

“The Panama Canal: Writings of the U. S. Army Corps of Engineers Officers Who Conceived and Built It.”

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Introduction

Americans had envisaged an interoceanic passage through Central America early in the nineteenth century. Army engineers began playing a role in determining a favorable route as early as 1839, when Col. John J. Abert, Chief of the Corps of Topographical Engineers, ordered Lt. Thomas J. Lee to prepare an estimate of the amount of material to be excavated in order to build a canal through Nicaragua. Officers of the Corps of Topographical Engineers and the Corps of Engineers (into which the Topographical Engineers were merged in 1863) studied and reported on a number of proposed routes, from the Isthmus of Tehuantepec, in Mexico, to the Isthmus of Darien, in New Granada (later Colombia).

Meanwhile, an American corporation completed a railroad across the Isthmus of Panama in 1855. A French company began excavating a sea-level canal through Panama (then a province of Colombia) in 1879. Americans still believed that Nicaragua was the most favorable location for a canal, and Army engineers continued to examine proposed routes there.

The French canal company collapsed in 1889. A new French company resumed work on the canal in Panama in 1894, but it too experienced administrative, financial, and

sanitation difficulties. In 1902 the United States accepted the company's offer to sell its property (which included the railroad), franchises, and equipment. During the following year the American-backed revolt against Colombia produced the independent Republic of Panama, which leased the Canal Zone in perpetuity to the United States.

American work on the canal began in 1904. The first two chief engineers of the project were railroad men, John F. Wallace and John F. Stevens. Both soon quit their positions. In 1907 President Theodore Roosevelt announced that he would appoint a chief engineer that could not resign. He chose Maj. George W. Goethals. Like many other Army engineers, Goethals (soon to be promoted to lieutenant colonel and later to colonel) had much experience in the designing and building of canals, locks, and dams. He directed the work in Panama to a successful conclusion in 1914.

The construction of the canal was not a Corps of Engineers mission as such. Goethals reported to Roosevelt and the secretary of war, not to the chief of engineers. Many engineer officers, however, were detailed to key positions on the project.

As the work progressed, several of the officers contributed articles to both professional and popular periodicals that informed readers of many aspects of the building of the Canal. In addition to Goethals, some of his more important subordinates, such as William L. Sibert and David D. Gaillard, added to the literary record. Like Goethals, both men came to the job with extensive experience with civil works projects assignments. Majors (later Lieutenant Colonels) Sibert and Gaillard commanded, respectively, the Atlantic and Central Divisions of the project. Sibert's main responsibilities were the construction of three sets of locks and Gatun Dam, which was to check the unruly Chagres River and create the large artificial lake that would provide

water for the operation of the locks and the hydroelectric power plant. Gaillard's principal task was to blast and dredge a path through the continental divide and remove the frequent slides that plagued the effort. A civilian engineer, Sydney B. Williams oversaw construction in the Pacific Division.

Other Army engineer authors include: Lt. Col. Harry F. Hodges, Goethals' assistant chief and the man charged with designing mitering gates for the locks; Maj. Frank C. Boggs; Lt. Charles K. Rockwell; and Lt. James G. Steese.

Two distinguished retired engineer officers wrote important articles before and during the American phase of canal construction. Brig. Gen. Henry L. Abbot, coauthor of a classic work on the hydrology of the Mississippi River, began his involvement with the Panama Canal as a member of the new French canal company's Comité Technique and Comité Statutaire, from 1897 to 1900. While the United States was assuming responsibility for building the Canal, Abbot worked for the French company as a consulting engineer during the transitional period, dividing his time between Paris and the isthmus. After the Americans assumed control of the project Abbot served from 1905 to 1906 on the Board of Consulting Engineers, a body appointed by Roosevelt and charged with the preparation of a plan for canal construction. The majority of the board recommended a sea-level canal. The minority report, probably written largely by Abbot, helped to persuade Roosevelt and Secretary of War William Howard Taft to adopt a plan for a lock canal. Abbot's last service to the canal was as a member of the Panama Canal Slide Committee in 1915.

Abbot's numerous articles and one book account for over half of the entries in this bibliography. They range widely over several topics. In addition to arguing for a lock

canal he insisted that the Americans abandon once and for all any thought of building a canal in Nicaragua. Other articles answered critics who asserted that Panama was too hot, wet, and unhealthy, and that the area was subject to earthquakes. Abbot successfully presented the case for creating two artificial lakes instead of one. He maintained that the wild and unpredictable Chagres could be tamed and made useful in the building and operation of the canal.

Brig. Gen. Peter C. Hains's involvement with isthmian canal projects began with his service on the Nicaragua Canal Commission, 1897-99, where he studied possible routes in the Central American republic. From 1899 to 1904 Hains was a member of the Isthmian Canal Commission, a body charged with examining feasible routes. Following his retirement from the Army in 1904 he was appointed to the second Isthmian Canal Commission, serving from 1905 to 1907.

Although not as prolific as Abbot, Hains would write articles that addressed a number of important facets of the canal question. He contended that the canal would have virtually no military value, that there was no need to fortify it, and that it should always be open to neutral shipping. Hains believed that the building of the canal should be a government project rather than one undertaken by contractors. Like Abbot, he championed a lock canal. Surprisingly, proponents of a sea-level canal and advocates of a Nicaragua route continued to speak out even while the Americans were well along with the building of a lock canal in Panama.

The Bibliography

The works listed here deal with virtually every major consideration associated with the building of the canal. They range from discussions of political and social questions to matters of hydrology, meteorology, medicine, excavation, lock and dam construction, and the progress of the work. Some of the publications are of a technical nature and aimed at an audience of professional engineers. Others, written for popular consumption, appeared in mass circulation periodicals.

Reports by Goethals, Sibert, Gaillard, and Hodges are in the annual reports of the Isthmian Canal Commission. They have not been included in this bibliography.

The articles and books are here arranged alphabetically by author and thereunder by date of publication. The compiler makes no claim for completeness. Should other works come to his attention they will be added.

Abbot, Henry L. "The Present Status of the Panama Canal." Engineering News 40 (October 6, 1898):210-213. An optimistic view of the progress made by the new French canal company and its plans for future construction. Emphasizes the disadvantages of the proposed Nicaragua route. Published separately by the New York Evening Post Printing House, 1898.

_____. “The New Panama Canal.” Forum 26 (November 1898):343-53. Argues in favor of a Panama canal even though it would be in French hands, and urges Americans to abandon further consideration of a Nicaragua canal. Also printed separately by the Forum Publishing Company, 1898. Reprinted as Senate Document No. 41, 55th Congress, 3d Session, December 21, 1898, and as “General Abbot on the Panama Canal,” Engineering Record 39 (January 14, 1899):137-40.

_____.(?) “The New Panama Canal.” Scientific American 80 (February 4, 1899):73-75. Possibly by Abbot. “The present article is written for the purpose of putting the public in possession of the facts regarding the present status and future prospects of this undertaking.” (p. 73) Discusses the French canal company’s international Comité Technique, of which Abbot was a member; the Culebra Cut; control of the Chagres River; health concerns; and relationship of the new canal company to the old company.

_____. “Climatology of the Isthmus of Panama, Including the Temperature, Winds, Barometric Pressure, and Precipitation.” Monthly Weather Review 27 (May 1899):198-203. Temperature, barometric pressure, and precipitation tables compiled by the old and new French canal companies. “In tropical regions it is not the excessively high temperatures which increase the difficulties of out-door labor and construction, but those which remain permanently high and are

accompanied by great humidity of the air and heavy rainfall “ (p. 201)

Rainfall comparable to areas of the United States near the Gulf of Mexico.

The Weather Bureau issued, as a separate designated W. B. No. 201, a “slightly modified” (p. 3) version of this article.

_____. “Climatology of the Isthmus of Panama.” Monthly Weather Review 27 (July 1899):302-03. Supplemental to May 1899 article. Updates rainfall figures to 1899.

_____. “Meteorology of Panama.” Monthly Weather Review 27 (October 1899):463. More rainfall and temperature data for 1899.

_____. “Contributions to the Meteorology of Panama.” Monthly Weather Review 28 (January 1900):7. Hourly temperatures and barometric pressure at Alhajuela and La Boca, observed by personnel of the New Panama Canal Company, autumn of 1899.

_____. “Rainfall and Drainage in the Upper Chagres River.” Monthly Weather Review 28 (June 1900):243-44. Figures showing that “no fear of a lack of water in the dry season need be entertained with the reserves contemplated by the new French [Panama Canal] company.” (p. 244)

_____. “The Best Isthmian Canal.” Atlantic Monthly 86 (December 1900):844-48. “[T]his claim of gain of time by Nicaragua must be relegated to the class of

visionary arguments so often advanced to offset the solid merits of the Panama route.” (p. 848).

_____. (Communication on “The Present Condition and Prospects of the Panama Canal Works,” by James Thomas Ford, pp. 150-70.) Minutes of the Proceedings of the Institution of Civil Engineers (London) 144 (February 1901):199-202. Regulation of the Chagres River is essential for a canal with locks and dams. Data on the discharge of the river at various locations; estimates of time needed for lockages.

_____. “Present Condition of the Panama Canal.” Engineering Magazine 22 (January 1902):487-92. (Editor’s introduction to Abbot’s article “International Aspects of the Isthmian Canal,” pp. 485-87.) Abbot: there are “only three formidable difficulties”: “the cut at the continental divide, regulation of the Chagres River, and the tropical climate.” Despite these problems, “Nature has placed on the Isthmus of Panama far fewer obstructions to the construction of a ship canal than on any other possible route between the oceans.” (p. 488). Abbot favors use of black laborers and suggests that American capital, not the government, should buy out the French company.

_____. “Why The Panama Canal Should Be Selected.” Collier’s Weekly 28 (February 8, 1902):5. Panama route is preferable to one in Nicaragua because it would be shorter; no active volcanoes within ca.200 miles of Panama; lower annual rainfall; Colón a better port than Greytown; cheaper to operate and maintain a canal in

Panama; rates for insurance and shipping from United States ports would be lower. “Whatever ‘sentimental feeling’ may exist in favor of the Nicaragua route, it would appear that if those interested in commercial expansion appreciated these facts there would be little doubt which canal would be demanded.”

_____. “Mean Barometric Pressure at Sea Level on the American Isthmus.” Monthly Weather Review 31 (March 1902):124-25. “These figures certainly indicate a remarkable uniformity of barometric pressure in this tropical region throughout the year.” (p. 125).

_____. “The Panama Canal Question.” Medical News (April 12, 1902):707.
Communicates translation of health information, 1898-1901, submitted by Dr. (Elie?) Lacroisade, medical director of the New Panama Canal Company. Abbot: “The marked improvement in health since the early days of the enterprise is forcibly presented by these official hospital records.”

_____. “Earthquakes and the Isthmian Canal.” Collier’s Weekly 29 (July 12, 1902):7.
“[The commercial interests] of the world will protect us against placing a canal in the region of greatest danger from earthquakes to be found anywhere on the continent [i.e., Nicaragua], where we can have a safer, shorter and cheaper and in every respect better route elsewhere [i.e., Panama].”

_____. "The Panama Canal and the Regulation of the Chagres River." Engineering Magazine 24 (December 1902):329-68. Abbot had carefully studied the river and the data amassed by the two French canal companies and concluded that "Far from being a menace, the Chagres is a most useful friend." (p. 366) Topics include: "Topography of the Basin above Bohio"; "Regimen of the Chagres"; "Discharge of the Chagres"; "Great Floods of the Chagres"; "Regulation of the Floods"; "Ratio between Downfall and Drainage"; "Water Supply in the Dry Season."

_____. "Climatology of the Isthmus of Panama." Monthly Weather Review 31 (March 1903):117-24. Because it appeared likely that the United States would build the Panama Canal "it has seemed to me desirable to prepare a summary bringing these records [compiled by the New Panama Canal Company] up to date, with an analysis designed to develop the information they convey." (p. 117) Data on temperatures, rainfall, barometric pressure, winds, and health on the isthmus. Cites medical director Dr. Lacroisade as authority for asserting that health conditions had improved and that mortality and disease rates had declined in the last years of French activity.

_____. "Note on the Barometric Pressure at Colon." Monthly Weather Review 31 (April 1903):188. Update of his March 1903 article.

_____. “The Panama Canal: The Dual versus the Single-Lake Project.” Engineering Magazine 25 (June 1903):321-26. Followed by a reply by George S. Morison, “The Advantages of Lake Bohio at the Higher Level,” pp. 326-28. Abbot favors a dual lake system. Early planning called for a lake at Bohio.

_____. “The Solution of the Isthmian-Canal Problem.” Engineering Magazine 26 (January 1904):481-87. A Nicaragua canal would be “ill suited to the transit of ocean shipping.” (p. 483). Answers objections to the Panama route. “[N]ow that the problem has been thoroughly studied, and that the facts are known, and that fortune has enabled us to secure the better route, we have good reason to rejoice that hasty action was delayed, and that no mistake has been made in the selection.” (p. 487)

_____. “Disposition of Rainfall in the Basin of the Chagres.” Monthly Weather Review 32 (February 1904):57-65. “In connection with their other technical investigations the New Panama Canal Company found it obligatory to study some of these questions [relating to rainfall, evaporation, absorption by plants, and ground water] with considerable attention, and this paper is written in the hope that the resulting facts and figures may prove useful in throwing light upon the more general problem of the ultimate disposition of rainfall.” (p. 57) Article covers the basin of the Chagres above Bohio. See Abbot’s 1907 article “Rainfall and Outflow Above Bohio.”

_____. “Hourly Climatic Records of the Isthmus of Panama.” Monthly Weather Review 32 (June 1904):267-72. Mostly tables of temperature, rainfall, and barometric pressure data collected by engineers of the New Panama Canal Company at Alhajuela and Bohio. Abbot notes that the company’s rights and property had been transferred to the United States in April.

_____. “The Regimen of the Chagres.” Harvard Engineering Journal 3 (June 1904):153-62. Knowledge of the regimen of the river “has been secured by the elaborate and long continued investigations of the New French Company.” (p. 153) “The old popular belief that the regulation of the floods of the Chagres presents unprecedented difficulties . . . is erroneous.” (p. 154)

_____. “Natural Conditions Affecting the Construction of the Panama Canal.” Engineering Magazine 27 (August 1904):721-30. “While no one will claim that the climate of the Isthmus is salubrious, it is certain that much wild exaggeration has been circulated . . .” (p. 727) No danger of earthquakes. The Chagres River “is marvelously adapted to the needs of the canal.” (p. 729)

_____. Problems of the Panama Canal, Including Climatology of the Isthmus, Physics and Hydraulics of the River Chagres, Cut at the Continental Divide and Discussions of Plans for the Waterway. New York: Macmillan, 1905. “[A]n unbiased and truthful statement of how the work appears to a retired officer of the Corps of Engineers . . . who has spent his life in the prosecution of public works

confided to that Corps” (p. vi) Written before the United States took over the project from the French. The author believes that Americans could have a voice in the operation of the canal by purchasing stocks and bonds of the French company, and that the United States could control transits across the canal by its domination of the surrounding seas. The appendix presents a strong case for a canal through Panama rather than Nicaragua. Some of the content is based on Abbot’s periodical articles, but much of it is new. See also the second (1907) edition.

_____. “The Revival of De Lesseps’ Sea-Level Plan for the Panama Canal.” Engineering Magazine 28 (February 1905):721-26. “Why . . . waste an extra ten or a dozen years and untold millions of dollars to execute a scheme which the investigations of thirty-five years have demonstrated to possess only a sentimental merit due to the imagination of M. de Lesseps?” (p. 726) Cites advances in lock canal technology in recent years.

_____. “The Panama Canal Under Control of the United States.” Harvard Engineering Journal 5 (April 1906):1-13. Discusses the government of the Canal Zone; duties of the Isthmian Canal Commission; administration of the Panama Railroad; the work of Chief Engineer John F. Stevens, especially on the Culebra Cut; appointment of the Board of Consulting Engineers; the majority and minority reports of the board. Abbot responds to criticism that little had been

accomplished in the building of the canal, pointing out that needed preliminary work was being done.

_____. “The Panama Canal. Projects of the Board of Consulting Engineers.” Engineering Magazine 31 (July 1906):481-91. The board, of which Abbot was a member, was unable to agree whether to recommend a sea-level or lock canal. Abbot, who had studied both types throughout the world, likens the Panama Canal to the Sault Ste. Marie Canal.

_____. “Hydrology of the Chagres River.” George Washington University Bulletin 5 (December 1906):48-54. The Panama Canal would follow the valley of the Chagres for much of the way and the river would provide water for the operation of the locks. “[I]t may be said that the dominating element in deciding what type of canal should be adopted at the Isthmus of Panama is neither more nor less than this eccentric little river; and that the long years that have been devoted to its study have been well expended. They have made certainly known that all which is required is a judicious system of regulation by well understood engineering methods.” (p. 54) Abbot was then professor of hydraulic engineering at George Washington University.

_____. Problems of the Panama Canal, Including Climatology of the Isthmus, Physics and Hydraulics of the River Chagres, Cut at the Continental Divide, and Discussion of Plants for the Waterway, with History from 1890 to Date. 2d ed.

New York: Macmillan, 1907. “It has seemed desirable to extend this new edition [of the 1905 work] to cover the progress of events since the transfer of the work to the United States This has been accomplished by adding a new chapter to the historical portion of the book; by explaining and discussing . . . the new projects resulting from the studies of the Board of Consulting Engineers . . . and by introducing recent and valuable climatological and hydraulic data” (p. vii)

_____. “Rainfall and Outflow Above Bohio, in the Valley of the Chagres.” Monthly Weather Review 35 (February 1907):74-75. Update of Abbot’s articles of June 1900 and February 1904.

_____. “The Preparatory Period, Panama Canal.” Harvard Engineering Journal 6 (June 1907):1-10. Much preliminary work needed before “making the dirt fly,” as demanded by the impatient American public. Discusses the Isthmian Canal Commission, Panama Railroad, Board of Consulting Engineers, congressional legislation, reorganization of the canal’s administrative system, accomplishments of Dr. William C. Gorgas, flooding, rainfall, and work at Gatun and the Culebra Cut.

_____. “Present Status of the Panama Project.” Annals of the American Academy of Political and Social Science 31 (January 1908):12-35. Discusses lack of danger from earthquakes, the need to study the Chagres River, climate, Gorgas’ success in improving health conditions, lock construction, water supply, and the

government of the Canal Zone. “In fine, an era of rapid progress has been inaugurated under an efficient organization, with every promise of success, and the expenditures have been kept within reasonable limits.” (p. 35).

_____. “Hydraulics of the Chagres River.” Engineering Magazine 39 (June 1910):377-84. “In projecting a canal across the Isthmus of Panama, the dominating element is not the volume of excavation at the Continental Divide, but rather the hydraulics of the Chagres River whose valley must be traversed throughout the greater part of the route.” (p. 377)

_____. “Hydrology of the Isthmus of Panama.” In Professional Memoirs, Corps of Engineers, United States Army, and Engineer Department at Large 7 (November-December 1915):657-62. “The Panama Canal being now opened to traffic, there remains for study only one important hydraulic problem—the sufficiency of the available water supply to meet the needs for lockage , for mechanical power to operate the canal and railroad, and for the electric lighting of the Canal Zone.” (p. 657). See also Caleb Mills Saville, “Hydrology of the Panama Canal.” Transactions of the Society of Civil Engineers 76 (1913):985-987, “With Discussions by Henry L. Abbot and W. E. Fuller.”

Boggs, F. C. “Purchase of Supplies for the Panama Canal.” In Goethals, ed., Transactions I:205-222. Maj. Frank C. Boggs, Jr., served in Washington, DC, as assistant general purchasing officer of the Isthmian Canal Commission from

April 1 to July 1, 1908 and as general purchasing officer and chief of the ICC's Washington office from July 1, 1908 to March 31, 1916.

Gaillard, David D. "Culebra Cut and the Problem of Slides." Scientific American 107 (November 9, 1912):388-90. "So far as the time of completion of excavation in the Culebra cut is concerned, in spite of the large additions by slides, the work is still well up to the original schedule, and had there been no slides, would have been completed with ease in January, 1912: an amount of material equivalent to the total excavation, exclusive of slides, having been removed by that time. In reality, however, it would have been completed sooner, as slides have decreased the average monthly output in addition to adding a large surplus of material." (p. 390)

_____. "Universal Use of Electricity on the Panama Canal." Journal of the Western Society of Engineers 19 (January to December 1914):685-705 (Discussion, pp. 702-05). "Presented May 25, 1914, before the Electrical Section, W. S. E., and Chicago Section, A. I. E. E." "[I]n addition to furnishing light and power [for locks, towns and buildings], electricity will be applied to various other uses, some of the most important of which are in connection with the telephone and telegraph system, the automatic railway signaling system, and . . . the coast defenses of the Canal Zone." (p. 685)

Goethals, George W. The Isthmian Canal. Washington: Government Printing Office, 1909. The full text of a paper delivered before the Manufacturers Association of

Chicago, March 16, 1909 (see next entry). “The idea of a sea-level canal appeals to the popular mind, which pictures an open ditch offering free and unobstructed navigation from sea to sea, but no such substitute is offered for the present lock canal, the latter can be constructed in less time, at less cost, will give easier and safer navigation, and in addition secure such a control of the Chagres River as to make a friend and aid of what remains an enemy and menace in the sea-level type.” (p. 18) Also discusses the stability of Gatun Dam and changes in the original construction plans.

_____. “The Isthmian Canal.” Engineering News 61 (March 18, 1909):304-05. A shortened version of the preceding entry. “From a paper read on March 16 before the Manufacturers Association of Chicago.” (p. 303)

_____. “The Panama Canal.” National Geographic Magazine 20 (April 1909):334-55. Mostly a defense of the decision to build a lock canal, with some discussion of the housing, feeding, health, and recreation of the labor force.

_____. “The Panama Canal: A General Description of the Engineering and Construction Features of the Panama Canal.” Engineering: An Illustrated Weekly Journal (London) 89 (February 11 and 25, 1910; March 4 and 11, 1910):170-73, 238-41, 246, 292-96, 325-29. “The two formidable engineering difficulties presented by the Panama route are the control or disposition of the waters of the Chagres River and its tributaries, and the cut through the continental divide.” (p. 171)

- _____. “The Panama Canal.” National Geographic Magazine 22 (February 1911): 148-211. A February 10, 1911 address before the National Geographic Society. Floods of the Chagres river; defense of the decision to build a lock canal; health; Commissary Department; excavation; slides; Gatun Dam; spillway; filling the locks; safety devices; Gatun Lake; aerial cableways; Pedro Miguel and Miraflores locks; rebuilding the railroad; value of the Canal. Profusely illustrated.
- _____. “Progress on the Panama Canal. A Summary of the Report for the Year Ending June 30, 1911, by Col. George W. Goethals, Chairman and Chief Engineer of the Isthmian Canal Commission.” Engineering Record 64 (November 11, 1911):565-77. A comprehensive view of the activities of the canal’s various divisions, districts, and departments.
- _____. “The Building of the Panama Canal. I. Success of Government Methods.” Scribner’s Magazine 57 (March 1915):265-82. Arguments for and against contracting the work. “I had never held the opinion that it is, generally speaking, more economical or advantageous to the government to do its work by contract, basing my conclusion not only on experience gained by doing work both ways but from handling all matters relating to contracts for work connected with fortifications and rivers and harbors” (p. 275)

_____. “The Building of the Panama Canal. II. Labor Problems Connected with the Work.” Scribner’s Magazine 57 (April 1915):395-418. Topics include: “gold roll” (American and European) and “silver roll” (Caribbean) employees; sick leave; wages and salary scales; demands for pay increases; overtime pay; promotions; longevity pay increases; compensation for injuries; and Goethals’ handling of grievances. “An effort has been made to treat the men fairly and humanely, straightening their difficulties and differences when possible, assisting them when necessary, as well as taking an interest in their affairs when advisable to do so.” (p. 218)

_____. “The Building of the Panama Canal. III Organization of the Force.” Scribner’s Magazine 57 (May 1915):531-48. Topics include: the make-up and powers of the Panama Canal Commission; departments, divisions, and committees; administrative structure of the Canal Zone and the Panama Railroad; the evolution of Goethals’ authority.

_____. “The Building of the Panama Canal. IV. The Human Element in Administration.” Scribner’s Magazine 57 (June 1915):720-34. Asserts that in the construction of the canal administrative problems were greater than engineering problems, and that the French canal-building effort failed because of poor administration. Among the topics discussed are: housing and feeding of the work force; sanitation; governing structure; provisions for religious services and

Sunday schools; recreation and entertainment; liquor; and Goethals' "Sunday court," where he heard workers' complaints about food, quarters, furniture, and pay. "I had learned by experience, both in the army and on civil works, that the best results are secured through co-operation of men who are contented and who have respect for and confidence in their leader." (p. 734)

_____. "The Dry Excavation of the Panama Canal." In Goethals, ed., Transactions (1916) I:335-86. Had David D. Gaillard, chief of the Canal's Central Division, lived to see the completion of the project he probably would have contributed the paper on this topic. It chiefly concerns digging through the Culebra (renamed Gaillard) Cut.

_____, ed. Transactions of the International Engineering Congress, 1915. The Panama Canal. I. General Papers and Construction in the Three Division of the Canal. II. Design and Erection of Structures. 2 vols. San Francisco: Press of the Neal Publishing Co., 1916. Also published as The Panama Canal. An Engineering Treatise. 2 vols. New York: McGraw-Hill, 1916. McGraw-Hill's London edition appeared that same year. Twenty-five articles on various aspects of the construction of the Canal, written by military and civilian engineers engaged in the projects. Articles by Goethals, Boggs, Mears, Sibert, and Hodges are listed separately in this bibliography. Goethals' introduction is an overview of the canal question from Spanish colonial times to the American period. Included are tables of statistics, appropriations, and expenditures.

Hains, Peter C. "An Isthmian Canal from a Military Point of View." Journal of the Military Service Institution of the United States 28 (May 1901):371-80. A paper read before the American Academy of Political and Social Science. Mostly naval considerations. "From a military standpoint the canal is valuable only as a shortened line of communication. It has no other value." (p. 6). "The object of the foregoing remarks is to show that a neutral canal with a large area of neutral waters at each terminus is, in the existing status of the naval powers of the world, a more useful canal to the United States from a military standpoint than one that is controlled by military power." (p. 7) Reprinted in Journal of the Military Service Institution of the United States 28 (May 1901):371-80, Academy of Political and Social Science Annals 17 (May 1901):1-12 [397-08], and Journal of the United States Artillery 15 (May-June 1901):289-97. Abstract in Engineering News 45 (February 28, 1901):157. First printed as Senate Document No. 190, 56th Congress, 2d Session, February 27, 1901.

_____. "The Labor Problem on the Panama Canal." North American Review 179 (July 1904):42-54. Hains recommends that the government, rather than contractors, hire the laborers, and favors the employment of southern African Americans because they spoke English and were temperate, healthy, "intelligent, industrious, and ambitious." (p. 51) A paraphrase of this article appeared in American Monthly Review of Reviews 30 (August 1904):227-29.

_____. “The Panama Canal—Some Objections to A Sea-Level Project.” North American Review 180 (March 1905):440-52. “It will thus be seen that, after the failure of the De Lesseps project for a sea-level canal, and after more thorough surveys and studies, no less than three Boards or Commissions, comprising among it members no less than thirty-one engineers, reported in favor of the abandonment of the sea-level project and the building of a canal with locks [emphasis in original]. They may all have been wrong in their conclusions, but the unanimous verdict of these thirty-one engineers, who gave years of study to the problem, should not be set aside, unless new and convincing evidence be found to justify the change. Has such evidence been discovered?” (p. 452)

_____. “Neutralization of the Panama Canal.” American Journal of International Law 3 (April 1909):354-94. “The Panama Canal is the exclusive property of the United States Government, but it is located in a foreign country, the site of which has been conveyed to us in trust [emphasis in original] for the benefit of the world’s commerce. It was not conveyed with the idea of increasing the naval or military strength of the United States.” (p. 365). “The old [Clayton-Bulwer] treaty forbade fortifications, the new one [Hay-Pauncefote] is silent on the subject, but construed as authorization.” (pp. 367-368) “[T]he construction of permanent fortifications in time of peace is repugnant to the idea of neutralization and we are therefore, legally as well as morally, bound to abstain from their construction.” (p. 380)

Hodges, Harry F. Notes on Mitering Lock Gates. Professional Papers of the Corps of Engineers, United States Army, No. 26 (October 1892). Washington: Government Printing Office, 1892. A 132-page treatise on the subject, written long before the author would apply such technology to the locks of the Panama Canal.

_____. "The Panama Canal." Journal of the Engineers Society of Pennsylvania 1 (July 1909):311-39. An illustrated lecture delivered before the society June 10, 1909. In defending the commitment to a lock canal, Hodges addresses subjects such as: early interest in a passage through the Isthmus; the Panama Railroad; the French era of canal-building; the Chagres River; Gatun Dam; excavation; culverts; valves; mitering locks; the spillway and its Stoney gates; supposed danger of ships colliding with lock gates; recommendations of the Board of Consulting Engineers; cost and time of construction; water supply and lockage capacity; flood disposal; vulnerability of the Canal to earthquakes and war; work force; sanitary conditions; administration of the Canal Zone. An abstract of this paper, entitled "Notes on the Panama Canal, Past and Present," appeared in Engineering News 62 (September 30, 1909):348-52.

_____. "The Design of the Panama Canal Locks." Engineering News 62 (December 2, 1909):617-18. Hodges' letter to the editor in response to that of M. G. Barnes

(pp. 616-17) who finds four “uncertainties” in the design of the Gatun Locks.

Hodges responds to Barnes’ concerns point-by-point.

_____. “The Panama Canal.” In Professional Memoirs, Engineer Bureau, United States Army 1 (October-December 1909):355-88. A vindication of the lock-type canal.

_____. [Discussion, pp. 96-106, of] “Water Supply for the Lock Canal at Panama,” by Julio F. Sorzano. Transactions of the American Society of Civil Engineers 67 (1910):61-205. Hodges: “Mr. Sorzano’s paper on the probable water supply for the lock canal is most interesting. The conclusions he reaches are so different from those of others who have reasoned from the same data, that the writer feels impelled to join in the discussion which he so kindly invites.” (p. 96). Hodges is critical of several of the author’s points.

_____. “Action of Water in Locks of the Panama Canal.” In Professional Memoirs, Corps of Engineers, United States Army, and Engineer Department at Large 7 (January-February 1915):1-31. A detailed explanation of how the valves and culverts fill and empty the lock chambers.

_____. ”Discussion: Vertically Framed Mitering Lock Gates.” In Professional Memoirs, Corps of Engineers, United States Army, and Engineer Department at Large 7 (November-December 1915):685-90. “The writer has read with interest the valuable paper by Mr. Malcolm Elliott, printed in the PROFESSIONAL MEMOIRS

for July-August, 1915 [pp. 405-23], on ‘Vertically Framed Mitering Lock Gates,’ and hopes that it will have the effect of directing attention to this type of structure.” (p. 685) “In order to clear up any misunderstanding, it should be observed that the horizontally framed type was selected for the Panama Canal because the majority of the leaves are so high with respect to their length that the vertically framed type was out of the question.” (p. 688)

_____. “General Design of the Locks, Dams and Regulating Works of the Panama Canal.” In Goethals, ed., Transactions (1916) II:1-53. As Goethals’ assistant chief engineer; Hodges supervised the design of the work described here.

Mears, Frederick. “The Reconstruction of the Panama Railroad.” In Goethals, ed., Transactions II:291-331. Mears was the chief engineer of the Panama Railroad and oversaw its rebuilding during the construction of the Canal. The route of the Canal necessitated the relocation of the railroad, built in 1850-1855. Treated here are: the original location of the railroad; preliminary construction of the new line; revised location; construction work; traffic conditions; power transmission line; cost of rebuilding the railroad; terminals. At the time, Mears was a cavalry officer but, beginning with his work in Panama, he engaged in engineering work for the remainder of his military career and was later commissioned in the Corps of Engineers.

Rockwell, Charles K. "A Brief History of the Panama Canal." Professional Memoirs, Engineer Bureau, United States Army 1 (April-June 1909):164-74. An overview of diplomacy, plans, projects, and events up to 1907, when Goethals became chief engineer. Generally anti-foreign in tone. Lieutenant Rockwell seems not to have been in the Canal Zone nor involved in the canal-building effort.

Sibert, William L. "An Army View of American Government Engineering." Engineering Magazine 31 (June 1906):361-65. A defense of government, i.e., Army, engineering.

_____. "The Gatun Dam and Locks." Scientific American 107 (November 9, 1912):386-87. A general discussion of the two main projects directed by Sibert.

_____. "The Panama Canal." National Geographic Magazine 25 (February 1914):153-83. An illustrated popular account of various aspects of the Canal's construction.

_____, and John F. Stevens. The Construction of the Panama Canal. New York: D. Appleton, 1915. Sibert wrote Chapters I and VII-XX, covering "The Construction Period": changes in the original plans; designs for buildings and locks; excavations; construction of Gatun Dam; Gatun Lake; construction from Gatun to Pedro Miguel; Culebra Cut; south end of Culebra Cut to the Pacific; municipal engineering; shops and terminal facilities; operations of the Canal; costs. Stevens' chapters cover "The Preparatory Period, 1904 to March 1907."

_____. “Construction of Gatun Locks, Dam and Spillway.” In Goethals, ed.,
Transactions (1916) I:387-424. As chief of the Atlantic Division, Sibert oversaw
the building of these structures.

Steese, James Gordon. “The Corps of Engineers and the Isthmian Canal.” Professional
Memoirs of the Corps of Engineers, United States Army, and Engineer
Department at Large 4 (July-August 1912):523-29; Erratum, p. 668. Traces
Army Engineer involvement in the isthmus from 1849 to 1912. Lieutenant Steese
worked as a transitman and instrumentman in the relocation of the Panama
Railroad and as assistant engineer for the design of the canal’s locks, dams, and
regulating works and served under the chairman and chief engineer of the
Isthmian Canal Commission, 1908-12.

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