime. In early February the blocking ridge that had maintained a more or less stationary position along the Pacific coast for well over a month was finally broken down. This allowed for a series of powerful Pacific storms to come crashing ashore with heavy precipitation, mainly mountain snows, occurring as far east as the Rockies.

The impact of these storms on the snowpack of the region was notable, although not overwhelming. In Utah for example, the statewide snowpack increased from 55 percent of normal on February 1, to 77 percent of normal as of February 25. Despite this improvement, snowpacks remain well below seasonal averages (Fig. 1) in Utah and western Colorado. In Arizona, despite February precipitation near 200 percent of the median, snow cover only begins at the 6,000-7,000 foot level and is well below seasonal normals. Statewide, Arizona snowpacks are 80 percent of normal. The worst basin is the Gila at 50 percent of normal. Colorado snowpacks have recovered to about 78 percent of normal in the southwestern part of the state.

Both current streamflow and soil moisture (Figs. 2 and 3) are below normal throughout the entire Colorado basin. Streamflow in this region is highly dependent on snowmelt runoff and forecasts for the spring and summer reflect the relatively poor state of the winter's snow accumulation. In Arizona streamflow runoff through May is expected to be only 50-85 percent of the median. Runoff forecasts set to be updated on March 1 should show some improvement for most basins in the Colorado system.

Due to the extreme wetness of the winter of 1992-93, new water storage in the massive reservoirs was substantial last water year. The carry-over from last year should be enough to ensure adequate water supplies this summer (Fig. 6).

Looking ahead 6-10 days, there is not much hope for additional improvement in the Colorado River basin snowpacks. Forecasts for the period March 3-7 call for little or no precipitation across most of the basin. For March, normally the last month with substantial snow buildup in the West, the long-range outlook for precipitation (Fig. 4(a)) shows an equal probability for above or below normal precipitation in the Colorado River basin. A fairly strong likelihood of warmer than normal temperatures (Fig. 4(b)) during the next month implies that snowfall may be limited to the higher elevations and melt will be more rapid than usual.



PACIFIC NORTHWEST

Persistent high pressure was anchored over the Northwest during the middle of the winter season. Storms continually pushed northward, all the way into western Canada, resulting in well-below average precipitation in January across most of the western United States. More recently, the high pressure ridge has weakened, allowing a series of very wet weather systems into the Pacific Northwest. February snowfall has brought the snowpack (Fig. 1) to near normal levels in the higher elevations of the Cascade mountain range in the state of Washington. In Oregon, the late season storms in most of the Cascades only added enough precipitation to raise the snowpack to three-quarters of normal. Very little of the winter precipitation has spilled over into the interior regions of the Northwest, resulting in a much below normal snow cover in almost all of Idaho, Montana (west of the Continental Divide), and eastern sections of Oregon and Washington.

The relatively dry water year over most of the region has resulted in below normal streamflows across areas east of the Cascades (Fig. 2), along with a dry soil moisture content (Fig. 3) in the same sections.

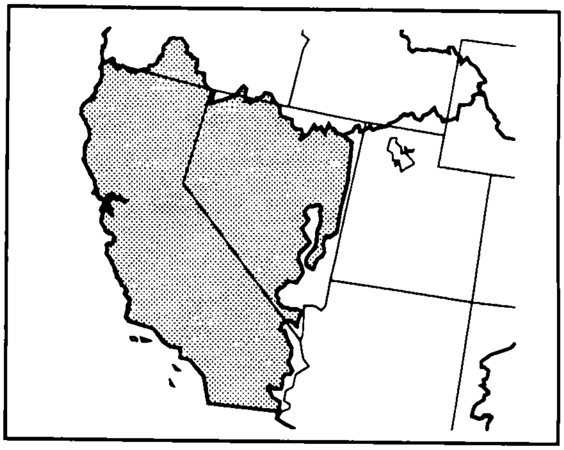
A few streams in the northern Great Basin have been running at only around half of their normal volumes. The situation was not quite as bad in the upper Snake River basin of Idaho, where flows are marginally below average. Some of the streams in the Cascades have flows only a little below normal, thanks to recent heavy precipitation. West of the Cascades, the effect of the wet pattern during February has been to produce significant rises in stream levels, and even some minor flooding in northwestern sections of Oregon.

Reservoir storage and water supply (Fig. 6) varies across the Northwest, with future problem areas possible in eastern Oregon and Washington. The highest potential for water supply problems as of the first of February was in the Yakima basin, where storage was only a quarter of normal.

Spring outlooks indicate below average streamflows across almost the entire Northwest, mainly as a result of generally below normal winter precipitation amounts for the season as a whole. Low streamflow projections indicate potentially marginal supplies for some users later this year.

The generally dry soil conditions east of the Cascades, combined with the below normal snowpack over all but the crest of the Cascades, translates to a below normal flood potential for most of the region. The snow cover (Fig. 1) is near average in the Okanogan mountain range of north central Washington, and soil moisture (Fig. 3) is average west of the Cascades. Either factor produces an average flood potential (Fig. 5) for this season in those areas. Heavy or persistent rainfall, especially combined with unseasonably warm temperatures, would significantly raise the potential for flooding.

CALIFORNIA/NEVADA



A persistent high pressure area over the West Coast pushed the storm track well north of the region during most of this winter. As a result, most areas received only about half of their normal precipitation as of the first of February. The month of January was especially dry, with only a fraction of normal precipitation falling over most of California and Nevada. The far northern sections, including the northern Sierra Nevada, fared somewhat better, averaging a little over half of normal precipitation amounts in January. On the other end of the scale, January precipitation amounted to only about one fifth of normal over headwaters of the Great Basin, east of the southern Sierra Nevada crest.

A more normal weather pattern during February brought a series of Pacific storms to the West Coast. Significant precipitation amounts fell, and during the Presidents' Day weekend, the strongest storm in the series deposited snowfall ranging from 4-8 feet at some locations in the Sierra Nevada. That improved the situation somewhat, but it would take twice the normal precipitation during the few remaining weeks in the wet season to bring seasonal precipitation amounts up to near normal in many of the critical watershed areas of the Sierra Nevada. Most of the rest of the two-state area will also need well above normal precipitation to even come close to normal levels for the season.

The snowpack (Fig. 1) over the Sierra Nevada was nearly doubled during the storm over Presidents' Day weekend, but the water content only rose from barely half of normal across most of the watersheds, to a maximum of nearly normal in the higher elevations of the northern Sierra Nevada. The central Sierras averaged barely a third of the normal snowpack at the first of February, but the recent stormy pattern generally raised the water content to a little over half of normal for this time of the season. Portions of the eastern Sierra Nevada and mountains of the Great Basin continued to suffer, with amounts rising only to around half of normal. Water content of the snowpack in the mountains of extreme eastern Nevada have come the closest to normal, presently at ninety percent.

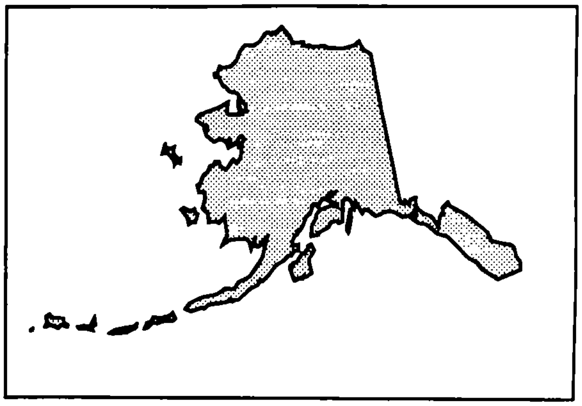
The relatively wet pattern of the last few weeks has brought soil moisture to near normal over the coastal mountains and valleys, and in most of California's Central Valley (Fig. 3). Summertime is normally dry in the West, and the shortage of rainfall since last summer led to a general lack of soil moisture under the snowpack in the mountainous areas of the region, as well as in the valleys of the Great Basin. This will reduce the amount of snowmelt runoff that reaches the storage reservoirs.

Streamflow conditions (Fig. 2) have also suffered from the lack of precipitation during the current winter season. Runoff in California and Nevada has been averaging around a third of normal. Conditions have improved a little recently, especially in the northwestern corner of California as a result of recent storms. Reservoir storage has been nearly normal in areas where sufficient runoff was been stored during the previous wet season. Ironically, most of the area's water supply situation is significantly better than conditions were at this time last year, long before much of the runoff had reached the reservoir system. This year, storage is below average across much of the Great Basin, and much below average in some of the storage basins of western Nevada. The lower Humboldt River had just over one-fifth of its normal storage at the beginning of February. Lake Tahoe has once again fallen below its rim, leaving no storage at all for the lower portions of the Truckee River drainage. However, several other reservoirs in the lower Truckee basin are tightly controlled, reducing the impact of non-existent Lake Tahoe storage.

The streamflow outlook is for continuing below normal conditions in most basins. A majority of the drainage areas will have streamflow near half, or even less than half, of normal flows. Consequently, with the dry soil conditions, a generally less than normal snowpack, and plenty of storage room in most of the reservoirs, the potential for flooding during this spring is low (Fig. 5). Warm storm systems with associated very heavy rainfall are the main threat for flooding this spring, but they are unlikely and increasingly rare, as the summertime approaches. A more realistic threat is along the coastal range of mountains and in the valleys, where conditions are more near normal. In southern California, protective vegetation has not returned to the burned-off hillsides, and even a moderate rainstorm could trigger additional flash flooding and mudslide activity. Coastal mountains of northern California don't normally have much of a snowpack, so the likelihood of spring flooding depends more on soil conditions and streamflow. These factors are near normal, due to the recent wet period and near normal season-long rainfall amounts.

Most of the California reservoirs presently average near normal storage levels, but latent water supply problems are possible in the eastern parts of the region (Fig. 6). Reservoir levels are already low in much of the Great Basin, and runoff in many cases will only be sufficient to do no more than maintain the current low levels.

ALASKA



Much of Alaska has average or below average snow cover (Fig. 7) for this time of the season. Notable exceptions are the south slopes of the central and western Brooks Range, with much above average snow cover, and portions of the Copper River Basin, which are slightly above average. River basins that are affected by the heavy snow cover along the Brooks Range include the Noatak, Kobuk, Koyukuk, and Buckland River basins. (See Figure 8 for the locations of major rivers in Alaska.)

Relatively warm fall and early winter weather led to a late start for the seasonal ice cover on rivers and lakes in Alaska. As of February 1, most river locations that report ice thickness data were about 70 percent of the normal, with measurements of about 2 feet compared with a normal of about 3 feet. Lake ice thickness reports ranged from 70-90 percent of normal. Weather in February has been dry and cold, allowing for ice thickness to continue to grow through the month. March 1 ice thickness measurements are still expected to remain below normal, however.

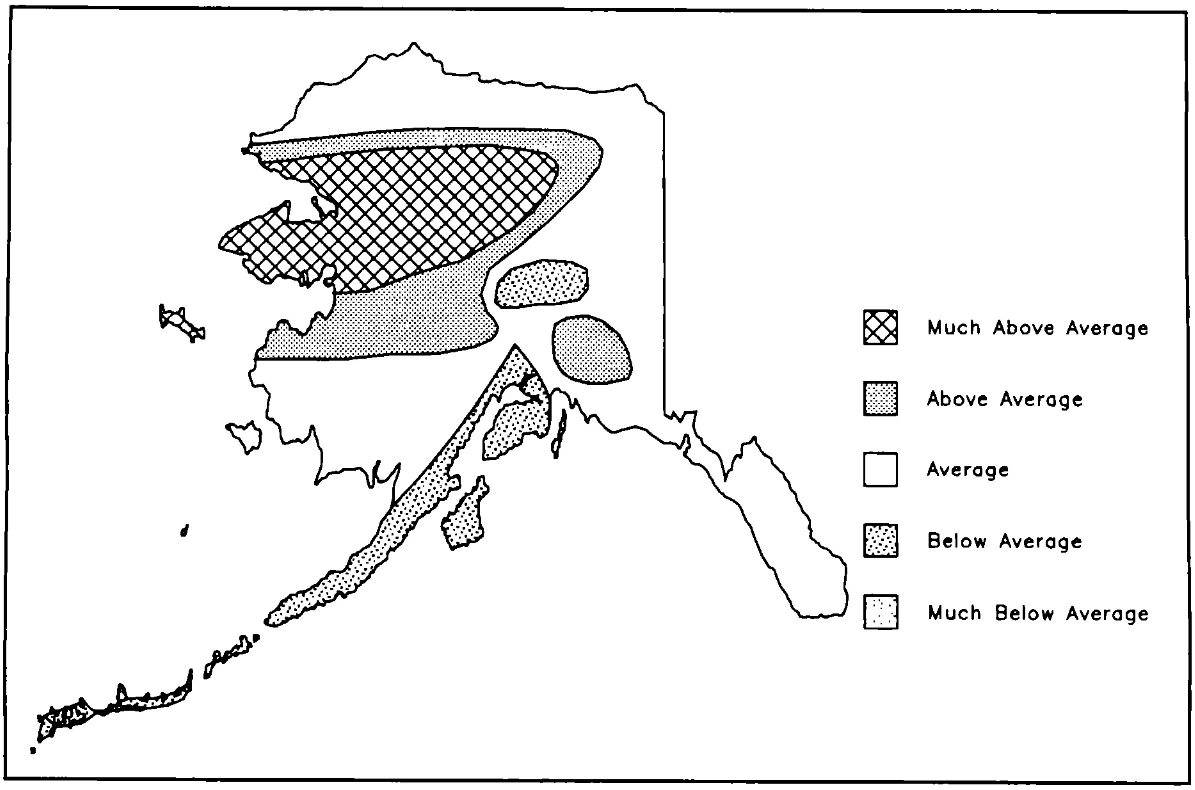


Figure 7. *Snow cover conditions in Alaska as of February 26, 1994.*

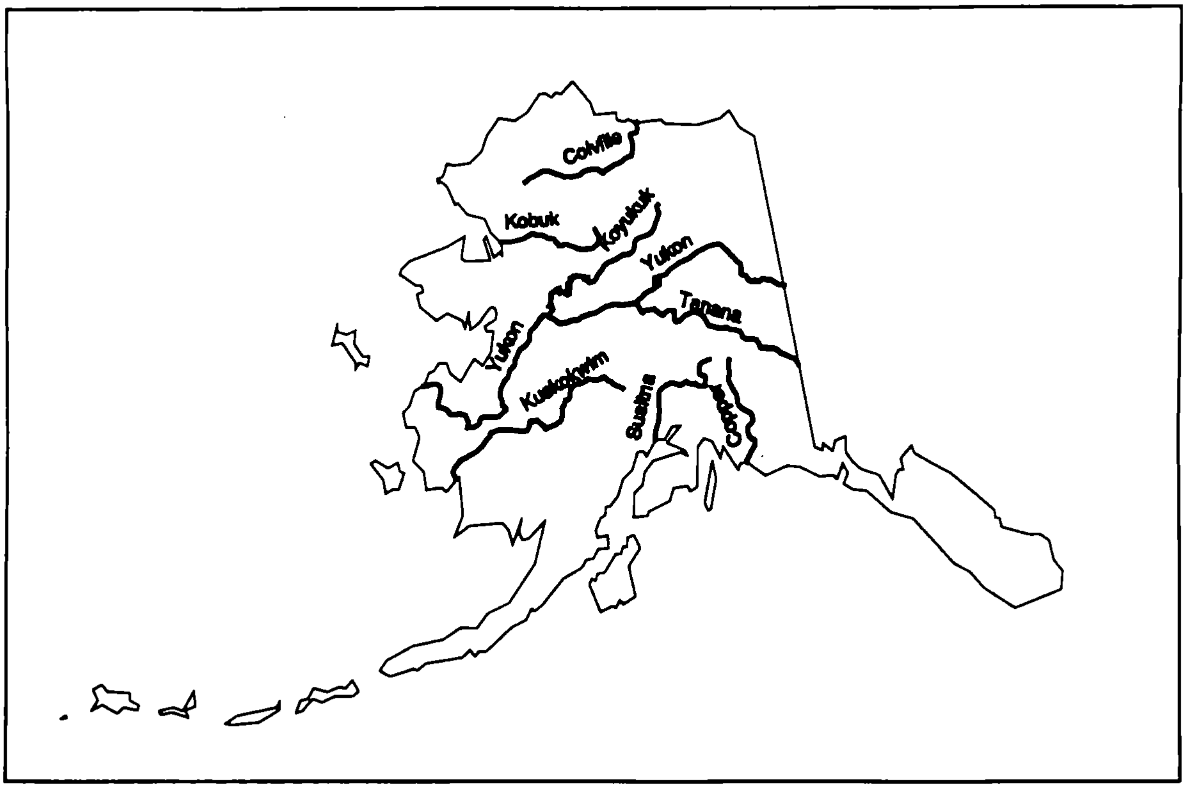


Figure 8. *Locations of major Alaskan rivers.*

The potential for spring breakup flooding from snowmelt and ice jams is moderate to high this year along rivers in interior Alaska that drain the south slopes of the central and western Brooks Range. The potential for ice jam flooding along the Yukon and Kuskokwim Rivers, which are susceptible to this type of flooding, is expected to be about normal. Ice jams that do materialize are expected to cause flooding in several villages, but the flooding is expected to be minor to moderate. Other areas of Alaska have a low to moderate flood potential. Weather conditions during March, such as heavy snow or early warming, can significantly alter the present river flood potential outlook.

HEADQUARTERS
UNITED STATES ARMY
CORPS OF ENGINEERS

SPRING FLOOD POTENTIAL: BACKGROUND AND INFORMATION

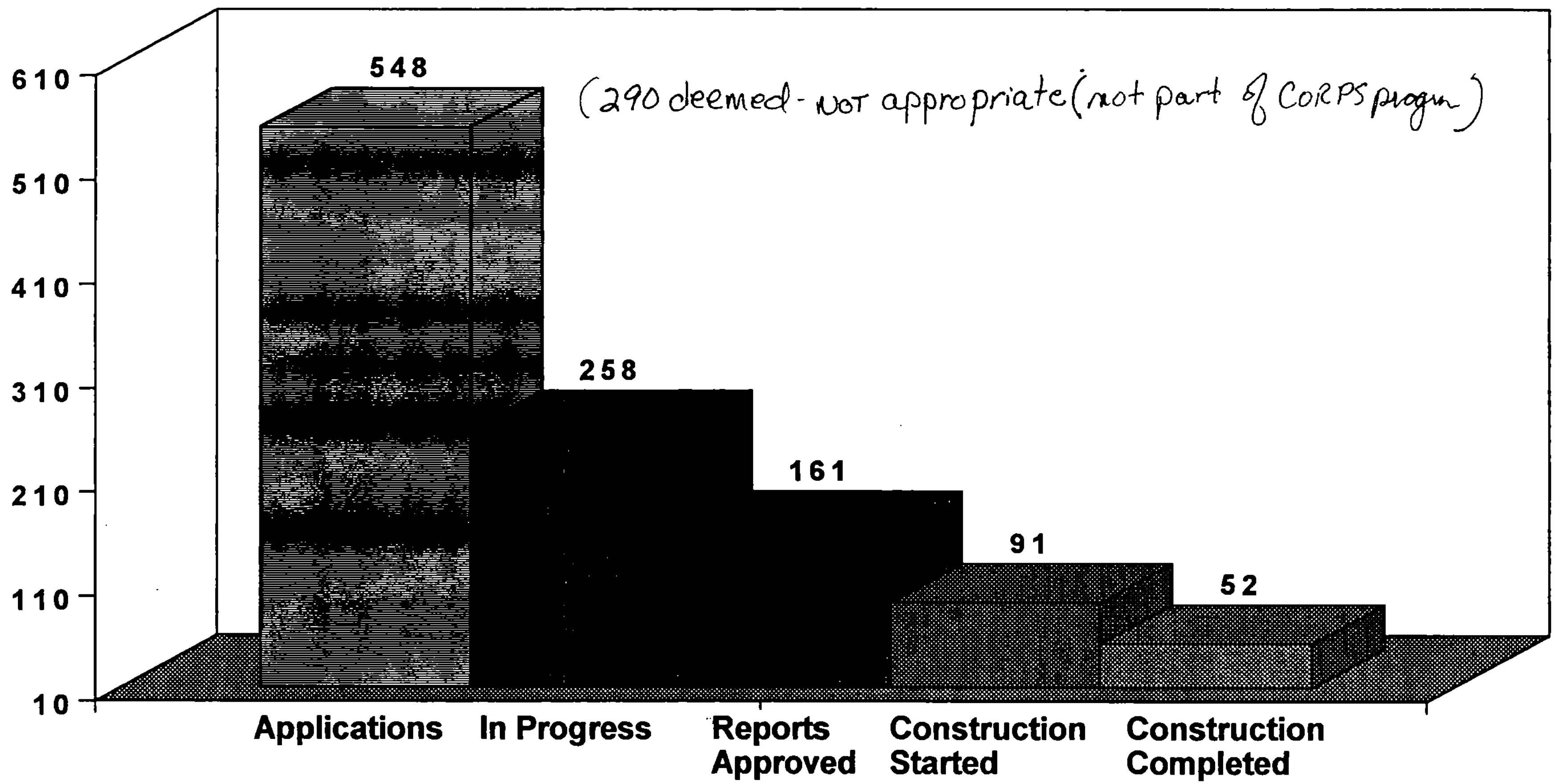
11 MARCH 1994

PREPARED BY

MR. JOHN P. ELMORE, P.E.

CHIEF, OPERATIONS, CONSTRUCTION,
AND READINESS DIVISION
DIRECTORATE OF CIVIL WORKS

LEVEE REHAB STATUS REPORT

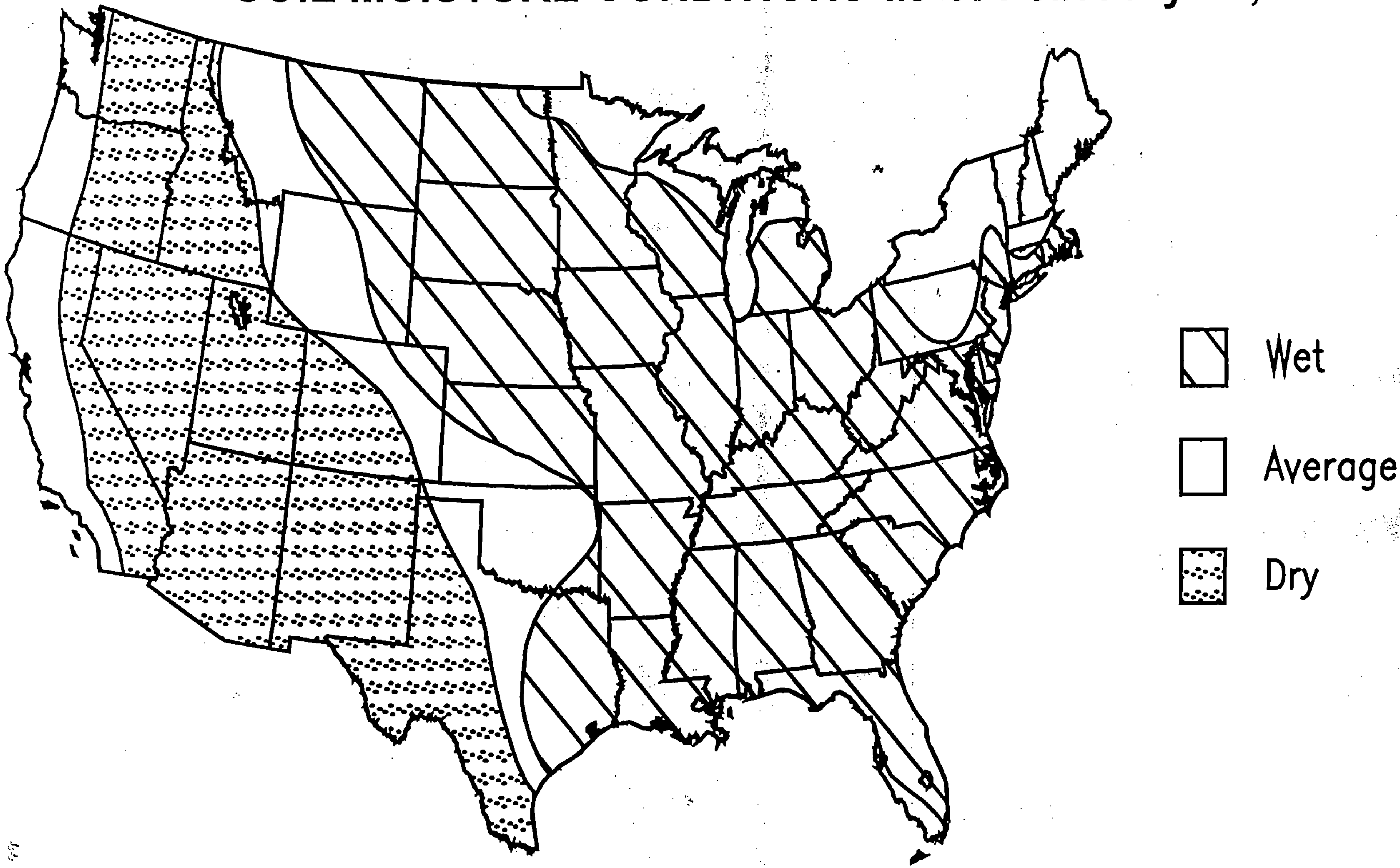


U.S. ARMY CORPS OF ENGINEERS
LEVEE STATUS REPORT
AS OF 10 MARCH 1994

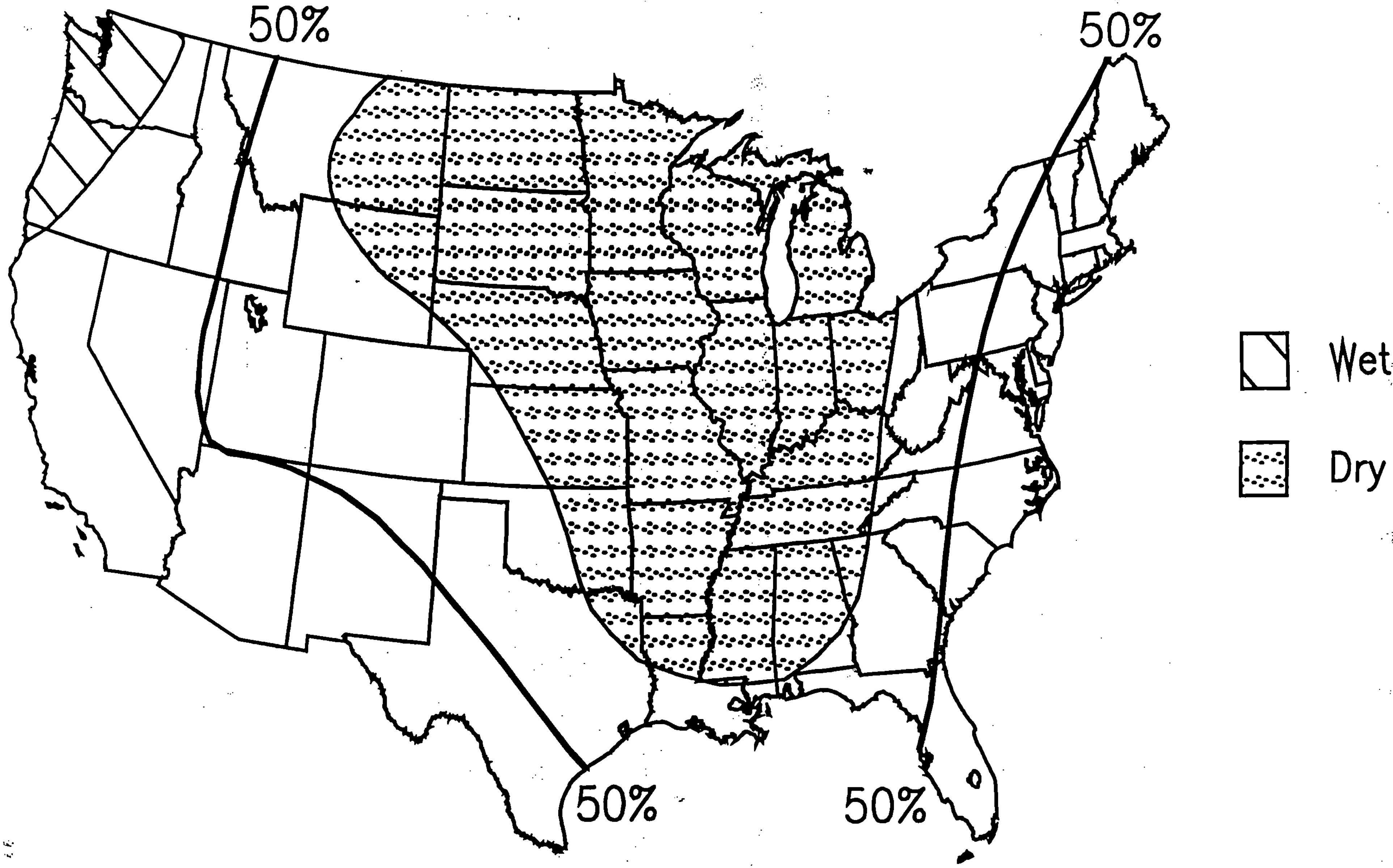
STATE	ILLINOIS	IOWA	KANSAS	MINNESOTA	MISSOURI	NEBRASKA	NORTH DAKOTA	SOUTH DAKOTA	WISCONSIN	TOTAL
NUMBER OF LEVEES FOR WHICH REPAIRS ARE UNDERWAY OR COMPLETE	22	13	5	0	42	7	0	1	1	91
ESTIMATE COST INITIAL REPAIRS ($000)	$44,000	$3,000	$1,000	$0	$36,000	$0	$0	$0	$0	$84,000
ESTIMATE COST FINAL REPAIRS ($000)	$26,000	$4,000	$10,000	$300	$92,000	$1,000	$0	$25	$32	$133,357
ESTIMATE COST TOTAL ($000)	$70,000	$7,000	$11,000	$300	$128,000	$1,000	$0	$25	$32	$217,357
FINAL REPAIRS COMPLETE	2	9	2	0	7	5	0	1	1	27
INITIAL REPAIRS COMPLETE	11	1	0	0	13	0	0	0	0	25
INITIAL REPAIRS UNDERWAY	5	1	0	0	5	0	0	0	0	11
FINAL REPAIRS UNDERWAY	4 *1	2	3	0	17 *2	2	0	0	0	28
REPORTS APPROVED CONSTR NOT STARTED	5	3	6	1	55	0	0	0	0	70
REPORTS COMPLETE NOT APPROVED BY DIVISION	4	1	0	0	9	0	0	0	0	14
REPORTS NOT COMPLETE	19	0	1	0	11	0	0	0	0	31
TOTAL	50	17	12	1	117	7	0	1	1	206

Note: (*) denotes final repair of a levee which had an initial repair. This number is not counted against column totals in order to avoid duplication of levees under repair and completed.

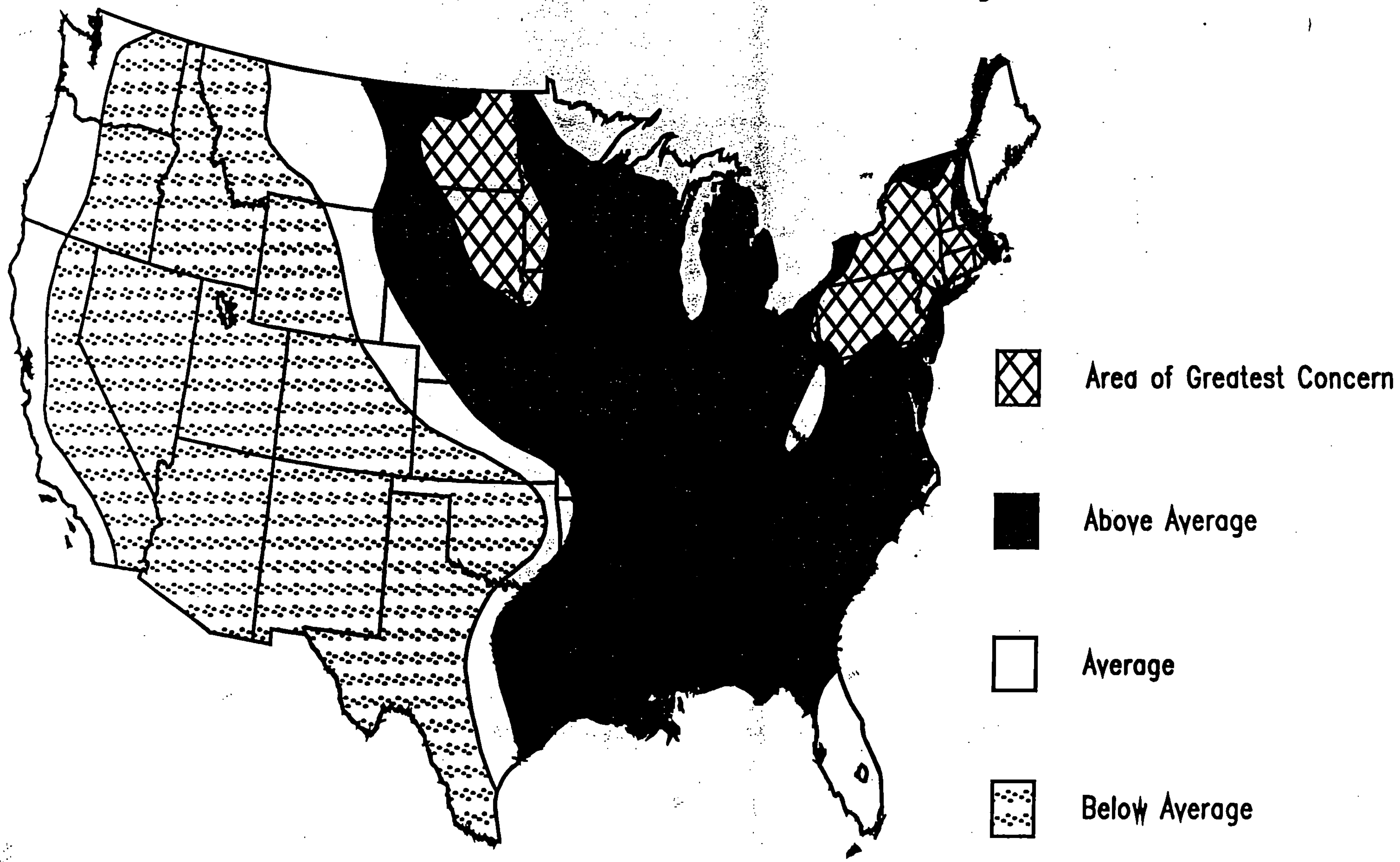
SOIL MOISTURE CONDITIONS as of February 26, 1994



30-DAY PRECIPITATION OUTLOOK for MARCH 1994



FLOOD POTENTIAL as of February 26, 1994



CORPS PREPARATIONS FOR SPRING FLOODS

- Potential Contractors for Emergency Work
- Potential Borrow Sources
- Sources for Sandbags and Pumps
- Flood Fight Technique Education
- Coordination with State and Local Officials