# WATER SUPPLY PROBLEMS IN EAST PAKISTAN

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## Description of Province

Located on the eastern side of the Indo-Pakistani sub-continent, East Pakistan is one of the two provinces of Pakistan. As shown on Fig. 1, East Pakistan is bordered by the Bay of Bengal on the south, India on the west, north, and northeast, and Burma on the southeast. East Pakistan is separated from West Pakistan by India, and the two provinces are about 1,000 miles apart.

The province is almost entirely flat in topography with the exception of rolling hills along the eastern and southeastern margins and covers a surface area of approximately 54,000 sq miles. The province is a deltaic plain which was formed by the Ganges, Brahmaputra, and Meghna Rivers and their tributaries. A typical aerial view of the countryside is shown in Fig. 2.

To better visualize East Pakistan, the reader might imagine that an area the size of the State of Illinois was to be transferred to the Mississippi River delta in Louisiana.

The average annual rainfall in East Pakistan is 75 inches. The maximum annual rainfall is as high as 200 inches in the Sylhet District, which is located in the northeast sector of East Pakistan. This vast tract of low-lying alluvial plain is subjected to inundations during the monsoon season.

The climate of the province is tropical with the area being subject to the cyclic rainfall pattern of the monsoons. Dry summer weather starts in March with a steady rise in temperature until the end of May. Storms, accompanied by rain, are frequent during May. The monsoon rains usually start in June and continue through September. The humidity is generally high throughout the year running from 75 to 82 per cent in the winter months and 84 to 90 per cent during the remainder of the year. As compared to the climatic conditions in the United States, the most significant characteristic of the climate of East Pakistan is that extremes of hot and cold weather are not experienced.

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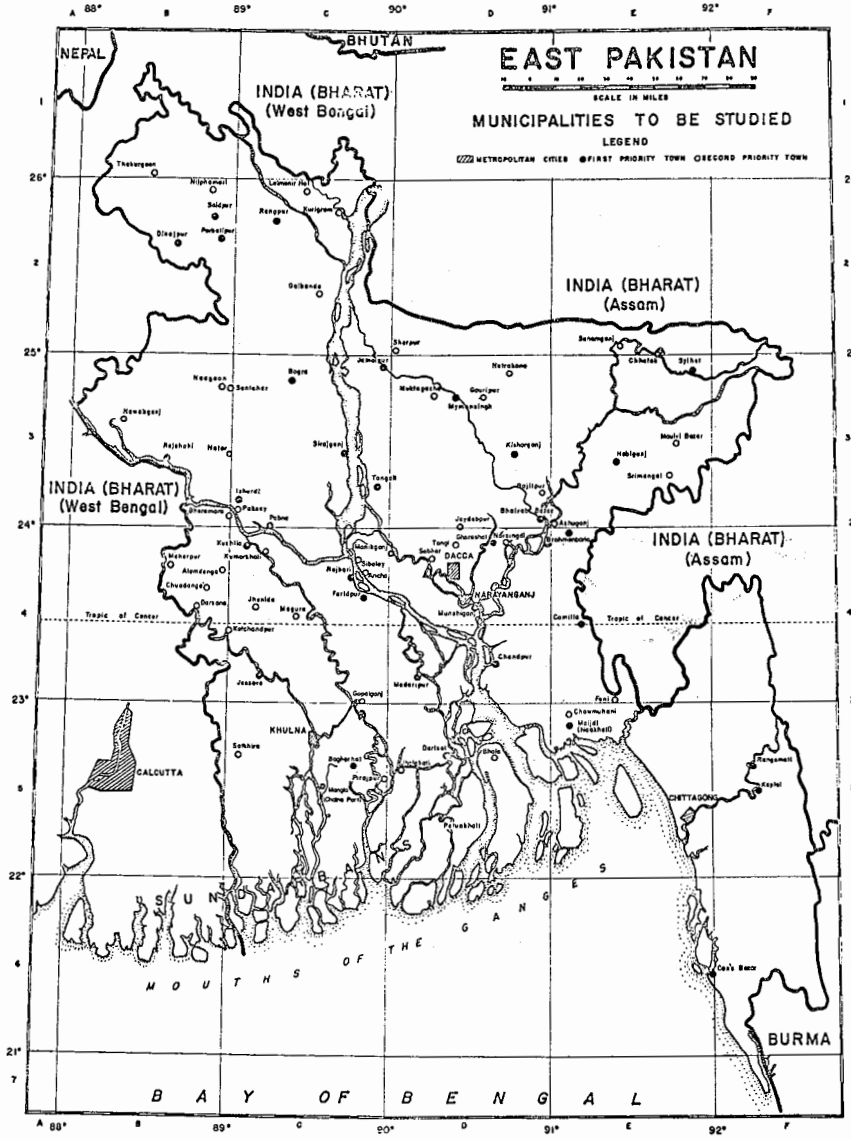


FIG. 1.—MAP OF EAST PAKISTAN

## Area and Population

East Pakistan is one of the most densely inhabited areas of the world. It has an area of about 54,000 sq. miles and a population of approximately 57,000,000 people, the average density being about 1,050 people per sq. mile, as compared to 60 people per sq mile in the U.S.A. The province makes up about 1/7 of the area of Pakistan, but it contains approximately 57 per cent of its total population.

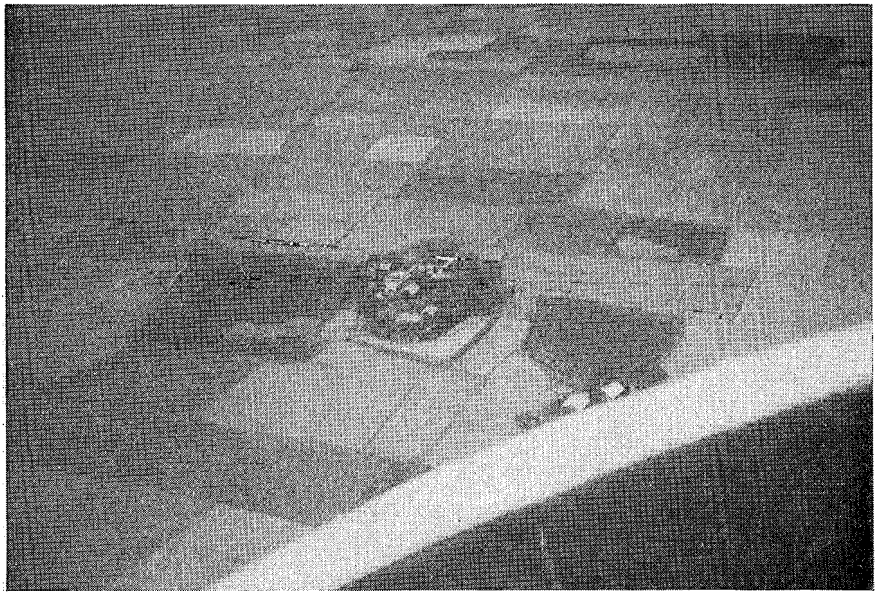

Fig. 2.—Aerial Photograph of East Pakistan

At the present time, approximately 2.9 million of the people in East Pakistan live in urban areas. It has been predicted by responsible planners, both Pakistani and American, that the population in 1985 in the urban areas may increase tenfold to approximately 27 million people because of the current migration of rural habitants to industrial urban areas. It is further predicted that if the current trends continue in East Pakistan, the population in the urban areas will increase between 25 to 30 times by the year 2015.

Currently, there are no cities within the province that have a population of one million or more. It is anticipated by the planners that

between 4 to 8 cities with populations in excess of 1 million people will exist in East Pakistan by 1985 and possibly 10 to 16 of these large metropolitan areas will exist by 2015. The work that must be done to provide these future metropolitan areas with adequate and potable water supply simply staggers the imagination of most sanitary engineers.

Approximately 70 per cent of the East Pakistanis currently reside in unfinished huts (Katcha), constructed of bamboo and mud without interior plumbing, heating, or modern facilities. The average annual income of the Pakistani is about $65.00.

Another problem in the country is that currently about 75 per cent of the populace cannot read or write any language. This factor seriously impedes many of the progressive works which are being implemented to change the water consumption and personal hygiene habits of a majority of the populace.

## History of Water Works

In 1947, the Indian sub-continent was partitioned by the British to form the two independent nations of Pakistan and India. Prior to independence, East Pakistan was known as the East Bengal Province of the Indian sub-continent. With the exception of the principal cities of Dacca and Chittagong, no significant development had taken place in the East Bengal Province prior to 1947. East Pakistan, since 1947, has made great strides in previously undeveloped fields, and now possesses a system of roads, hydroelectric power, schools, permanent buildings, and other major developments in very necessary fields. The history of water supply development in East Pakistan is a significant indication of the progress being made in other allied fields.

Prior to partition, water works within the province consisted mainly of very small water treatment plants processing surface water from rivers for the consumption of a privileged few. These were all built under the British rule in the major cities or government headquarters of Dacca, Comilla, Narayanganj, Mymensingh, and Paksey.

Some ground-water sources were developed in other municipalities, such as in Chittagong and Khulna. These facilities were usually of insufficient capacity and suitable only to serve a limited population. In the past, the majority of the population relied upon river water and ground-water "tanks" (open ponds) for bathing, drinking, and other miscellaneous uses. At the present time, as indicated on Fig. 3, these

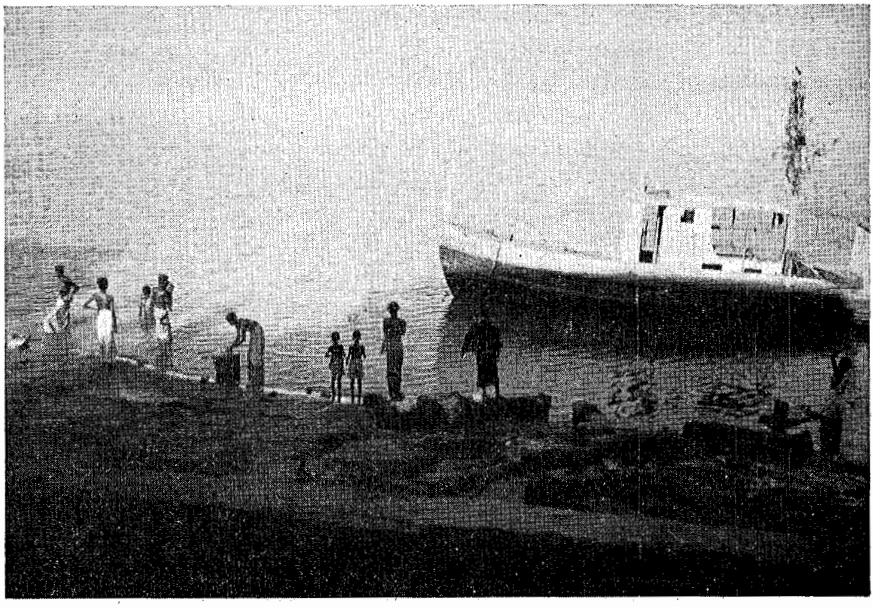

FIG. 3.—TYPICAL RIVER SCENE

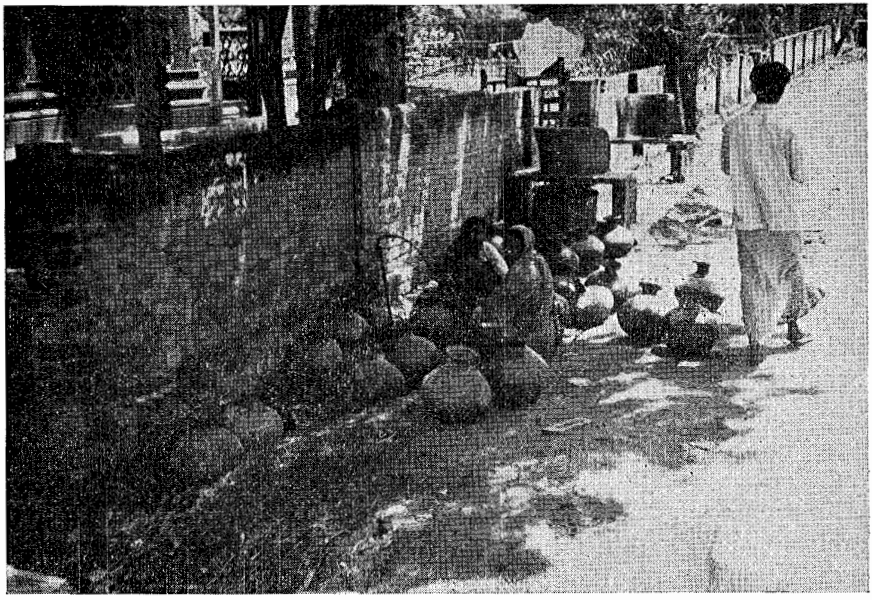

FIG. 4.—WOMEN OBTAINING WATER FOR HOUSEHOLD USE

same unsafe sources of water are being used by the people throughout the province for most of their water needs. As a result, East Pakistan is one of the remaining areas in the world where cholera and other water-borne diseases are still endemic.

Currently, where small distribution systems have been constructed, the majority of the population obtains its drinking and cooking water from street taps, shown on Fig. 4, which are usually under pressure from 4 to 8 hours a day. It has been estimated that from 200 to 400 people are currently served by each street tap.

## Present Water Works in East Pakistan

### *Urban Water Supply Systems*

The City of Dacca is now divided into two distinct sections; the old city, which was built before independence and the new city which has been constructed since partition. Dacca, which is also the capital of East Pakistan, has a water works system in the old city that was initially constructed in 1872 and after several modifications can deliver 4 mgd to the population. This main source of water, which still serves the old portion of Dacca, consists of a water treatment plant which treats water taken from the Buriganga River. Fig. 5 is a picture of the influent, baffle mix, and flocculation portion of this plant. This water is distributed to the system for a period of approximately 4 to 6 hours a day. The remainder of the city is served by 14 separate ground-water supply systems. All of the existing systems within the City of Dacca can only supply 14 mgd (million gallons per day). Based on a present municipal population of approximately 900,000 people and an average per capita consumption of 30 gallons per day, it is estimated that the average daily supply to the city should be about 27 mgd.

The City of Chittagong, which is the main seaport of the province, has a water supply system which was initially constructed in 1916 and expanded in 1952. The combined capacity of this water supply system is approximately 1.3 mgd. Based on the existing population and per capita consumption of 30 gallons per day, it is estimated that the average daily demand of the city should be around 17 mgd.

It is evident that both of the water systems of Dacca and Chittagong are grossly inadequate to take care of the present needs of the people.

In other metropolitan areas such as Comilla, Mymensingh, Ishurdi, and Paksey studies were made on the existing distribution systems to

FIG. 5.—MIXING AND FLOCCULATION BASIN AT OLD DACCA TREATMENT PLANT

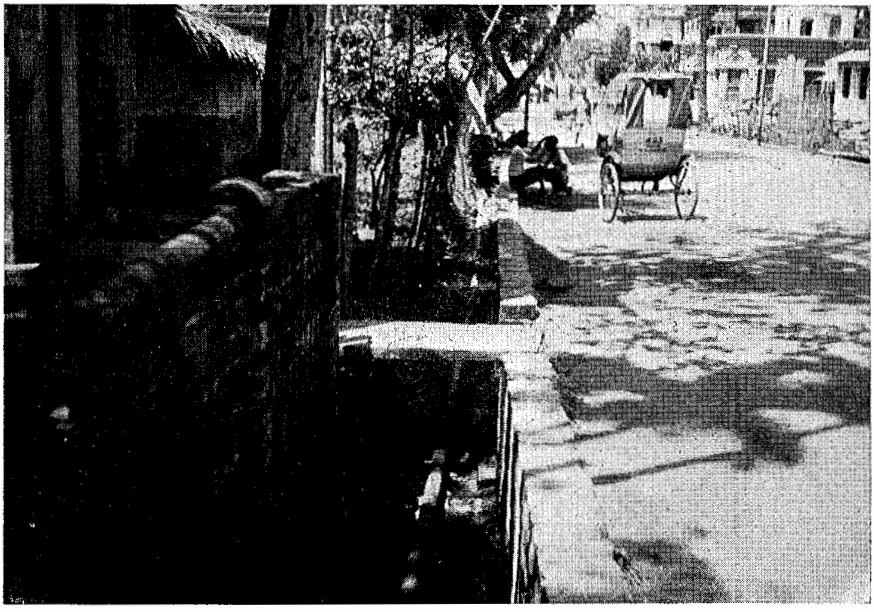

FIG. 6.—WATER MAIN LAID IN DRAINAGE DITCH

determine the amount of water that people were actually getting under the present method of operation. It was estimated that the consumer was being supplied with from 0.6 to 10.0 gallons per capita per day. Bacteriological analyses made on the water being supplied to the consumer in various areas indicated that although a potable water was being put into the distribution system, contamination was entering the distribution system during periods of no pressure. As shown on Fig. 6, the water mains are normally laid in the drainage ditches which transport the communities' waste water.

In many of the areas within these metropolitan centers, numerous hand-pumped tube wells have been installed to supplement the existing water systems. The spasmodic operation of the present distribution systems, the amount of potable water which is available for human consumption, and the habits of some of the people are just a few of the important reasons which create the health hazard that exists within East Pakistan today.

*Rural Water Supply*

Prior to partition, the rural water supply which served the bulk of the populace consisted of shallow wells or untreated surface water which was available from either the rivers or from ground-water "tanks." To improve the unsatisfactory conditions that existed throughout the rural areas, the Government of East Pakistan acting through the Directorate of Public Health Engineering initiated a program in 1960 to install 1-in. to 1 1/2-in. diameter tube wells equipped with hand pumps. The Government of East Pakistan initially planned at the beginning of the second 5-year plan (1960) to install 58,000 new tube wells and replace 25,000 defunct tube wells in the rural area within the 5-year plan period. At the end of the second 5-year plan period (1965), approximately 83,000 tube wells were constructed and 17,000 old tube wells were replaced. The enactment of this single program has brought untold benefits to the bulk of the populace, providing people who live in this agrarian country with potable water for their cooking and drinking needs. The installation of so many tube wells has been one of the contributing factors to the recent decrease in the incidence of waterborne diseases, especially cholera.

*Availability of Water and Water Quality*

As stated hereinbefore, the deltaic plain known as East Pakistan is crossed by the Ganges, the Brahmaputra, and Meghna Rivers which

drain the entire Himalayan Mountain ranges. Furthermore, because of the flatness of the land, the high ground-water table and the presence of suitable water-bearing substrata, the province is richly endowed with great ground-water resources in most areas. As a result of these factors, adequate water resources are available for development throughout East Pakistan. The surface water sources within the province are highly turbid during certain periods of the year and must be treated and disinfected to provide a good quality potable water. Because of the very flat slopes of the rivers and the tidal fluctuations in the Bay of Bengal, care must be exercised by the engineer in selecting the proper intake location so that high saline water will not be taken into a treatment plant. Recently the intake of a proposed treatment plant had to be relocated 7 miles upstream from the initially proposed location because it was found that during low river flows and high tide conditions the seawater was backed upstream from the Bay of Bengal many more miles than were originally conceived. Fortunately, this discovery was caught during the planning stage rather than the construction stage and indicates the necessity for good preliminary planning.

Although the ground water within the province is usually potable without disinfection, the quality in many areas is seriously impaired because of high iron, hardness and total dissolved solids.

Analysis of ground-water supplies throughout the province is currently being conducted and has indicated that the ground water in the Comilla area has an iron content that varies from 0.9 mg/1 up to as high as 7.0 mg/1. Analyses of the ground water in the Rajshahi District indicate that hardness expressed as calcium carbonate is in excess of 400 mg/1. Although the ground water in the Khulna area does not possess excessively high iron or hardness, it has a tendency to be high in total dissolved solids. The dissolved solids in the ground water in the Khulna area have run as high as 1,300 mg/1.

The limited analyses done thus far on the ground-water quality within the province clearly indicates that treatment of this water may be required in the very near future when it is demanded and can be paid for by the consumers.

It is anticipated that at least initially the majority of the water supplies within East Pakistan will be of ground-water origin with only the larger metropolitan areas requiring the construction of the more costly surface water supply facilities.

## Future Plans for Providing Water to East Pakistan

### *Urban Areas*

Final plans and specifications for the construction of modern water works facilities for the principal cities of Dacca and Chittagong were completed by Ralph M. Parsons, Inc., Los Angeles, California. These plans consisted of detail layouts for conventional water treatment, transmission, and distribution facilities for the municipalities. Because the bids received in 1965 for these projects were far in excess of the funds available for construction, the scope of these projects is currently being revised. Recently, Camp, Dresser & McKee were retained by the Government of East Pakistan as general advisors in public health engineering to study and review the planning done on these cities for their respective water supply and sewerage authorities (WASA).

Current thoughts are to utilize ground-water resources more extensively, where practicable, in order to reduce the cost of this project.

It is anticipated that if the revised project costs for furnishing potable water are within the budget authorized by the World Bank and Government of Pakistan, construction will start on these projects in the near future.

A water study report has been completed for the City of Khulna, which is currently the third largest city (220,000 people) within East Pakistan, by James M. Montgomery, Inc., of Pasadena, California, and Zafar & Associates, a Pakistani concern. This report has recommended that ground-water supply be utilized for an interim period until it becomes necessary to construct a modern water treatment plant to handle the water supply needs of the municipality. No final planning has been initiated thus far for implementing the recommendation of the report.

Camp, Dresser & McKee's contract with the Government of East Pakistan specifies that the firm shall "provide general advisory services in public health engineering for the province of East Pakistan, with the ultimate goal of developing within East Pakistan the capacity to plan, design, install, manage, operate, and maintain water and sewerage systems, and to develop manufacturing capability in the private sector for the greater part of the materials and equipment required for their installation and operation."

In cooperation with the Directorate of Public Health Engineering, we are currently studying the water requirements for about 80 com-

munities within East Pakistan. Comprehensive preliminary planning has been completed for Comilla, Mymensingh, and Ishurdi and is almost completed for Narayanganj and Rajishahi.

Ground-water resources are going to be developed for use in most of the municipalities as the main source of water supply. Initially, no treatment of the supply will be incorporated into the design, but space will be allotted in the stations for the addition of chlorination equipment.

The water works improvements which have been recommended in the completed reports fall into three basic categories, which are as follows:

1. Correction of the deficiencies within the existing water systems by improving pumping operations, eliminating severe leaks in the distribution system, repairing improperly operating street taps, and roof tanks, etc.
2. Immediate construction of a modified distribution system which will be under pressure 24 hours a day to serve a population of about 100 families who live in "Katcha" homes. The modified system will consist of small distribution piping and a "Fordilla-Type" outlet in front of each house. The "Fordilla-Type" outlet is equipped with a dash pot arrangement which automatically closes after discharging a predetermined volume of water. This valve must be manually activated for each discharge. If this system proves to be acceptable, it will be utilized extensively throughout the province.
3. Construction of a new distribution system which will consist of multiple-feed points from wells and elevated tanks which are strategically located within the core of the municipality. It is anticipated that by the use of control valves, piping, and roof tanks for each individual house connection that the "fluctuations in draft experienced in the U.S.A. can be substantially reduced in East Pakistan. It is further planned that no additional capacity will be built into the distribution systems to handle fire flows. Since the permanent buildings are of masonry construction and the area is literally strewn with ground-water "tanks" and rivers, this design factor, in the writer's opinion, is not a severe one. Small fluctuations in draft and elimination of additional fire flow capacity will substantially reduce the sizing of the distribution piping and, therefore, the cost.

Because of the scope of work which is involved in developing water supply throughout the province, many other allied studies are proceeding while pertinent water supply studies are being made. It is necessary, for example, to determine the applicable design criteria to be used by sanitary engineers, the commodity requirements in order to supply the equipment and materials from local sources to implement these plans, and many other necessary factors to get the province in the position so that it will be able to supply potable water in modern systems to the consumers in the metropolitan areas. It has been estimated that in order to provide potable water of acceptable quality for the future urban areas in the province, the cost would be well over a half billion dollars. It is evident that it will require a considerable amount of engineering, planning, and construction in order to implement the works being planned for East Pakistan.

*Rural Areas*

Because of the success of the present hand tube well program, a goal for providing a hand tube well for every 200 people within the rural areas has been set by the DPHE. The hand tube well program has been made an important part of the third 5-year program (1965-1970), and work has been scheduled so that the above goal can be met.

## Conclusion

In conclusion, it has been the intent of the writer to present only a generalized idea of the present water supply problem which must be met and resolved within East Pakistan. Future water work facilities which must be planned, constructed, operated, and maintained within the province are numerous and far exceed the number of suitable works that have been constructed thus far. Although a start has been made to solve this very important problem in East Pakistan, the challenge that awaits the sanitary engineers in the province is tremendous.