Panama Canal

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When he crossed the Atlantic, the object Columbus had in view was to find a western passage from Europe to Cathay. It was with the greatest reluctance, and only after a generation of unremitting toil that the explorers who succeeded him became convinced that the American continent was continuous, and formed a barrier of enormous extent to the passage of vessels. The question of cutting a canal through this barrier at some suitable point was immediately raised. In 1550 the Portuguese navigator Antonio Galvao published a book to demonstrate that a canal could be cut at Tehuantepec, Nicaragua, Panama or Darien, and in 1551 the Spanish historian F. L. de Gomara submitted a memorial to Philip II. urging in forcible language that the work be undertaken without delay. But the project was opposed by the Spanish Government, who had now concluded that a monopoly of communication with their possessions in the New World was of more importance than a passage by sea to Cathay. It even discouraged the improvement of the communications by land. To seek or make known any better route than the one from Porto Bello to Panama was forbidden under penalty of death. For more than two centuries no serious steps were taken towards the construction of the canal, if exception be made of William Paterson's disastrous Darien scheme in 1698. In 1771 the Spanish government, having changed its policy, ordered a survey for a canal at Tehuantepec, and finding that line impracticable, ordered surveys in 1779 at Nicaragua, but political disturbances in Europe soon prevented further action. In 1808 the isthmus was examined by Alexander von Humboldt, who pointed out the lines which he considered worthy of study. After the Central American republics acquired their independence in 1823,

there was a decided increase of interest in the canal question. In 1825 the Republic of the Centre, having received applications for concessions from citizens of Great Britain, and also from citizens of the United States, made overtures to the United States for aid in constructing a canal, but they resulted in nothing. In 1830 a concession was granted to a Dutch corporation under the special patronage of the king of the Netherlands to construct a canal through Nicaragua, but the revolution and the separation of Belgium from Holland followed, and the scheme fell through. Subsequently numerous concessions were granted to citizens of the United States, France and Belgium, both for the Nicaragua and the Panama lines, but with the exception of the concession of 1878 for Panama and that of 1887 for Nicaragua, no work of construction was done under any of them. Knowledge of the topography of the isthmus was extremely vague until the great increase of travel due to the discovery of gold in California in 1848 rendered improved communications a necessity. A railroad at Panama and a canal at Nicaragua were both projected. Instrumental surveys for the former in 1849, and for the latter in 1850, were made by American engineers, and, with some small exceptions, were the first accurate surveys made up to that time. The work done resulted in geographical knowledge sufficient to eliminate from consideration all but the following routes: (i) Nicaragua; (2) Panama; (3) San Bias; (4) Caledonia Bay; (5) Darien; (6) Atrato river, of which last there were four variants, the Tuyra, the Truando, the Napipi and the Bojaya. In 1866, in response to an inquiry from Congress, Admiral Charles H. Davis, U.S. Navy, reported that " there does not exist in the libraries of the world the means of determining even approximately the most practicable route for a ship canal across

the American isthmus." To clear up the subject, the United States government sent out, between 1870 and 1875, a series of expeditions under officers of the navy, by whom all of the above routes were examined. The result was to show that the only lines by which a tunnel could be avoided were the Panama and the Nicaragua lines; and in 1876 a United States Commission reported that the Nicaragua route possessed greater advantages and offered fewer difficulties than any other. At Panama the isthmus is narrower than at any other point except San Bias, its width in a straight line being only 35 ft and the height of the continental divide is only 300 ft., which is higher than the Nicaragua summit, but less than half the height on any other route. At Nicaragua the distance is greater, being about 156 m. in a straight line, but more than one third is covered by Lake Nicaragua, a sheet of fresh water with an area of about 3000 sq. m. and a maximum depth of over 200 ft., the surface being about 105 ft. above sea-level. Lake Nicaragua is connected with the Atlantic by a navigable river, the San Juan, and is separated from the Pacific by the continental divide, which is about 160 ft. above sea-level. At Nicaragua only a canal with locks is feasible, but at Panama a sea-level canal is a physical possibility. By the Clayton-Bulwer Treaty of 1850 with Great Britain, by the treaty of 1846 with New Granada (Colombia), Article XXXV., and by the treaty of 1867 with Nicaragua, Article XV., the United States guaranteed that the projected canal, whether the Panama or the Nicaraguan, should be neutral, and, furthermore, that it be used and enjoyed upon equal terms by the citizens of both countries in each case. A modification of the Clayton-Bulwer Treaty being necessary to enable the United States to build the canal, a treaty making such modifications, but preserving the

principle of neutrality, known as the Hay-Pauncefote Treaty, was negotiated with Great Britain in 1900; it was amended by the United States Senate, and the amendments not proving acceptable to Great Britain, the treaty lapsed in March 1901. A new treaty, however, was negotiated in the autumn, and accepted in December by the U.S. Senate. The completion of the Suez Canal in 1869, and its subsequent success as a commercial enterprise, drew attention more forcibly than ever to the American isthmus. In 1876 an association entitled " Societe Civile Internationale du Canal Interoceanique " was organized in Paris to make surveys and explorations for a ship canal. An expedition under the direction of Lieut. L. N. B. Wyse, an officer of the French navy, was sent to the isthmus to examine the Panama line. In May 1878 Lieut. Wyse, in the name of the association, obtained a concession from the Colombian government, commonly known as the Wyse Concession. This is the concession under which work upon the Panama Canal has been prosecuted. Its first holders did no work of construction. In May 1879 an International Congress composed of 135 delegates from various nations—some from Great Britain, United States and Germany, but the majority p/rst from France—was convened in Paris under the Panama auspices of Ferdinand de Lesseps, to consider the Company. best situation for, and the plan of, a canal. After a session of two weeks the Congress decided that the canal should be at the sea-level, and at Panama. Immediately after the adjournment of the Congress the Panama Canal Company was organized under a general law of France, with Lesseps as president, and it purchased the Wyse Concession at the price of 10,000,000 francs. An attempt to float this company in August 1879 failed, but a second attempt, made in December 1888, was

fully successful, 6,000,000 shares of 500 francs each being sold. The next two years were devoted to surveys and examinations and preliminary work upon the canal. The plan adopted was for a sea-level canal having a depth of 295 ft. and bottom width of 72 ft., involving excavation estimated at 157,000,000, cub. yds. The cost was estimated by Lesseps in 1880 at 658,000,000 francs, and the time required at eight years. The terminus on the Atlantic side was fixed by the anchorage at Colon, and that on the Pacific side by the anchorage at Panama. Leaving Colon, the canal was to pass through low ground by a direct line for a distance of 6 m. to Gatun, where it intersected the valley of the Chagres river; pass up that valley for a distance of 21 m. to Obispo, where it left the Chagres and ascended the valley of a tributary, the Camacho; cut through the watershed at Culebra, and thence descend by the valley of the Rio Grande to Panama Bay. Its total length from deep water in the Atlantic to deep water in the Pacific was about 47 m. It was laid out in such a way as to give easy curvature everywhere; the sharpest curve, of which there was but one, had a radius of 6200 ft., four others had a radius of 8200 ft., and all others had a radius of 9800 ft. or more. To secure this it was necessary to select a point for crossing the watershed where the height was somewhat greater than that of the lowest pass. The line was essentially the same as that followed by the Panama railroad, the concession for which granted a monopoly of that route; the Wyse Concession, therefore, was applicable only upon condition that the canal company could come to an amicable agreement with the railroad company. The principal difficulties to be encountered in carrying out this plan consisted in the enormous dimensions of the cut to be made at Culebra, and in the control of the Chagres river, the valley of which

is occupied by the canal for a large part of its length. This stream is of torrential character, its discharge varying from a minimum of about 350 cub. ft. to a maximum of over 100,000 cub. ft. per second. It rose at Gamboa on the 1st of December 1890, i8| ft. in twelve hours, its volume increasing from 15,600 cub. ft. to 57,800 cub. ft. per second at the same time; and similar violent changes are not uncommon. To admit a stream of this character to the canal would be an intolerable nuisance to navigation unless space could be provided for its waters to spread out. For a canal with locks the remedy is simple, but for a sea-level canal the problem is much more difficult, and no satisfactory solution of the question was ever reached under the Lesseps plan. Work under this plan continued until the latter part of 1887, the management being characterized by a degree of extravagance and corruption rarely if ever equalled in the history of the world. By that time it had become evident that the canal could not be completed at the sea-level with the resources of time and money then available. The plan was accordingly changed to one including locks, and work was pushed on with vigour until 18S9, when the company, becoming bankrupt, was dissolved by a judgment of the Tribunal Civil de la Seine, dated the 4th of February 1889, a liquidator being appointed by the court to take charge of its affairs. One of the more important duties assigned to this official was to keep the property together and the concession alive, with a view to the formation of a new company for the completion of the canal. He gradually reduced the number of men employed, and finally suspended the works on the 15th of May 1889. He then proceeded to satisfy himself that the canal project was feasible, a question about which the failure of the company had caused grave doubts, and to this end caused an

inquiry to be held by a commission of French and foreign engineers. This commission reported on the 9th of May 1890 that a canal with locks, for which they submitted a plan, could be built in eight years at a cost of 580,000,000 francs for the works, which sum should be increased to 900,000,000 francs to include administration and financing. They reported that the plant in hand was in good condition and would probably suffice for finishing the canal, and they estimated the value of the work done and of the plant in hand at 450,000,000 francs. The time within which the canal was to be completed under the Wyse Concession having nearly expired, the liquidator sought and obtained from the Colombian government an extension of ten years. Twice subsequently the time was extended by the Colombian government, the date ultimately fixed for the completion of the canal being the 31st of October 1910. For each of these extensions the Colombian government exacted heavy subsidies. The liquidator finally secured the organization of a new company on the 20th of October 1S94. The old company and the liquidator had raised by the sale of stock and bonds the sum of 1,271,682,637 francs. The securities issued to raise this money had a par value of 2,245,151,200 francs, held by about 200,000 persons. In all about 72,000,000 cub. yds. had been excavated, and an enormous quantity of machinery and other plant had been purchased and transported to the isthmus at an estimated cost of 150,000,000 francs. Nearly all of the stock of the Panama railroad—68,534 of the 70,000 shares existing — also had been purchased, at a cost of 93,268,186 francs. The new company was regularly organized under French law, and was recognized by the Colombian government. It Second was technically a private corporation, but

the great Panama number of persons interested in the securities of the Company. ^^^ company, and the special legislation of the French Chambers, gave it a semi-national character. By the law of the 8th of June 1888, all machinery and tools used in the work must be of French manufacture, and raw material must be of French origin. Its capital stock consisted of 650,000 shares of 100 francs each, of which 50,000 shares belonged to Colombia. It succeeded to all the rights of the old company in the concessions, works, lands, buildings, plant, maps, drawings, &c., and shares of the Panama railroad. For the contingency that the canal should not be completed, special conditions were made as to the Panama railroad shares. These were to revert to the liquidator, but the company had the privilege of purchasing them for 20,000,000 francs in cash and half the net annual profits of the road. The Panama railroad retained its separate organization as an American corporation. Immediately after its organization in 1894 the new company took possession of the property (except the Panama railroad shares, which were held in trust for its benefit), and proceeded to make a new study of the entire subject of the canal in its engineering and commercial aspects. It resumed the work of excavation, with a moderate number of men sufficient to comply with the terms of the concession, in a part of the line—the Emperador and Culebra cuts—where such excavation must contribute to the enterprise if completed under any plan. By the middle of 1895, about 2000 men had been collected, and since that time the work progressed continuously, the number of workmen varying between 1900 and 3600. The amount of material excavated to the end of 1899 was about 5,000,000 cubic yards. The amount expended to the 30th of June 1899 was about 35,000,000 francs, besides about 6,500,000

francs advanced to the Panama Railroad Company for building a pier at La Boca. The charter provided for the appointment by the company and the liquidator of a special engineering commission of five members, to report upon the work done and the conclusions to be drawn therefrom, this report to be rendered when the amounts expended by the new company should have reached about one-half its capital. The report was to be made public, and a special meeting of the stockholders was then to be held to determine whether or not the canal should be completed, and to provide ways and means. The time for this report and special meeting arrived in 1898. In the meanwhile the company had called to its aid a technical committee composed of fourteen engineers, European and American, some of them among the most eminent in their profession. After a study of all the data available, and of such additional surveys and examinations as it considered should be made, this committee rendered an elaborate report dated the l6th of November 1898. This report was referred to the statutory commission of five, who reported in 1899 that the canal could be built according to that project within the limits of time and money estimated. The special meeting of stockholders was called immediately after the regular annual meeting of the 30th of December 1899. It is understood that the liquidator (who held about one-fourth the stock) refused to take part in it, and that no conclusions were reached as to the expediency of completing the canal or as to providing ways and means. The engineering questions had been solved to the satisfaction of the company, but the financial questions had been made extremely difficult, if not insoluble, by the appearance of the United States government in the field as a probable builder of an isthmian canal. The company continued to conduct its operations

in a provisional way, without appealing to the public for capital. The plan adopted by the company involved two levels above the sea-level—one of them an artificial lake to be created by a dam at Bohio, to be reached from the Atlantic by a flight of two locks, and the other, the summit-level, to be reached by another flight of two locks from the preceding. The summit-level was |to have its surface at high water 102 ft. above the sea, and to be supplied with water by a feeder leading from an artificial reservoir to be constructed at Alajuela in the upper Chagres valley; the ascent on the Pacific side to be likewise by four locks. The canal was to have a depth of 29^ ft. and a bottom width of about 98 ft., with an increased width in certain specified parts. Its general plan was the same as that adopted by the old company. The locks were to be double, or twin locks, the chambers to have a serviceable length in the clear of 738 ft., with a width of 82 ft. and a depth of 32 ft. 10 in., with lifts varying from 20 to 33 ft., according to situation and stage of water. The time required to build the canal was estimated at ten years, and its cost at 525,000,000 francs for the works, not including administration and financing. The occupation of the Panama route by Europeans, and the prospect of a canal there under foreign control, was not a pleasing spectacle to the people of the United Nicaragua States. The favour with which the Nicaragua Scheme. route had been considered since 1876 began to assume a partisan character, and the movement to construct a canal on that line to assume a practical shape. In 1884 a treaty, known as the Frelinghuysen-Zarala Treaty, was negotiated with Nicaragua, by the terms of which the United States Government was to build the canal without cost to Nicaragua, and after completion it was to be owned and managed jointly by the two governments. The treaty

was submitted to the United States Senate, and in the vote for ratification, on the 20th of January 1885, received thirty-two votes in its favour against twenty-three. The necessary two-thirds vote not having been obtained, the treaty was not ratified, and a change of administration occurring soon afterwards, it was withdrawn from further consideration. This failure led to the formation in New York by private citizens in 1886 of the Nicaragua Canal Association, for the purpose of obtaining the necessary concessions, making surveys, laying out the route, and organizing such corporations as should be required to construct the canal. They obtained a concession from Nicaragua in April 1887, and one from Costa Rica in August 1888, and sent parties to survey the canal. An act for the incorporation of an association to be known as the Maritime Canal Company of Nicaragua passed Congress and was approved on the 20th of February 1889, and on the 4th of May 1889 the company was organized. It took over the concessions and, acting through a construction company, began work upon the canal in June 1889. Operations upon a moderate scale and mainly of a preliminary character were continued until 1893, when the financial disturbances of that period drove the construction company into bankruptcy and compelled a suspension of the work. It has not since been resumed. At that time the canal had been excavated to a depth of 17 ft. and a width of 280 ft. for a distance of about 3000 ft. inland from Greytown; the canal line had been cleared of timber for a distance of about 20 m.; a railroad had been constructed for a distance of about 11 m. inland from Greytown; a pier had been built for the improvement of Greytown harbour and other works undertaken. In all, about $4,500,000 had been expended. Congress continued to take an interest in the

enterprise, and in 1895 provided for a board of engineers to inquire into the possibility, permanence, and cost of the canal as projected by the Maritime Canal Company. The report of this board, dated April 1895, severely criticized the plans and estimates of the company, and led to the appointment in 1897 of another board, to make additional surveys and examinations, and to prepare new plans and estimates. The second board recommended some radical changes in the plans, and especially in the estimates, but its report was not completed when the revival of the Panama scheme attracted the attention of Congress, and led to the creation in 1899 of the Isthmian Canal Commission. In the meanwhile the property of the Maritime Canal Company has become nearly worthless through decay, and its concession has been declared forfeited by the Nicaraguan government. The interest of the United States in an isthmian canal was not essentially different from that of other maritime nations Isthmian down to about the middle of the 19th century, but Cara/ Com- it assumed great strength when California was acquired, and it has steadily grown as the importance of the Pacific States has developed. In 1848 and again in 1884, treaties were negotiated with Nicaragua authorizing the United States to build the canal, but in neither case was the treaty ratified. The Spanish War of 1898 gave a tremendous impetus to popular interest in the matter, and it seemed an article of the national faith that the canal must be built, and, furthermore, that it must be under American control. To the American people the canal appears to be not merely a business enterprise from which a direct revenue is to be obtained, but rather a means of unifying and strengthening their national political interests, and of developing their industries, particularly in the Pacific States; in short, a means essential to their

national growth. The Isthmian Canal Commission created by Congress in 1899 to examine all practicable routes, and to report which was the most practicable and most feasible for a canal under the control, management and ownership of the United States, reported that there was no route which did not present greater disadvantages than those of Panama and Nicaragua. It recommended that the canal at Panama have a depth of 35 ft. and a bottom width 150 ft., the locks to be double, the lock chambers to have a length 740 ft., width 84 ft. and depth 35 ft. in the clear. The cost of a canal with these dimensions, built essentially upon the French plans, was estimated at $156,378,258. A plan, however, was recommended in which the height of the Bohio dam was increased about 20 ft., the level of Lake Bohio raised by that amount, the lake made the summit-level, and the Alajuela dam omitted. The cost upon this plan was estimated at $143,971,127. According to the plan recommended by the Commission for Nicaragua the line began at Greytown on the Caribbean Sea, where an artificial harbour was to be constructed and follow the valley of the San Juan for 100 m. to Lake Nicaragua; thence across the lake about 70 m. to the mouth of Las Lajas river; then up the valley of that stream through the watershed, and down the valley of the Rio Grande, 17 m. to Brito on the Pacific, where also an artificial harbour was to be constructed. The distance from ocean to ocean is 187 m. About midway between the lake and the Caribbean the San Juan receives its most important affluent, the San Carlos, and undergoes a radical change in character. Above the junction it is a clear water stream, capable of improvement by locks and dams. Below, it is choked with sand, and not available for slack-water navigation. A dam across the San Juan above the mouth of the San

Carlos was to maintain the water of the river above that point on a level with the lake. The line of the canal occupied essentially the bed of the river from the lake to the dam; from the dam to the Caribbean it followed the left bank of the river, keeping at a safe distance from it, and occasionally cutting through a high projecting ridge. The lake and the river above the dam constitute the summit-level, which would have varied in height at different seasons from 104 to no ft. above mean sea-level. It would have been reached from the Caribbean side by five locks, the first having a lift of 365 ft., and the others a uniform lift of 185 ft. each, making a total lift of 1105 ft. from low tide in the Caribbean to high tide in the lake. From the Pacific side the summit would have been reached by four locks having a uniform lift of 28j ft. each, or a total lift of 114 ft. from low tide in the Pacific to high tide in the lake. The time required to build the canal was estimated at ten years, and its cost at $200,540,000. The report of the commission, transmitted to Congress at the end of 1900, ended thus: — The Panama Canal, after completion, would be shorter, have fewer locks and less curvature than the Nicaragua Canal. The measure of these advantages is the time required for a vessel to pass through, which is estimated for an average ship at 12 hours for Panama and 33 hours for Nicaragua. On the other hand, the distance from San Francisco to New York is 377 m., to New Orleans 579 m. and to Liverpool 386 m. greater via Panama than via Nicaragua. The time required to pass over these distances being greater than the difference in the time of transit through the canals, the Nicaragua line, after completion, would be somewhat the more advantageous of the two to the United States, notwithstanding the greater cost of maintaining the longer canal. The government of Colombia, in

which lies the Panama Canal, has granted an exclusive concession, which still has many years to run. It is not free to grant the necessary rights to the United States, except upon condition that an agreement be reached with the New Panama Canal Company. The Commission believes that such agreement is impracticable. So far as can be ascertained, the company is not willing to sell its franchise, but will allow the United States to become the owner of part of its stock. The Commission considers such an arrangement inadmissible. The Governments of Nicaragua and Costa Rica, on the other hand, are untrammeled by concessions, and are free to grant to the United States such privileges as may be mutually agreed upon. In view of all the facts, and particularly in view of all the difficulties of obtaining the necessary rights, privileges and franchises on the Panama route, and assuming that Nicaragua and Costa Rica recognize the value of the canal to themselves, and are prepared to grant concessions on terms which are reasonable and acceptable to the United States, the Commission is of the opinion that " the most practicable and feasible route for " an isthmian canal, to be " under the control, management and ownership of the United States," is that known as the Nicaragua route. This report caused the New Panama Canal Company to view the question of selling its property in a new light, and in the spring of 1901 it obtained permission from the Panama Colombian government to dispose of it to the United Route States. It showed itself, however, somewhat reluctant adopted to name a price to the Canal Commission, and it was not till January 1902 that it definitely offered to accept $40,000,000. In consequence of this offer, the commission in a supplementary report issued on the i8th of January 1902 reversed the conclusion it had stated in its main report, and

advised the adoption of the Panama route, with purchase of the works, &c., of the French company. A few days previous to this report the Hepburn bill authorizing the Nicaragua canal at a cost of $180,000,000, had been carried in the House of Representatives by a large majority, but when it reached the Senate an amendment—the so-called Spooner bill—was moved and finally became law on the 28th of June 1902. This authorized the president to acquire

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distance from it, and occasionally cutting through a high projecting ridge. The lake and the river above the dam constitute the summit-level, which would have varied in height at different seasons from 104 to no ft. above mean sea-level. It would have been reached from the Caribbean side by five locks, the first having a lift of 365 ft., and the others a uniform lift of 185 ft. each, making a total lift of 1105 ft. from low tide in the Caribbean to high tide in the lake. From the Pacific side the summit would have been reached by four locks having a uniform lift of 28j ft. each, or a total lift of 114 ft. from low tide in the Pacific to high tide in the lake. The time required to build the canal was estimated at ten years, and its cost at $200,540,000. The report of the commission, transmitted to Congress at the end of 1900, ended thus: — The Panama Canal, after completion, would be shorter, have fewer locks and less curvature than the Nicaragua Canal. The measure of these advantages is the time required for a vessel to pass through, which is estimated for an average ship at 12 hours for Panama and 33 hours for Nicaragua. On the other hand, the distance from San Francisco to New York is 377 m., to New Orleans 579 m. and to Liverpool 386 m. greater via Panama than via Nicaragua. The time required to pass over these distances being greater than the difference in the time of transit through the canals, the Nicaragua line, after completion, would be somewhat the more advantageous of the two to the United States, notwithstanding the greater cost of maintaining the longer canal. The government of Colombia, in which lies the Panama Canal, has granted an exclusive concession, which still has many years to run. It is not free to grant the necessary rights to the United States, except upon condition that an agreement be reached with the New Panama Canal Company. The

Commission believes that such agreement is impracticable. So far as can be ascertained, the company is not willing to sell its franchise, but will allow the United States to become the owner of part of its stock. The Commission considers such an arrangement inadmissible. The Governments of Nicaragua and Costa Rica, on the other hand, are untrammelled by concessions, and are free to grant to the United States such privileges as may be mutually agreed upon. In view of all the facts, and particularly in view of all the difficulties of obtaining the necessary rights, privileges and franchises on the Panama route, and assuming that Nicaragua and Costa Rica recognize the value of the canal to themselves, and are prepared to grant concessions on terms which are reasonable and acceptable to the United States, the Commission is of the opinion that " the most practicable and feasible route for " an isthmian canal, to be " under the control, management and ownership of the United States," is that known as the Nicaragua route. This report caused the New Panama Canal Company to view the question of selling its property in a new light, and in the spring of 1901 it obtained permission from the Panama Colombian government to dispose of it to the United Route States. It showed itself, however, somewhat reluctant adopted. to name a price to the Canal Commission, and it was not till January 1902 that it definitely offered to accept $40,000,000. In consequence of this offer, the commission in a supplementary report issued on the i8th of January 1902 reversed the conclusion it had stated in its main report, and advised the adoption of the Panama route, with purchase of the works, &c., of the French company. A few days previous to this report the Hepburn bill authorizing the Nicaragua canal at a cost of $180,000,000, had been carried in the House of Representatives by

a large majority, but when it reached the Senate an amendment—the so-called Spooner bill—was moved and finally became law on the 28th of June 1902. This authorized the president to acquire, and government to continue the work, which was placed under the more immediate control of the U.S.A. Corps of Engineers. At the same time the Isthmian Canal Commission was reorganized, Major G. W. Goethals, of the Corps of Engineers, becoming engineer in chief and chairman, in succession to Mr J. F. Stevens who, after succeeding Mr T. P. Shonts as chairman, himself resigned on the 1st of April. The following are the leading particulars of the canal, the course of which is shown on the accompanying map. The length from deep water in the Atlantic to deep water in the Pacific will be about 50 m., or, since the distance from deep water to the shore-line is about 45 m. in Limon Bay and about 5 m. at Panama, approximately 40J m. from shore to shore. The summit level, regulated between 82 and 87 ft. above sea-level, will extend for 31 5 m. from a large earth dam at Gatun to a smaller one at Pedro Miguel, and is to be reached by a flight of 3 locks at the former point. The Gatun dam will be 7200 ft. long along the crest including the spillway, will have a maximum width at its base of 2000 ft., and will be uniformly 100 ft. wide at its top, which will rise 115 ft. above sea level. The lake (Lake Gatun) enclosed by these dams will be 1641 sq. m. in area, and will constitute a reservoir for receiving the floods of the Chagres and other rivers as well as for supplying water for lockage. A smaller lake (Lake Miraflores), with a surface elevation of 55 ft. and an area of about 2 sq. m. will extend from a lock at Pedro Miguel to Miraflores, where the valley of the Rio Grande is to be closed by an earth dam on the west and a concrete dam with spillway on the east, and the

canal is to descend to sea-level by a flight of two locks. All the locks are to be in duplicate, each being no ft. wide with a usable length of 1000 ft. divided by a middle gate. The channel leading from deep water in the Caribbean sea to Gatun will be about 7 m. long and 500 ft. broad, increasing to 1000 ft. from a point 4000 ft. north of the locks in order to form a waiting basin for ships. From Gatun locks, 0-6 m. in length, the channel is to be 1000 ft. or more in width for a distance of nearly 16 m. to San Pablo. Thence it narrows first to 800 ft., and then for a short distance to 700 ft., for jj m. to mile 27 near Juan Grande, and to 500 ft. for 4J m. from Juan Grande to Obispo (mile 3ij). From this point through, the Culebra cut to Pedro Miguel lock, it will be only 300 ft. wide, but will widen again to 500 ft. through Miraflores lake, ij m. long, to Miraflores locks, the total length of which including approaches will be nearly a mile, and will thence maintain the same width for the remaining 8 m. to deep water on the Pacific. The minimum bottom width of the canal will thus be 300 ft., the average being 649 ft., while the minimum depth will be 41 ft. In 1909 it was estimated that the construction of the canal would be completed by the 1st of January 1915, and that the total cost to the United States would not exceed $375,000,000 including $50,000,000 paid to the French Canal Company and the Republic of Panama, $7,382,000 for civil administration, and $20,053,000 for sanitation. The last was one of the most necessary expenditures of all, since without it disease would have greatly retarded the work or perhaps prevented it altogether.

See W. F. Johnson, Four Centuries of the Panama Canal (New York, 1906) ; Report of the Board of Consulting Engineers for the

Panama Canal (Washington, 1906); Annual Reports of the Isthmian Canal Commission (Washington) ; Vaughan Cornish, The Panama Canal and its Makers (London, 1909).