1927

Biennial Report: Everglades Drainage District Engineering Department 1925-1926

F C. Elliot

EVERGLADES DRAINAGE DISTRICT

BIENNIAL REPORT
1925-1926

F. C. ELLIOT
Chief Drainage Engineer

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T. J. APPLEYARD, INC., TALLAHASSEE, FLORIDA

BIENNIAL REPORT
EVERGLADES DRAINAGE DISTRICT
ENGINEERING DEPARTMENT
1925-1926

Tallahassee, Florida, January 1st, 1927.

Board of Commissioners of
Everglades Drainage District,
Tallahassee, Florida.
Gentlemen:

It has been the practice of this office to transmit to the Board of Commissioners of Everglades Drainage District every two years a report covering the work accomplished in the Everglades during the two preceding years, to submit estimates for continuing the work, to make recommendations for new work, and suggest such other subjects as should come to the attention of the Board in reference to the District, not only relating to the work going on, but also from the standpoint of taxation, provision of money for future work, and matters in general relating to the District connected with drainage. The Board proceeds with the raising of money under authority from the Legislature, based upon the District drainage taxes imposed by law. The Legislature will meet in April, 1927, hence it is advisable that information be presented to the Board in advance which will assist in planning for the works of the future, in financing such works, and for carrying out the needs of the District in reference to drainage.

In consideration of the foregoing, this report is submitted.

Respectfully,

F. C. ELLIOT,
Chief Drainage Engineer.

FCE/B.

STATUS OF PRESENT WORK.

TABLE "A"

Canals	Excavation From Beginning to December 31st, 1926 Cu. Yds.	Miles of Canals Open
Caloosahatchee	3,128,664	28.00
Cypress Creek	768,288	12.20
Dania	1,169,019	5.95
Harney's Pond	226,952	3.65
Nine Mile	148,610	9.73
Snake Creek	292,346	14.30
Tamiami	419,577	5.52
South New River	3,693,207	25.00
Snapper Creek	572,090	12.56
Snapper Creek Extension	328,847	8.47
Indian Prairie	1,668,705	20.83
Hillsboro	8,147,393	50.00
North New River	7,819,311	59.20
Miami	8,211,169	78.70
Saint Lucie	22,267,958	25.00
West Palm Beach	10,439,985	40.90
Lateral Canals	976,672	32.36
Total Canal Excavation	70,278,793	432.37

11-31-1926

Levees	Levee Construction	Miles of Levees
Moore Haven-Sand Point	919,735	11.28
Sand Point-Miami	405,581	11,52
N. N. River-Hillsboro	244,215	2.66
Miami-N. N. River	641,848	6.98
Hillsboro-Bacom Point	644,360	18.89
Moore Haven-North West	177,788	3.16
Total Levee Construction	3,033,527	54.49
Miscellaneous excavation for Locks, Dams, Docks, etc	80,720	
Total Excavation	73,393,040 cu. yds.	486.86

The work accomplished during 1925 and 1926 is as follows:

TABLE "B."

Canal	Cu. Yds. 1925	Cu. Yds. 1926
Saint Lucie	1,257,151	1,459,712
West Palm Beach	1,099,804	1,185,626
North New River	509,881	1,242,673
Hillsboro	246,339	404,177
Indian Prairie	234,945	31,258
Caloosahatchee	141,119	.....
Snapper Creek	3,941	.....
Lateral Canals	68,986	168,781
Total	3,562,166	4,492,227
Levees		
Moore Haven-Sand Point Div.	207,637	241,130
Sand Pt.-Miami Div.	65,927	19,343
Hillsboro-Bacom Pt. Div.	1,500	193,760
Moore Haven-Northwest Div.	2,730	44,888
Miami-N. N. River Div.	32,000	239,431
N. N. River-Hillsboro Div.	.....	119,814
Total	309,794	858,366
Miscellaneous	27,808	4,700
Total work accomplished	3,899,768 (1925)	5,355,293 (1926)

RECAPITULATION

	1925	1926
Canals	3,562,166	4,492,227
Levees	309,794	858,366
Miscellaneous	27,808	4,700
Total	3,899,768	5,355,293
Total 1925 and 1926		9,255,061

The Status of Lock and Dam Construction in the Everglades is as follows:

TABLE "C."

Lock	Dimensions. W. ft.	L. ft.
North New River No. 1	25	130
North New River (Temp., use discon'td.)	20	90
North New River (Temp., use discon'td.)	20	90
North New River No. 4	22	110
South New River No. 1	22	90
Miami No. 1	25	130
Miami No. 4	22	90
Hillsboro No. 1.	25	130
Hillsboro No. 2	25	130
West Palm Beach No. 1	25	130
West Palm Beach No. 2	25	135
Caloosahatchee No. 1	30	150
Caloosahatchee No. 2	30	150
Caloosahatchee No. 3	30	150
Saint Lucie No. 1	30	150
Saint Lucie No. 2	30	150

NOTE:—No new construction undertaken on these locks during years 1925 and 1926.

MONEY EXPENDED

The amount of money expended on all construction work of Everglades Drainage District includes the following:

Canal construction and maintenance, levee construction and maintenance, maintenance of locks and dams and their operation, maintenance of plant, new plant and equipment, drainage investigations and surveys, superintendence and administration.

The expenditures for the above, reduced to three classes under which distribution is made for convenience, are set forth by months in the following Tables "D" and "E."

TABLE "D."

EXPENDITURES FOR 1925.

Month	Construction	Maintenance	Engineering
January	$ 95,992.94	$ 3,877.85	$ 5,620.86
February	99,012.71	3,600.55	5,812.93
March	95,572.78	5,343.62	5,970.40
April	91,913.35	4,671.91	7,454.99
May	114,852.93	4,166.06	7,002.87
June	127,705.59	4,816.37	7,400.63
July	125,674.16	6,249.69	5,957.16
August	94,283.85	7,535.20	7,648.09
September	107,324.35	2,631.00	4,782.98
October	110,707.86	5,477.90	6,504.70
November	164,951.81	4,872.92	6,911.82
December	103,024.95	8,401.67	6,107.84
Total	$1,331,017.28	$61,644.74	$77,175.27

RECAPITULATION

Construction	$1,331,017.28 =	90.55%
Maintenance	61,644.74 =	4.19%
Engineering	77,175.27 =	5.26%
Total	$1,469,837.29 =	100.00%

The work consisted principally in excavating rock and earth in nearly equal proportions in deepening present canals and in constructing the Saint Lucie Canal.

TABLE "E."

EXPENDITURES FOR 1926.

Month	Construction	Maintenance	Engineering
January	$ 72,796.53	$ 3,850.45	$ 7,257.34
February	163,848.86	4,319.42	5,533.81
March	155,687.89	3,987.22	5,840.38
April	150,866,65	3,982,57	9,076.73
May	178,191.67	4,987.76	6,130.28
June	70,655.49	6,036.60	6,463.47
July	287,010.35	5,500.46	6,230.05
August	195,087.05	8,638.35	7,475.76
September	144,882.90	9,877.48	6,505.59
October	124,073.76	13,013.00	6,492.63
November	344,691.12	15,887.10	5,531.26
December	172,817.25	12,611.53	8,178.57
Total	$2,060,609.52	$92,691.94	$80,715.87

RECAPITULATION.

Construction	$2,060,609.52 =	92.24%
Maintenance	92,691.94 =	4.15%
Engineering	80,715.87 =	3.61%
Total	$2,234,017.33 =	100.00%

1925 AND 1926.

Construction	$3,391,626.80 =	91.57%
Maintenance	154,336.68 =	4.17%
Engineering	157,891.14 =	4.26%
Total	$3,703,854.62 =	100.00%

Total Expenditures to January 1, 1925	$11,200,000.00
Total Expenditures for 1925 and 1926	3,703,854.00
Total Expenditures to January 1, 1927	$14,903,854.00

TABLE "F."

New Canals		Estimate January 1st, 1927		
Canal	Length Miles	Cubic Yards	Unit Cost c.	Cost $
A(1)	23.2	3,994,000	25	998,500.00
(2)	10.0	1,842,300	15	276,345.00
B(1)	46.0	5,975,000	20	1,195,000.00
(2)	5.0	1,485,000	13	193,050.00
C(1)	29.5	2,141,000	40	856,400.00
(2)	20.5	2,010,000	21	422,100.00
D(1)	32.0	6,400,000	33	2,112,000.00
(2)	8.2	778,000	33	256,740.00
E(1)	36.0	6,901,000	33	2,277,330.00
F(1)	17.7	1,961,000	40	784,400.00
(2)	13.0	1,500,000	40	600,000.00
(G)	(26.6)	(4,350,000)	.....	(Being constructed by Dade Drainage District)
H(1)	36.0	14,000,000	16	2,240,000.00
K & K1	34.0	5,490,000	25	1,372,500.00
L(1)	21.2	801,000	15	120,150.00
Total		55,278,300 Cu. Yds.		$13,704,515.00

(1) New original cuts.
(2) Additional cuts for outlets in old canals.

TABLE "G."

ESTIMATE OLD CANALS.

Total Remaining Yardage, January 1st, 1927.

Canal—	Cubic Yards.	Unit Cost.	Cost.
Saint Lucie	1,809,700	40c	$ 723,880.00
Caloosahatchee	1,200,000	25c	300,000 00
West Palm Beach	1,157,720	15c	173,655.00
Hillsboro	3,834,800	30c	1,150,440.00
North New River	1,766,000	60c	1,059,600.00
Miami	2,485,000	65c	1,615,250.00
Total	12,253,220		$5,022,825.00

Note.—Estimates include overdepth of 1 ft., except 2 ft. on Saint Lucie.

The canals as above described are on a basis of gravity flow.

As time goes on it is certain that pumping from local areas into the main canals will come more and more into use as affording more flexible and wider range of drainage and water regulation.

Such use of pumps will make possible much higher levels in the main canals, even to elevation above the adjoining land. Canals running at such levels would afford a very considerable increase in discharge capacity and provide a degree of drainage about 20% above that for which they have been designed as pure gravity outlets.

The foregoing covers the work necessary to be done for providing the main drainage outlets for that part of the Everglades Drainage District lying East and North of Miami Canal toward the Eastern boundary of the District, Northward to Saint Lucie Canal, Northwestward and Westward around that section North and Northwest of Lake Okeechobee, and Southward and Southwesterly along the Caloosahatchee Canal to the Western boundary of the District, and thence Eastward near the Southern margin of Lake Hicpochee and Nine-Mile Canal, following the South shore of Lake Okeechobee to its intersection with the Miami Canal, representing approximately two-thirds of the reclaimable land of Everglades Drainage District. This is the area in which all of the drainage work has been done

to date. The area includes some of the most valuable lands in the Everglades and is nearer and more accessible to principal centers of population and includes practically all of that portion of Everglades Drainage District in which private development has taken place. This area, embodying approximately 2,300,000 acres, is large enough to accommodate all requirements for land settlement and cultivation for several years to come. No estimate is submitted covering the Southwestern section of the Everglades, as it will undoubtedly be a number of years before demand for land will warrant beginning drainage in this untouched area. The drainage of the latter section is referred to in a general way, with suggestions as to what may be expected when the drainage of the Southwest section of the Everglades may be undertaken. Working out of final plans for this section is a proper subject for the future, inasmuch as the work will probably not be begun shortly, and for the further reason that construction and cost conditions will not be the same a few years hence.

FLOOD PROTECTION WORK AROUND LAKE OKEECHOBEE

With reference to protective works along Lake Okeechobee for future construction, experience during the year 1926 and observations of the hurricane of last September and the results therefrom, indicate the advisability, if not absolute necessity, of undertaking on a broad, comprehensive scale, not only the protection of lands around the lake against storm damage in so far as practicable, but also reducing the danger to human life. That there will be other storms is certain. The occurrence of hurricanes such as that experienced last September, according to available records, is at extremely infrequent intervals, but records are often broken and there is no way of forecasting how soon another may be experienced, hence the early preparation for and speedy completion of works for combatting hurricane dangers is must desirable. The protection of life and property against hurricanes is a feature not strictly a part of land drainage, but the experience of last September makes clear the necessity of combatting this danger, as well a providing against heavy rainfall. The construction of drainage canals adequate for carrying away heavy rainfall, or of the regulation of Lake Okeechobee to a degree satis-

factory for agricultural purposes, and as protecting the land against overflow, is strictly a part of the drainage enterprise. The reduction of danger from hurricanes is another matter. Correlation of these two forces, water and wind, and the aggravation of danger by reason of the simultaneous culmination of them in combination, especially in the Lake region, is productive of conditions similar to those along the shore of the sea itself, and against which it is absolutely imperative to undertake work which will bring the dangers resulting from their combination within reasonable limits by breaking up the combination of these two destructive agencies. Since but one of these is susceptible of treatment, efforts must be confined to works to resist the storm-driven waters. In other words, dykes must be built along the shore of Lake Okeechobee.

The investigations and studies made, the data collected, and the information now at hand, all gathered from the September hurricane, makes possible the working out of plans to better advantage for securing safer conditions to the Everglades, especially the Okeechobee sections, than could have heretofore been possible.

When the best remedy has been determined, the most practicable works devised, and the cost has been estimated, the project cannot be soundly urged for adoption unless expenditures required for securing the desired and necessary protection are warranted by the benefits to be secured and the financial ability of the area to pay. Asssessments of taxes must not exceed the ability of the property to pay, regardless of future benefits.

In planning for flood relief and for lessening hurricane danger, it may seem that the expenditures necessary for its accomplishment are large. The degree of protection necessary should be carefully considered. If such protection is for agricultural purposes only, perhaps works affording less degree of protection and at reduced cost, might be justified on the theory that almost any expenditure would improve conditions, hence warranted. There are situations, therefore, where partial protection may be wise and where property losses at infrequent periods could be borne. On the other hand, there are other situations, such as the protection of towns and homes, involving the consideration of human life, where anything less than complete protection not only would be unwise, but a menace to the lives and property intended to be protected, and

where the provision of insufficient works might lead the inhabitants to a feeling of false security which would result in aggravating the danger, rather than ameliorating it.

With the above consideration emphasized, attention is invited to works suggested for protection against Lake Okeechobee during storms of hurricane character. Such protective works should be considered from the same standpoint as drainage works for the Everglades. The plans of the Everglades Drainage District are for main drainage works only. It is not the purpose of the District to provide the secondary drainage works, or works of local character for local areas. Following the same policy with reference to storm protection works, it would be the part of the District to provide the main structures, such as levees, around Lake Okeechobee only, but not the levees, dykes or barriers for separating town or city areas from outlying farm areas, or others of local nature.

The construction of an adequate levee around the Southwestern, Southern and Southeastern shores of Lake Okeechobee of sufficient height to prevent hurricane driven waters going over them, and of sufficient mass and resistance to withstand wave action under hurricane conditions, will require works of far greater height, strength and mass, and at much greater cost, than any required merely for retaining the waters of Lake Okeechobee under non-hurricane conditions, but structures capable of resisting the effects of such storms as that which occurred last September can be built, and though at large cost, the exigencies of the case must be its justification. The plans worked out in this office contemplate:

1. Protective works which will be adequate to resist the action of hurricane driven water from Lake Okeechobee.
2. The provision of such works with as great economy as is consistent with safety.
3. Protective works with which can be combined other uses at small cost, thereby increasing their value and affording additional benefits to the protected section.

With the foregoing principal points in mind, location of the levee should be along the lake shore approximately at the level which the lake will stand under normal conditions; that is to say, between 14 and 16 feet. That the

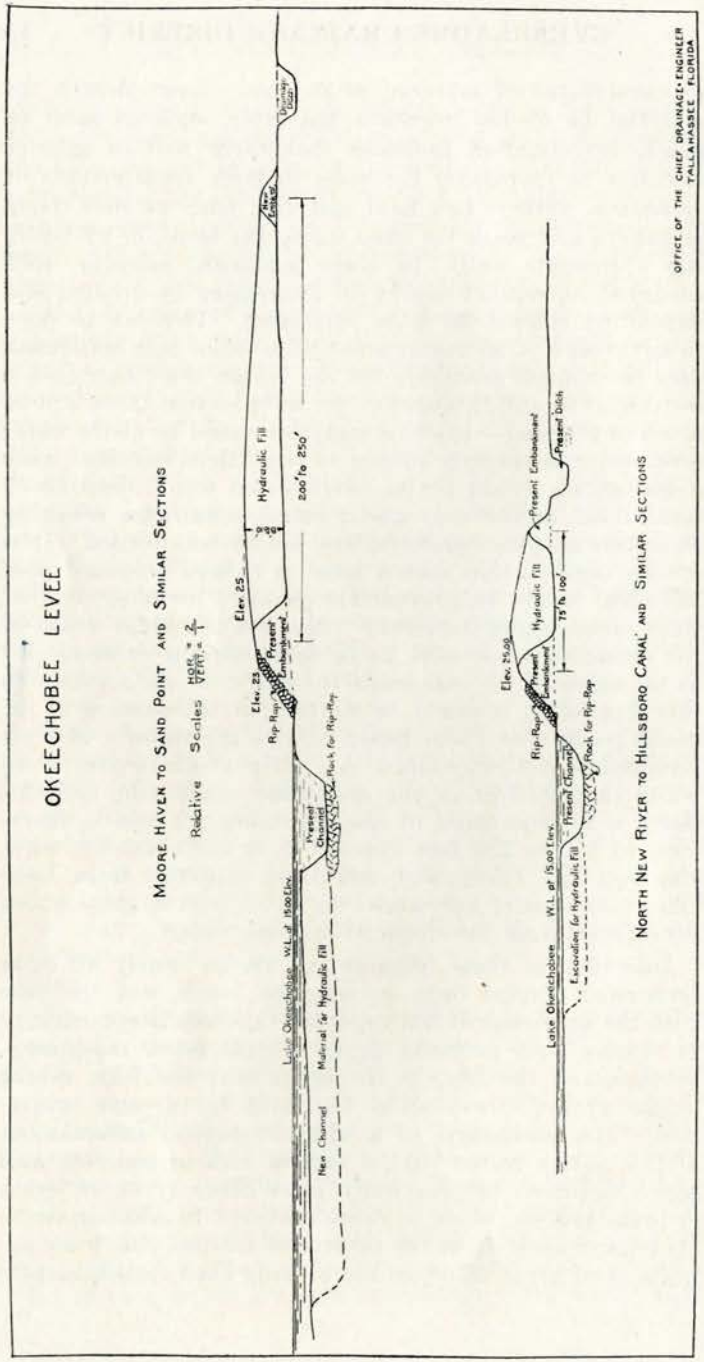
levee be constructed of local material and of such proportions for differing materials, according to their resistant qualities, as will be safe for the purpose intended, and of constructing the same according to such design as will enhance property, not only by adequate protection to the same, but by making it more attractive and for better uses. With this point in mind the following is stated:

The Trustees of the Internal Improvement Fund own practically all of the land on which the levee will be constructed, and in many localities there exists a strip of land owned by the Trustees between the levee and the high water mark of the lake which can be reclaimed and protected against overflow. This land in its present condition is of little value. The construction of the levee can be so carried out as to form a high embankment 150 to 250 feet wide on top, which will afford attractive home sites for the Everglades section. The building up of such areas and the creating of attractive and valuable home sites will greatly enhance, not only the land improved and made fit for such use, but property adjoining. Since this land belongs to the Trustees of the Internal Improvement Fund, it does not seem unreasonable for the Trustees to join with the Drainage Board in the expense of providing the levee in such proportion as the Trustees and the Drainage Board may deem equitable, based upon the enhanced value of property after such improvement. If the Trustees should decline to join the Drainage Board in construction cost, it is suggested that they deed to the Drainage District land occupied by the levee in order that the District may proceed with its construction as described, and reimburse itself in part by the sale of lots on its own account.

The construction of such a levee would be carried out by using the present levee along the lake shore as the outer embankment, and building a second at the proper distance on the land side of the first, say at a distance of 150 to 250 feet, or such other width as local conditions warrant, and of filling the space between these two embankments by pumping material from the bottom of the lake in front of the outer levee. The resulting levee would be an embankment about 8 to 10 feet high, and about 200 feet wide. Drawings and estimates covering the construction of such levees are shown herewith. The levee should

be constructed of material at the site. Even though the material be of low resistant character, such as sand or muck, investigation indicates that there will be greater economy in increasing the mass to meet requirements of resistance, rather than haul material, such as rock, from elsewhere and place the same along the levee, or of building a concrete wall. In many locations, however, rock occurs at convenient depths for excavating by dredges and depositing against the levee revetment. This can be done to advantage. The construction of wooden pole mattresses does not appear advisable for the reason that their cost is considerable, and throughout the levee section there will be much of the time when this mattress would be above water level and consequently subject to rapid deterioration. Such deterioration would not be obvious and would most likely make itself known only under storm conditions, resulting in failure at times when failure cannot be afforded. It is not anticipated that such a levee as is here proposed is of sufficient height to prevent the possible breaking over of wave crests under hurricane force, but the great width of the embankment is such as to resist serious erosion, just as the shore of the sea resists the action of the waves. In this connection it might be stated that the damage to the ocean beach near Palm Beach and in the vicinity of Fort Lauderdale did not extend to a strip of shore greater in width than 90 feet on the immediate ocean side, and this beach is of loose sand of low resistance. A width, therefore, of 150 to 250 feet appears to be sufficient for withstanding any effect that might be expected from Lake Okeechobee under hurricane conditions such as those which prevailed during the storm of last September.

Inasmuch as these disturbances are in nearly all cases forecasted several days in advance (such was the case with the hurricane of last September), there is opportunity to remove such property as farm equipment, machinery, vehicles and the like, in the areas near the lake, to the higher ground provided by the levee for greater protection. The advantages of a wide flat-topped embankment of this nature rather than a narrow rock or concrete wall seems sufficient to practically place other types of levees or protection works out of consideration. In addition to the above, and aside from the protective feature, this levee appeals as of great value, as has already been stated, in pro-



viding attractive building sites along what would then be truly lake front property. The embankment would have sufficient width to accommodate an improved road on the lake side, with building lots immediately back of the road. The present shallow lake bottom at ordinary high levels and the exposed muddy marsh at low levels, would be converted into a valuable navigable channel about 200 feet wide, with a depth of water varying from about 6 to 10 feet adjacent to the shore line. Such advantages for building purposes, road location, water front and commodious navigable channel would result in greatly enhanced values of the land and shore line thus developed.

A levee such as the above, therefore, is recommended above any other type of structure suitable for this locality and for the purpose required.

OKEECHOBEE LEVEE

26 miles excavation 200' x 8'= 8,135,100 cu. yds. at 12c.....	$976,212.00	
Rock excavation and riprap, 19 miles—200 cu. yds. per 100 ft. of levee=200,640 cu. yds. at 40c	80,264.00	
7 miles—150 cu. yds. per 100 ft. = 55,440 cu. yds. at $1.60.....	88,704.00	
Total 26 miles		$1,145,180.00
North New River Hillsboro Design— 21.6 miles excavation 85' x 8'= 2,872,320 cu. yds. at 12c	$334,678.00	
Rock excavation and riprap, 200 cu. yds. per 100 feet of levee— 228,100 cu. yds. at 40c.....	91,240.00	
Total 21.6 miles		$ 435,918.00
Total Okeechobee Levee, 47.6 miles		$1,581,098.00

Twenty-six miles of heavy levee divided into building lots 90 feet wide with right-of-way 60 feet wide at quarter-mile intervals across the levee, affords 56 lots per mile, or

a total of 1,165 lots for four-fifths of the levee owned by the trustees.

Value at $500.00 per lot $582,000.00
Value at $750.00 per lot 873,000.00

If the Trustees join with Drainage Board at ratio represented by $500.00 per lot, the heavy section of the levee would cost as follows:

Everglades Drainage District $563,180.00
Trustees of the I. I. Fund $582,000.00

and the entire levee would cost:

Everglades Drainage District $999,098.00
Trustees of the I. I. Fund $582,000.00

The heavier sections cover portions of lake shore exposed to open water. The lighter sections cover the naturally protected shores of the lake.

MEMORANDUM

Since preparation of the above report the following Law has been enacted by Congress:

"An Act authorizing a survey of the Caloosahatchee River drainage area in Florida, and of Lake Okeechobee and certain territory bordering its shores in Florida.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that the Secretary of War be, and is hereby authorized and directed to cause a survey of the Caloosahatchee River drainage area in Florida and to determine what control works are necessary for navigation in connection with flood control and the cost thereof, and also a survey of Lake Okeechobee in Florida and certain territory bordering its shores and from Lake Okeechobee to the Atlantic Ocean to determine what measures are necessary for flood control, such as additional diking and outlets, and further lowering of the levels of Lake Okeechobee.

Sec. 2. The sum of $45,000 or so much thereof as may be necessary, is hereby authorized to be expended out of any funds heretofore or hereafter appropriated for the improvement of rivers and harbors to carry out the provisions of this Act.

Approved, February 14, 1927."

The above relates to certain work which, if carried out, will be of great assistance to Everglades Drainage District. If such work is carried out, it will be desirable that the Board arrange with the Federal Government for undertaking work by Everglades Drainage District in harmony with whatever work may be done by the United States. The coordination of the drainage work by the Board and work of flood control and navigation by the United States will result in greater benefit to that section than the independent works of either without reference to the other. This office will keep in touch with the War Department in this regard and will furnish information to the Board on the subject as soon as the results of the survey referred to in the Act shall have disclosed the nature of the works proposed, if any, by the Federal Government, and the extent to which such works and those of Everglades Drainage District may be coordinated to the best advantage.

ADDITIONAL DRAINAGE CANALS.

It does not seem to be generally known that the main canals at present constructed or under construction in the Everglades, form but a part of the complete plan for the major canal system. That the present canals can drain the Everglades is not and never has been claimed or expected by the Board. There is a rather widespread belief that the present outlets are all that the Board have in mind, even though they have taken pains to state the contrary. Hasty conclusions arrived at by judging drainage, or lack of drainage, from the uncompleted plan, are bound to be incorrect.

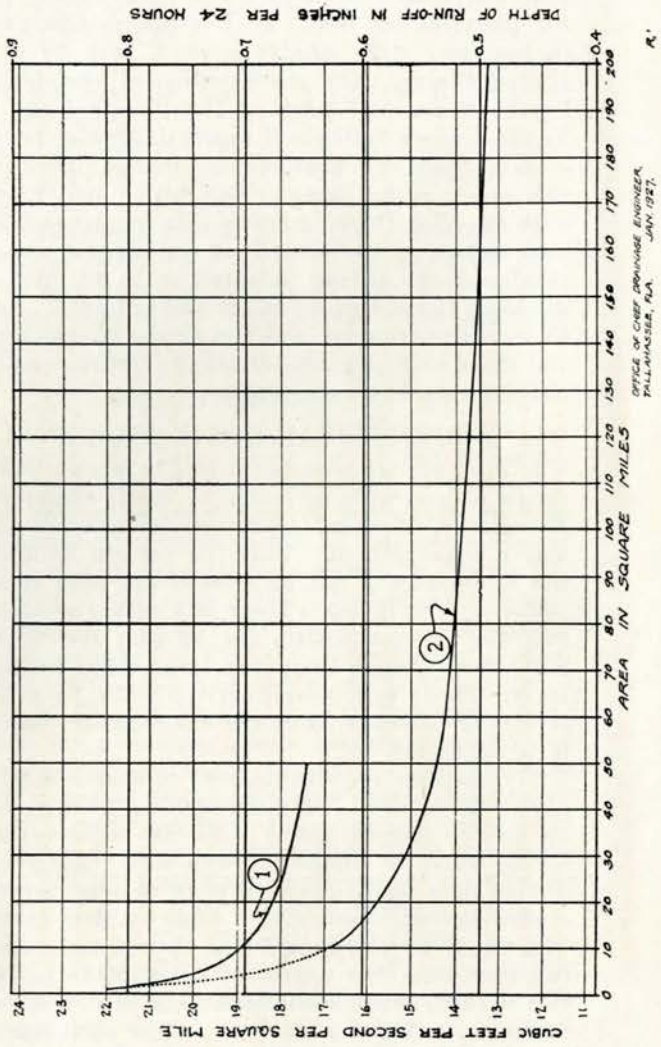
To complete the drainage of that section of the Everglades where work is already well under way, representing an area of approximately 2,300,000 acres, certain existing canals must be improved and new canals constructed. Tables showing improvements to present projects are included herewith and also a table of new canals showing excavation required and the approximate cost of their construction. The degree of drainage to be provided by this system, when completed, will afford adequate main drainage outlets for the area. The drainage coefficient on which they are planned is represented by the equation.

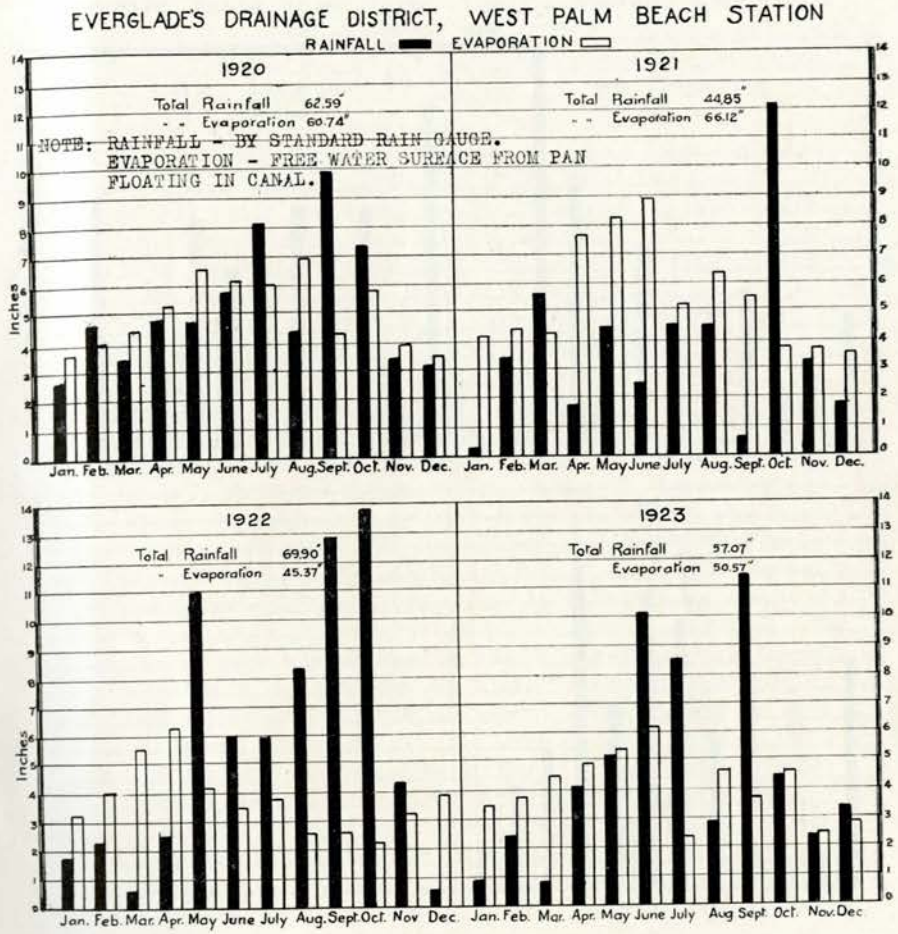
$$D = \frac{20}{1 + \sqrt{A}} + 12.$$

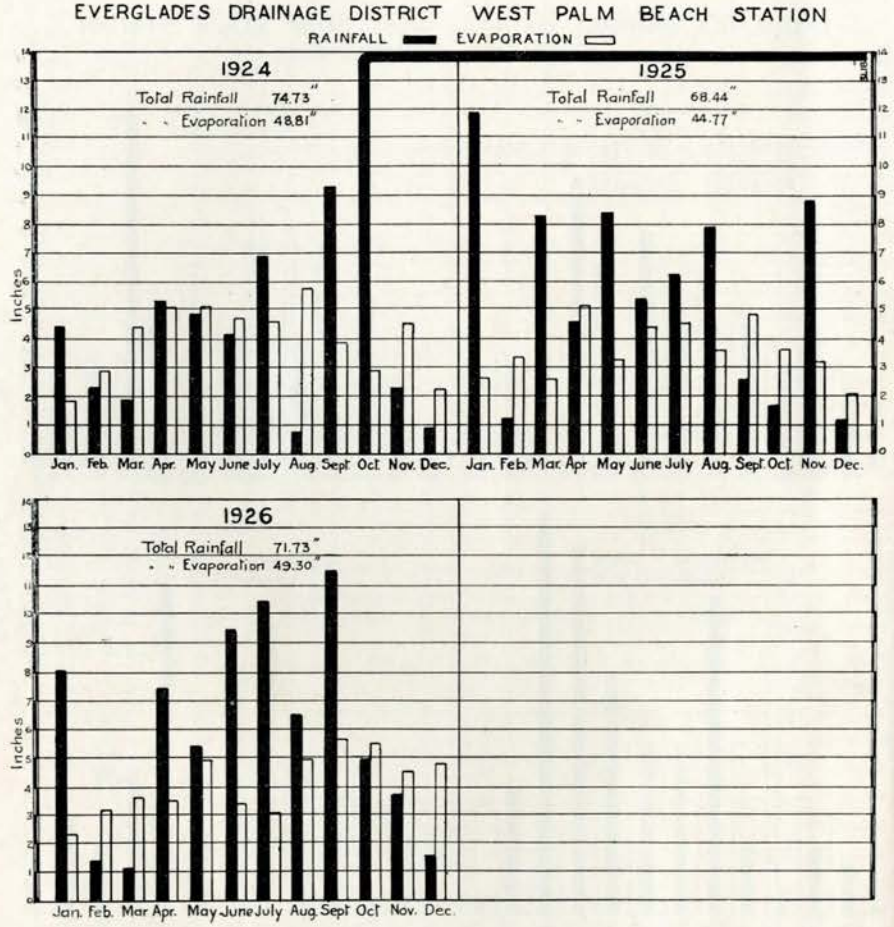
RUN-OFF CURVES

(1) FOR MUCK ONLY, BETWEEN THE LIMITS OF 1 SQUARE MILE AND 50 SQUARE MILES — $D=\frac{12}{1+\sqrt{A}}+16$
FLOW 1 FOOT BELOW BANK FULL THRU FLAT AREA.

(2) FOR GENERAL CONDITIONS IN VARIABLE SOIL AND SUBSOIL BETWEEN THE LIMITS OF 10 SQUARE MILES AND 200 SQUARE MILES — $D=\frac{20}{1+\sqrt{A}}+12$
FLOW 1 FOOT BELOW BANK FULL THRU FLAT AREA.







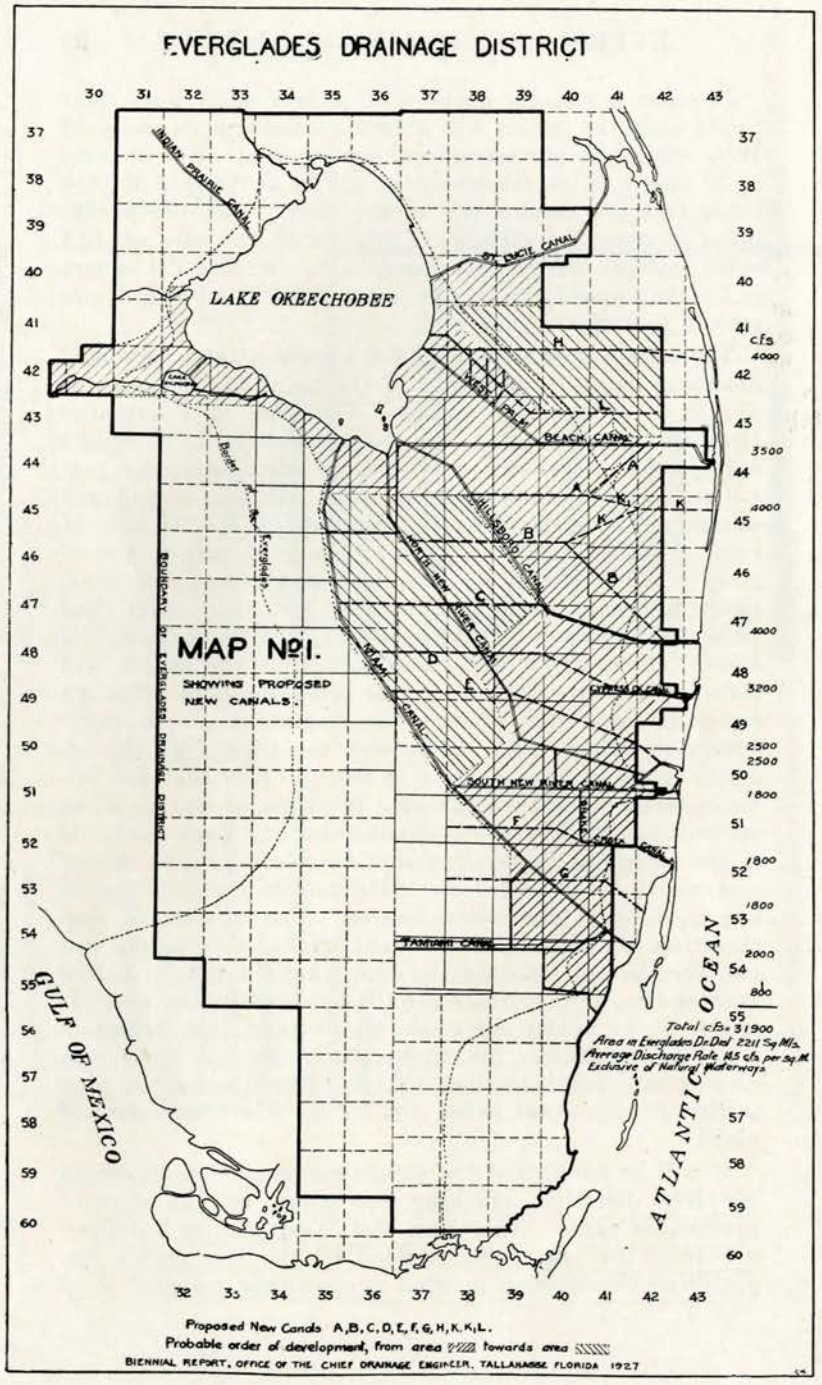
In other words, for areas of 20 square miles, near their upper ends the canals will afford a discharge capacity of 16½ cubic feet per second per square mile. For an area of 50 square miles, the discharge will be at the rate of 14½ cubic feet per second per square mile. For 100 square miles of area the capacity would be at the rate of 13.8 cubic feet per second per square mile, and for 200 square miles the capacity is at the rate of 13½ cubic feet per second per square mile.

The canals shown on Map No. 1 have a total combined discharge capacity, exclusive of the Saint Lucie Canal, of 31,900 cubic feet per second. The area of Everglades Drainage District served by these canals is 2,211 square miles, and the drainage coefficient or rate of drainage provided by such canals is 14.4 cubic feet per second per square mile, representing the removal of 54/100 inch of rainfall for 24 hours. This is exclusive of natural waterways of which there are few, and omits from consideration a few small areas near the coast served by other than Everglades canals. That the above will be sufficient is based further upon the assumption that the canals will flow at the above capacity 1 foot below the banks through low lands, and that prior to the beginning of the rainy season the water table throughout the Glades will be reduced to an average of about 3 feet in order that the valuable factor of soil storage may be taken advantage of in controlling floods and for diminishing the peak load. It is also upon the assumption that the secondary, or lateral systems to be provided by sub-drainage districts are in operation to a substantial degree. The method of constructing the canals of the District heretofore followed has resulted in obtaining a depth approximately 1 foot greater than that called for by the specifications, and the width is, in nearly all cases, wider than that required. The above estimates for discharge do not take these conditions into consideration, but are based upon the neat section of the canal called for by the specifications and plans.

Area served by canals

It will be noted that the canals recommended follow an Easterly direction, reaching the ocean by the shortest practicable route. This East and West plan is a departure from the plan recommended by the Everglades Engineering Commission in what is commonly referred to as

E + W Plan

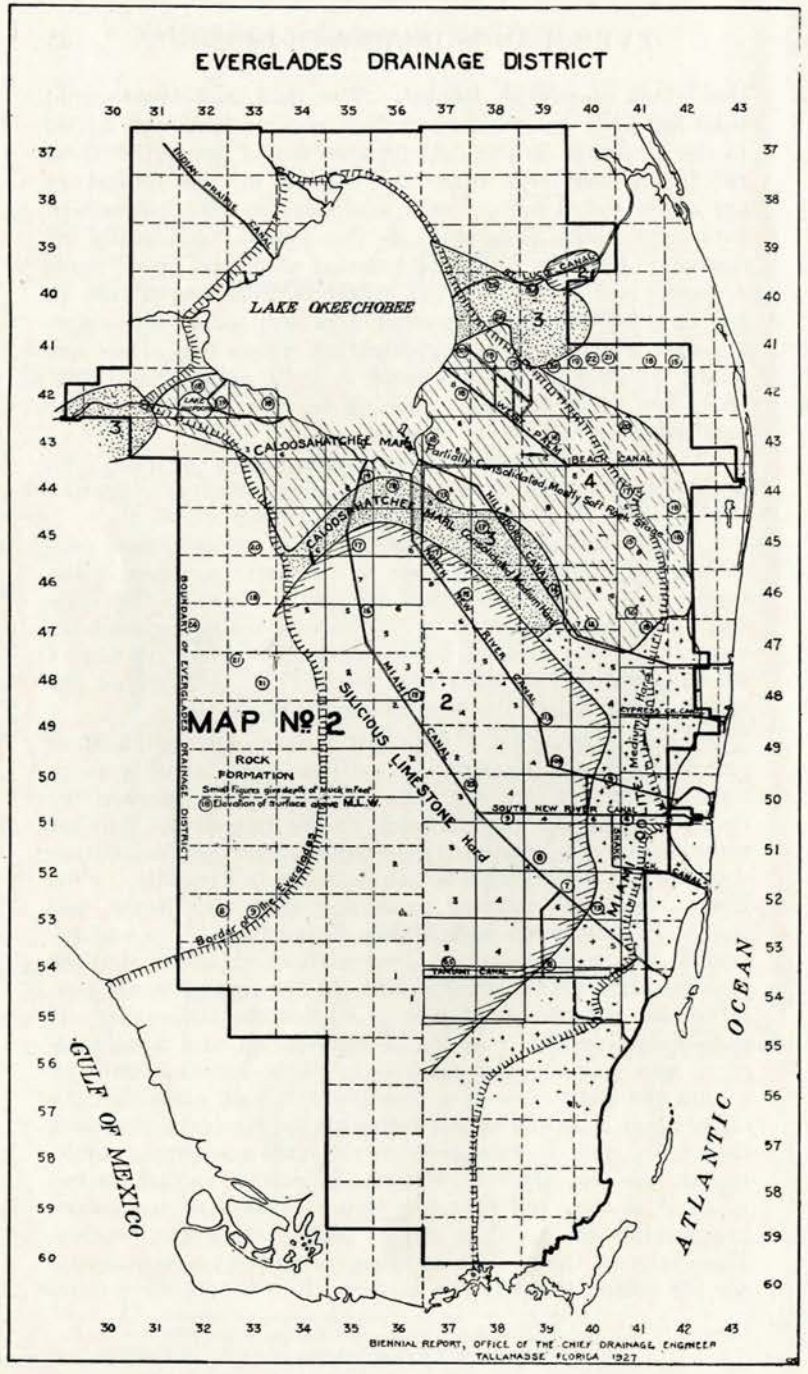


the Isham Randolph Report. The East and West canal plan has been described in former reports from this office to the Drainage Board, but because it is a departure from the Isham Randolph plans the reasons for this departure are again stated here. Such modification does not constitute any basic difference in the general principles of drainage, but is a different location of canals based upon economy and efficiency. It might be here stated that in the light of far more extended data and information now at hand, and extensive investigation which this office has made, which were not available in 1912, certain modifications are to be expected looking to improvement in the original plan.

The reasons why this office recommends the East and West Canal system as againt the diagonal system suggested in the Isham Randolph report, are as follows:

1. The land of the Everglades is low. Under best conditions it has not enough slope to the sea to produce in the canals more than a sluggish current. There is too little fall to waste a particle of it. Unnecessarily long canals are wasteful of fall. So important is this consideration that I set this down as an axiom—a self-evident truth—that the canals must follow the shortest route to the sea.

2. An examination of Map No. 2 shows that sub-surface formation in the Everglades and discloses the other principal reason for locating the canals Eastward toward the ocean. Along the Eastern edge of the Everglades and for some distance in places into the interior, the predominating rock formation is soft and not difficult to excavate. Further toward the interior extending generally North and South, lies the hard rock of the Everglades. The excavation of this rock cannot be done without extensive drilling and blasting, which greatly adds to the cost of canal construction. Character of rock is indicated on the map. If canals were located running Northwesterly and Southeasterly, much greater proportion of their length would be within the hard rock area, resulting in high cost. On the other hand, with the canals following an Easterly direction, they more quickly emerge from the hard rock area, resulting in less cost of construction. This is of special import when it is observed that the upper reaches of the canals are smaller and of less depth than their lower reaches. Especially on Canal "B" is this arrangement advantageous for the reason that the depth of muck in the upper reaches



is sufficient, or nearly so, to provide a canal of sufficient depth without rock excavation at all. This East and West system of canals on the basis of cost can be constructed at a saving of more than $5,000,000.00 over a Northwest and Southeast system of equal drainage capacity. The conditions as to rock have been so well prospected and explored that the above facts are indisputable. This East and West system makes use of the long diagonal canals already in process of construction in Everglades Drainage District and on which work was begun in the early stages of the project. They will perform their part in the general plan, principally as connecting or equalizing canals, but they will not be constructed to as great size as would be necessary if they had been considered as draining all the lands tributary to them from end to end.

CONTROL WORKS

In addition to new canal construction above described, the provision of certain controlling works in some of them will be necessary. It will be noted from the map that Canals A, B and C empty into other canals already constructed. No controlling works will be necessary in the nature of locks or dams in them. Canals D, E, F, H and K empty directly into tidewater and controlling works of a character similar to those heretofore provided at the outfall ends of other canals should be constructed in connection with them. Canal G is omitted from consideration for the reason, as before stated, that the Dade Drainage District is constructing this outlet. No additional entrances are to be made into Lake Okeechobee by any of the new canals, hence no controlling works will be required at their upper ends. An examination of the location of Canals D, E and F in relation to existing canals which already have locks for harmonizing the navigation feature, suggests that the lock may be omitted and a dam only of movable type provided. Canal H will be of such character from the standpoint of water levels and its location with reference to other canals that a lock will probably be warranted in connection with the other control works. The lock, if decided upon, may be constructed at a later date after development of the area along the canal shall have advanced sufficiently. Based upon the cost of locks and dams here-

tofore constructed, the approximate estimate for these structures is as follows:

	Lock and Dam	Dam Only
Canal D	$ 200,000	$ 55,000
Canal E	180,000	45,000
Canal F	180,000	45,000
Canal H	250,000	65,000
Canal K	250,000	65,000
Total	$1,060,000	$275,000

The controlling works would consist of dam having concrete abutments and sub-structure having a part of the dam of movable type, 50 feet in width, Everglades Standard Type.

TOTAL CONSTRUCTION.

	Gravity System
New Canals	$13,704,515.00
Present Canals	5,022,825.00
Control works	275,000.00
Okeechobee Levee	1,581,098.00
Total	$20,583,438.00

The above represents a cost of approximately $8.95 per acre for 2,300,000 acres of land served.

Observation of the operation of the drainage canals at their upper ends during the past five years and bearing in mind the probability of further subsidence of the muck soil, suggests that some time in the future it may become desirable to install pumps in the upper end of each canal at Lock Number One for draining the land adjacent to Lake Okeechobee into the Lake, and thence to the ocean via Saint Lucie Canal, rather than through the entire length of the long drainage canals to the sea.

Taking as an illustration an area adjacent to the Hillsboro Canal through 9 miles of its length at the upper end, it will be seen that the distance from the middle of such tract to the lake is 4½ miles, and thence from the Lake via Saint Lucie Canal to the sea, 25 miles, or a total of 29½ miles to the ocean. The distance from the middle

of the same tract to the ocean via Hillsboro Canal would be 47 miles. Thus the distance would be reduced by nearly half. There is also the element of time. The Saint Lucie Canal has about twice the velocity of the Hillsboro, hence the time within which the water would reach the sea via Okeechobee and Saint Lucie Canal would be reduced in like proportion. In other words, water would pass from the tract to the lake and thence through Saint Lucie Canal to the sea, in approximately one-fourth the time required for reaching the sea via the Hillsboro Canal. There would be the further advantage of relieving each of the drainage canals of the water coming in them near their upper ends, thus permitting the remainder of the canal to operate to better advantage in serving its tributary area. The operation of pumps would be necessary only during flood periods. At all ordinary periods gravity flow would be maintained through the entire length of the canal. The quantity of water which might thus be discharged into Lake Okeechobee from the area bordering the Southeastern, Southern and Southwestern shore would reach a great volume during the time when heavy rain storms would prevail and thus increase the amount of water to be ultimately discharged through Saint Lucie Canal. The great storage capacity of Lake Okeechobee, together with the margin allowed in Saint Lucie Canal, will be sufficient to take care of this additional quantity, especially in view of the certainty that the improvement of present canals will tend to increase the available discharge from the Lake. The Lake thus used would be in the nature of a temporary storage reservoir to reduce the peak load upon the canals. After the storm rains have passed, the canals would resume gravity flow and the water placed in temporary storage in the Lake could be drawn off through them. This again illustrates one of the advantages of the Lake as a storage basin, due to its great size.

The work of constructing new canals and of improving those now existing is susceptible of being carried out in such manner that blocks of land can be added in various areas prior to the completion of the entire program. In fact, upon the completion of half of such program there will be a million acres of land in Everglades Drainage District ready for settlement and cultivation insofar as main drainage outlets are concerned. The final completion of

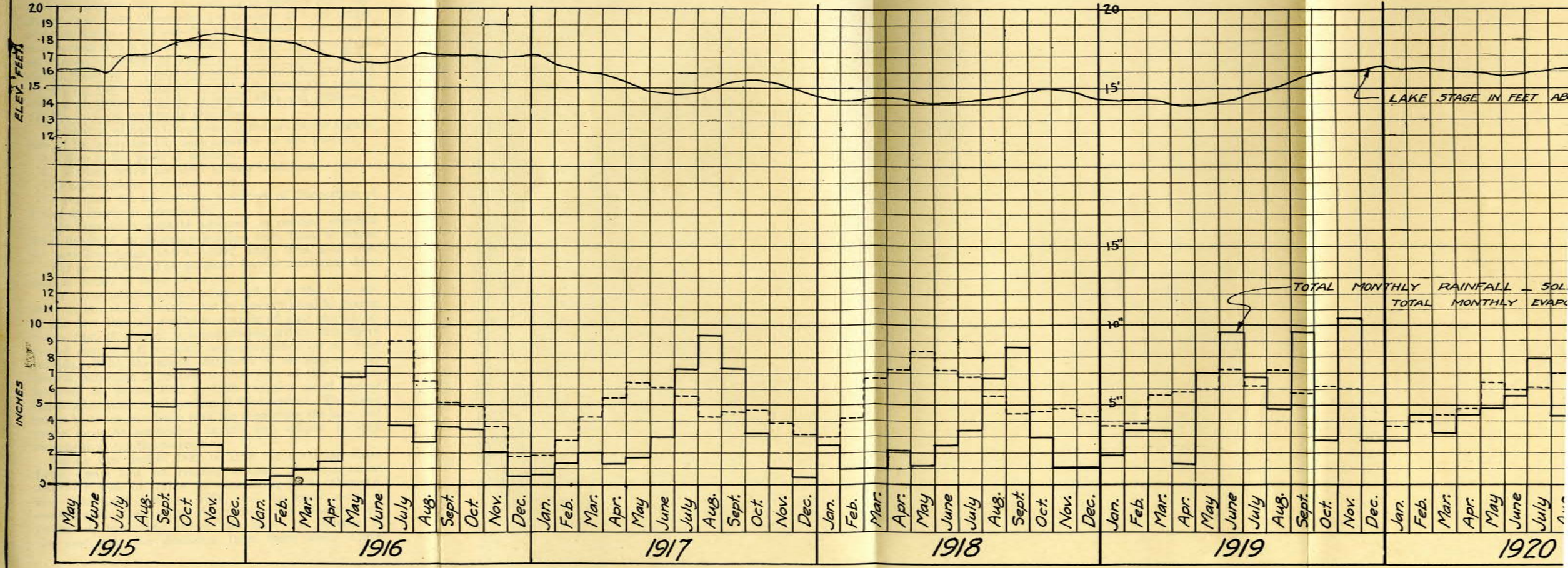
such plan covering 2,300,000 acres under a reasonable construction schedule, would require about eight years. Reference to rate of drainage will be made later in this report.

CONTROL OF LAKE OKEECHOBEE

Since the drainage of the Everglades depends in so large degree upon the control of Lake Okeechobee to prevent overflow of Everglades lands by this lake, and since there are now available much additional data relating to lake control, attention is invited to the subject. Much of these data are presented in the form of diagrams. They have been prepared from our records of Lake Okeechobee, together with rainfall and evaporation which affected the lake. The diagram "RAINFALL, EVAPORATION AND LAKE STAGE, LAKE OKEECHOBEE," shows the level of the lake, and rainfall and evaporation observations plotted from daily readings since 1915. It may be interesting to know that this diagram represents more than 47,000 recorded observations. The elevations are shown in feet above Mean Low Water at Punta Rasa, to which datum Lake Levels are referred. The solid lines in the lower portion of the diagram represent rainfall in inches each month. The dotted lines plotted adjacent to rainfall represent evaporation in inches each month from the lake.

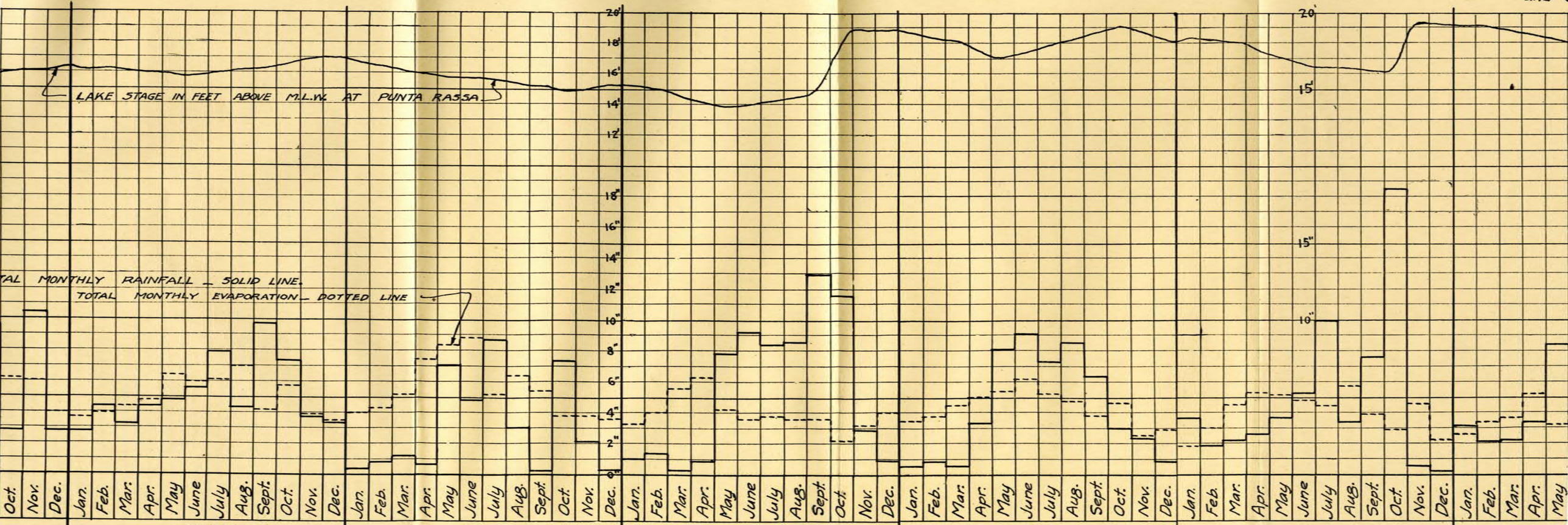
From 1915 to 1918 inclusive relatively small amounts of water escaped from the lake through the drainage canals at all seasons except for occasional short periods during the peak of a rainy season when the canals reversed their direction of flow for short distances of their upper reaches and emptied into the lake. The small amount of water coming into the lake and the short period of time during which this condition prevailed, did not materially affect the lake. Also, the low discharge capacity of the long drainage canals had an almost negligible effect toward lowering the lake from month to month, or from year to year. Their cumulative effect in a period of four years probably represents a total of two to three feet. In other words, on December 31st, 1918, Lake Okeechobee was probably two and one-half feet lower as a result of four years continuous draft upon it by the drainage canals than it would have been had all the canals been closed. Subsequent to 1918, the locks and dams in the several canals emerging

RAINFAL


ELEV. FEET
INCHES
LAKE STAGE IN FEET AB
TOTAL MONTHLY RAINFALL – SOL
TOTAL MONTHLY EVAPO
1915
1916
1917
1918
1919
1920

RAINFALL EVAPORATION AND LAKE STAGE
LAKE OKEECHOBEE

NOTE:- Saint
from
Appro
Note
and



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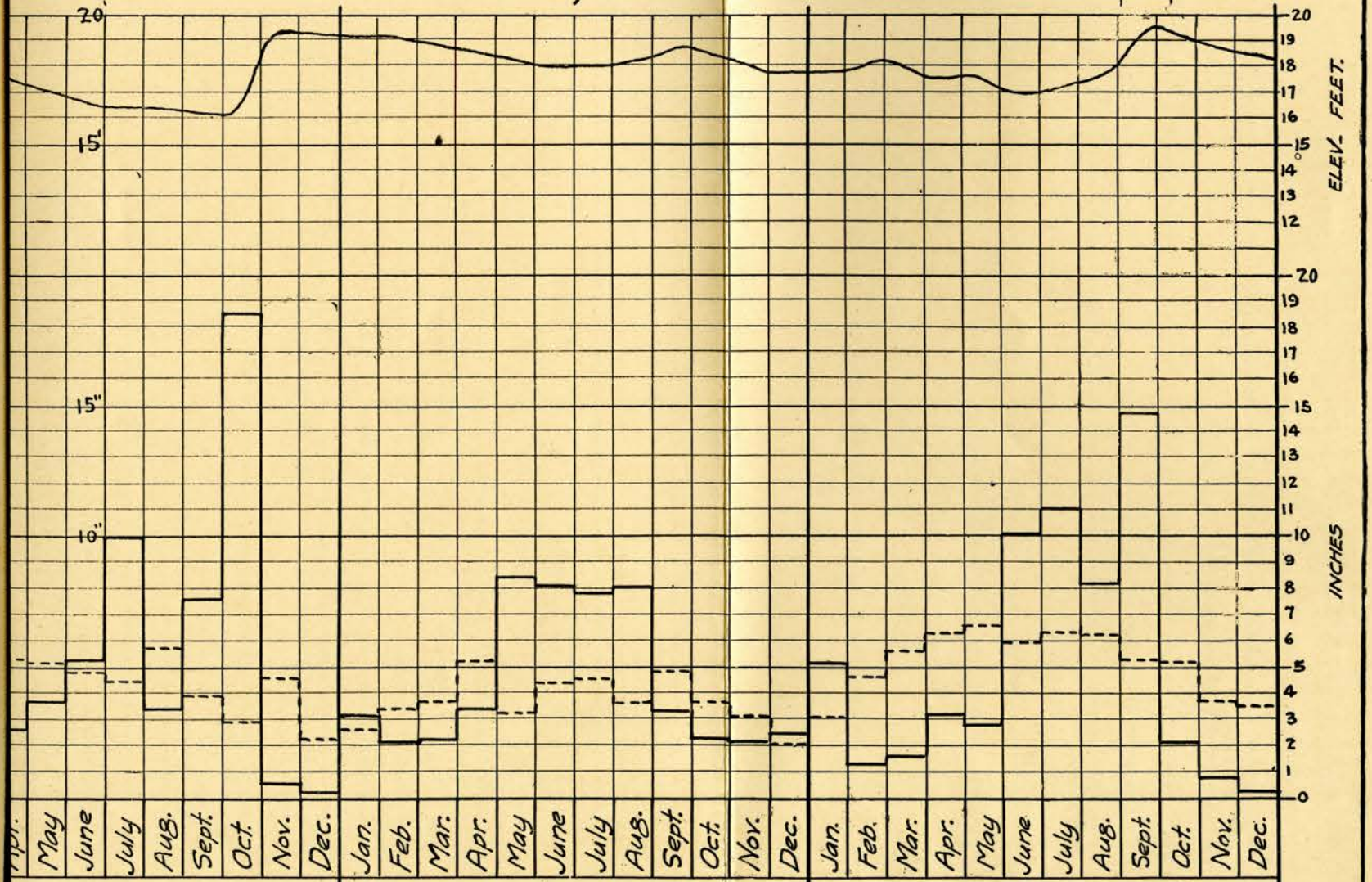
NOTE:- SAINT LUCIE CANAL Discharge Increased from Approximately 35% in SEPTEMBER to Approximately 65 or 75% in OCTOBER.- Note Immediate Downward Trend and Compare with Previous Years.



DRAINAGE ENGINEER, TALLAHASSEE, FLA. FEB. 1927. .R.

from Lake Okeechobee having been completed, the discharge through the drainage canals from the lake could be completely cut off when desired. The prevailing water level of the lake, however, during the entire period from 1915 till August 1922, was such as to require little discharge from Lake Okeechobee for holding its level within desirable limits. This was due to the absence of excessive rain periods within the above time. In 1922 there occurred six successive months of heavy precipitation in the Everglades, resulting in a total rise of 5.0 feet in lake level, and succeeding years continued to provide above the normal amount of annual rainfall, of which 1924 and 1926 were notable in flood producing qualities.

The control of Lake Okeechobee is defined as the regulation of its water level in such measure as will prevent:

1. Rise to the point of overflow.
2. Falling below the level of best usefulness.

The assumptions for control are:

To regulate the lake within a margin of fluctuation of 3 feet as nearly as practicable.

That regulation must be adequate to prevent overflow from floods of an intensity not less than those of which we have knowledge, to-wit:—1912, 1922, 1924, and 1926.

That control should be adequate for the maximum three months period of these storm years.

The three months period is arrived at as the time element within which control must be accomplished by reason of the fact that all available records of past storms indicate that if control is accomplished within the above period, control will certainly be accomplished for all other periods. With the above statement of assumptions for control, attention is invited to that part of the diagram covering the period 1922 to 1926 inclusive as of special application in the consideration of flood control. The above might be taken as a basic plan for regulating the lake, but which must be considered flexible and subject to such variations as conditions require.

During this period, 1922 to 1926 inclusive, the Saint Lucie Canal had not reached a stage of advancement where it was of value in controlling Lake Okeechobee. Not until October, 1926, did the canal reach a construction stage affording a discharge capacity sufficient to materially affect the lake. In October of the past year the discharge from Saint Lucie Canal

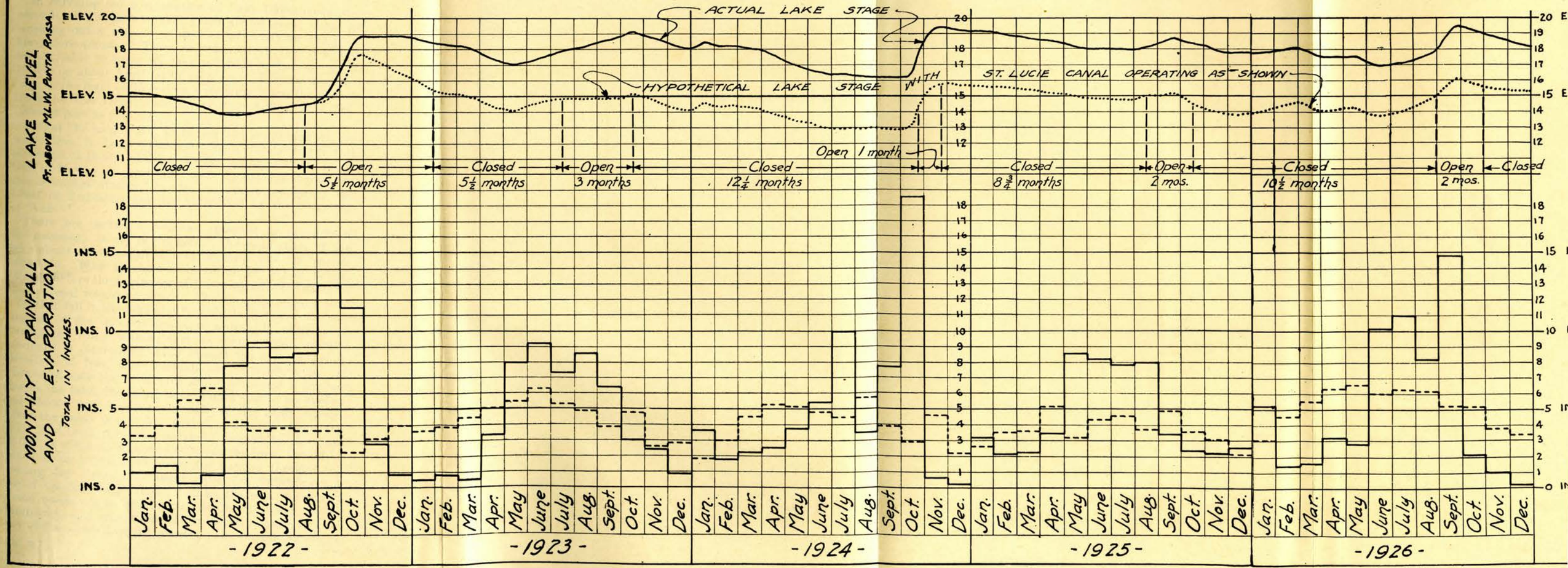
became sufficient to have material effect upon the lake, and its capacity has continued to increase till on January 1, 1927, it is discharging at approximately three-fourths of its ultimate capacity. The effect of the canal upon Lake Okeechobee since about October 5th of 1926 will be noted upon an examination of the lake stage diagram. In observing the behavior of the lake from October 5th, 1926, to January 1st, 1927, comparison should be made with the period November 1st, 1922, till January 15th, 1923, and the period November 15th, 1924, till March 1st, 1925. During the two last mentioned periods there was practically no discharge from Lake Okeechobee. The long drainage canals were burdened with a surplus of water from adjacent lands tributary to them and were not usable to an appreciable extent for lowering the lake level. It will be noted in both of these periods that the high level of the lake was reached and continued for two and one-half months and three and one-half months respectively. That is to say, the lake remained nearly stationary during the above periods. In 1926 it will be noted that the lake reached the maximum elevation on September 29th. A downward trend was established about October 4th. The conditions relating to all these periods were similar except that in the latter case the Saint Lucie Canal had been brought into operation. Observing the 1926 period, it will be noted that the effect of the Saint Lucie Canal was promptly felt upon the lake and a downward trend took place within four or five days after reaching its highest level, and also, that the decline shown by the diagram is steeper than at any previous time. The above is conclusive evidence of the effect of the Saint Lucie Canal upon the Lake.

Attention is now invited to a second diagram on which is plotted lake levels, rainfall and evaporation for the years 1922 to 1926 inclusive. There is also plotted and shown by a dotted line the hypothetical level of the Lake arrived at by assuming that water was discharged from the Lake at a rate equal to that afforded by the Saint Lucie Canal under operating conditions. It will be seen that it was not necessary for the Saint Lucie Canal to have operated all the time. In fact, it is disclosed that it would have been necessary to use the canal as a discharge outlet but a small proportion of the time. The further assumption is that no water was discharged from Lake Okee-

LAKE OKEECHOBEE ACTUAL AND HYPOTHETICAL STAGES,

1922 TO 1926 INCLUSIVE

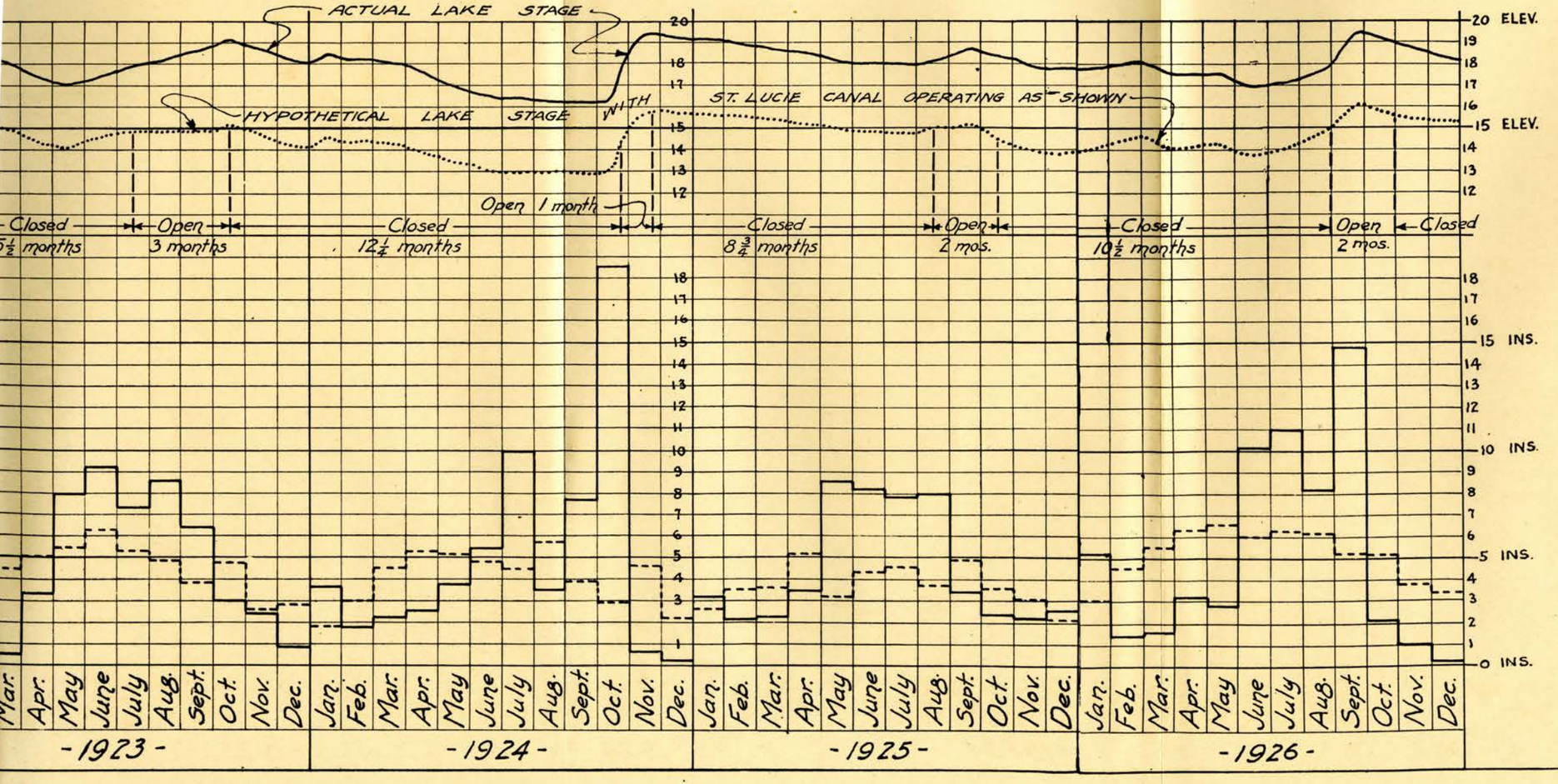
SHOWING HYPOTHETICAL OPERATION OF ST. LUCIE CANAL PLOTTED AS CONSERVATIVE AVERAGE OF OPERATING CONDITIONS.



OKEECHOBEE ACTUAL AND HYPOTHETICAL STAGES,

1922 TO 1926 INCLUSIVE

CAL OPERATION OF ST. LUCIE CANAL PLOTTED AS CONSERVATIVE AVERAGE OF OPERATING CONDITIONS.



CONDITIONS:-

(1) All Drainage Canals Closed.

(2) a. At approach of Rainy Season:
St. Lucie Canal closed when Lake becomes lowered to Elev. 15.0 .

b. During Rainy Season:
St. Lucie Canal open at all times when Lake is above Elev. 15.0 .

c. After Rainy Season:
St. Lucie Canal closed when Lake becomes lowered to Elev. 16.0 .

(3) St. Lucie Canal Discharge:

At elevation	19.0	Discharge	7,000	c.f.s.
" "	18.0	"	6,000	" .
" "	17.0	"	5,000	" .
" "	16.0	"	4,200	" .
" "	15.0	"	3,500	" .

(Note:)
The above conditions are subject to such modification as Rainfall and Conditions of Watershed dictate.
Flow measurements taken indicate that the ultimate actual discharge will be approximately 20% above the computed quantities given in the table above.

OFFICE OF CHIEF DRAINAGE ENGINEER,
TALLAHASSEE FLA. FEB. 1927.

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chobee by any of the drainage canals during the above period, so that the entire control as plotted is from the discharge through Saint Lucie Canal only, and with all other canals closed.

In carrying out a regulation of Lake Okeechobee, the records of the past several years are of great value in working out a plan of control or of verifying the plan heretofore adopted. These records indicate that it would be advisable to have the lake not higher than elevation 15 feet on about April 1st of each year. Further in reference to the level of 15 feet as a working basis, the permit from the War Department dated August 21st, 1924, provides in part as follows:

"That the said work, including the regulation of the water level in Lake Okeechobee to a standard lake full elevation of 15 feet above mean low water at Punta Rasa, Gulf of Mexico, in accordance with the plans shown on the two drawings attached hereto—are recommended by the Chief of Engineers and are authorized by the Secretary of War—"

There are certain conditions attached to the permit not necessary to set down here. The regulation of the lake about elevation 15 is in conformity with the permit aforesaid. With the lake at elevation 15 feet or below, shortly before the beginning of the rainy season, the Saint Lucie Canal would be closed. The records indicate that a further fall in the lake may be expected prior to the setting in of the upward tendency ordinarily anticipated during the rainy season; that as soon as this upward tendency is established, even though the lake be below elevation 15 feet, when rainfall has been heavy in the watershed and the watershed full, indicating a further rise in the lake, the Saint Lucie Canal should be opened and should remain open throughout the rainy season. After the rainy season has passed, ordinarily about October 31st, and the Lake becomes lowered to elevation 16 feet, if it has been above that level, the canal should be closed so as to conserve water for passing through the ensuing dry season, till about April 1st following. A rise of the lake to elevation 16.5 by the end of the wet season would not be disadvantageous from a lake control standpoint, and would provide a larger margin to take care of the succeeding dry season. The regulation of the

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LAKE OKEECHOBEE -1922-

RAINFALL AND LAKE STAGE

COVERING PERIOD OF RISE IN 1922 —

1922 Date To Date	Period Days	Elevation at Begin of Period	Actual Rise in Feet	Elevation at End of Period	Estimated Rate of Volume Increase Cu. Ft. per Sec. from Rainfall	from Watershed	TOTAL
Oct. 12 - Oct. 23	10	17.3	1.1	18.4	7,000	18,800	25,800
Sept. 19 - Oct. 19	30	15.3	2.8	18.1	6,800	12,100	18,900
Aug. 5 - Nov. 3	90	14.3	4.4	18.7	4,700	5,100	9,800
June 1 - Nov. 20	172	13.8	5.0	18.8	3,200	3,500	6,700

Lake Elevation	St. Lucie Canal Discharge C.F.S.
15.0	4,400
16.0	5,200
17.0	6,000
18.0	6,900
19.0	7,900

Elev. 19.0
Elev. 18.0
Elev. 17.0
Elev. 16.0
Elev. 15.0
Elev. 14.0
Elev. 13.0

Actual Lake Stage

80 days rise 4.4 ft.

30 days rise 2.8 ft.

10 days rise 1.1 ft.

Effect of Inflow from Watershed

Effect of Rain and Evaporation on Lake

Hypothetical Lake Stage with St. Lucie Canal in Operation from Aug. 15th Based on Flow Measurements to Date of Jan. 1927 and Computations for Discharge.

2 inches.

1 inch

1 inch

Rainfall

1922 June July August September October November Dec. 1922

(Daily Record) June 1st to Dec. 15th.

Office of Chief Drainage Engineer, Tallahassee, Fla. Jan. 1927

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LAKE OKEECHOBEE -1924-

RAINFALL AND LAKE STAGE

COVERING PERIOD OF RISE IN 1924.

1924 Date To Date	Period Days	Elevation at Begin of Period	Actual Rise in Feet	Elevation at End of Period	Estimated Rate of Volume Increase Cu. Ft. per Sec. from Rainfall	from Watershed	TOTAL
Oct. 16 - Oct. 26	10	16.5	2.2	18.7	18,800	32,800	51,600
Oct. 4 - Nov. 4	30	16.2	2.8	19.0	9,000	12,900	21,900
Sept. 13 - Dec. 13	90	16.1	3.2	19.3	2,200	6,100	8,300
Sept. 13 - Nov. 16	52	16.1	3.2	19.3	4,700	9,700	14,400

Elev. 19.0
Elev. 18.0
Elev. 17.0
Elev. 16.0

Actual Lake Stage

30 days rise 2.8 ft.

10 days rise 2.2 ft.

10 days rise 0.3 ft.

30 days rise 3.2 feet

Effect of Inflow from Watershed

Effect of Rain and Evaporation on Lake

3 Inches

2 Inches

1 Inch

Rainfall

1924 September October November Dec. 1924

Daily Record - Sept. 1st to Dec. 15th.

Office of Chief Drainage Engineer, Tallahassee, Fla. Jan. 1927.

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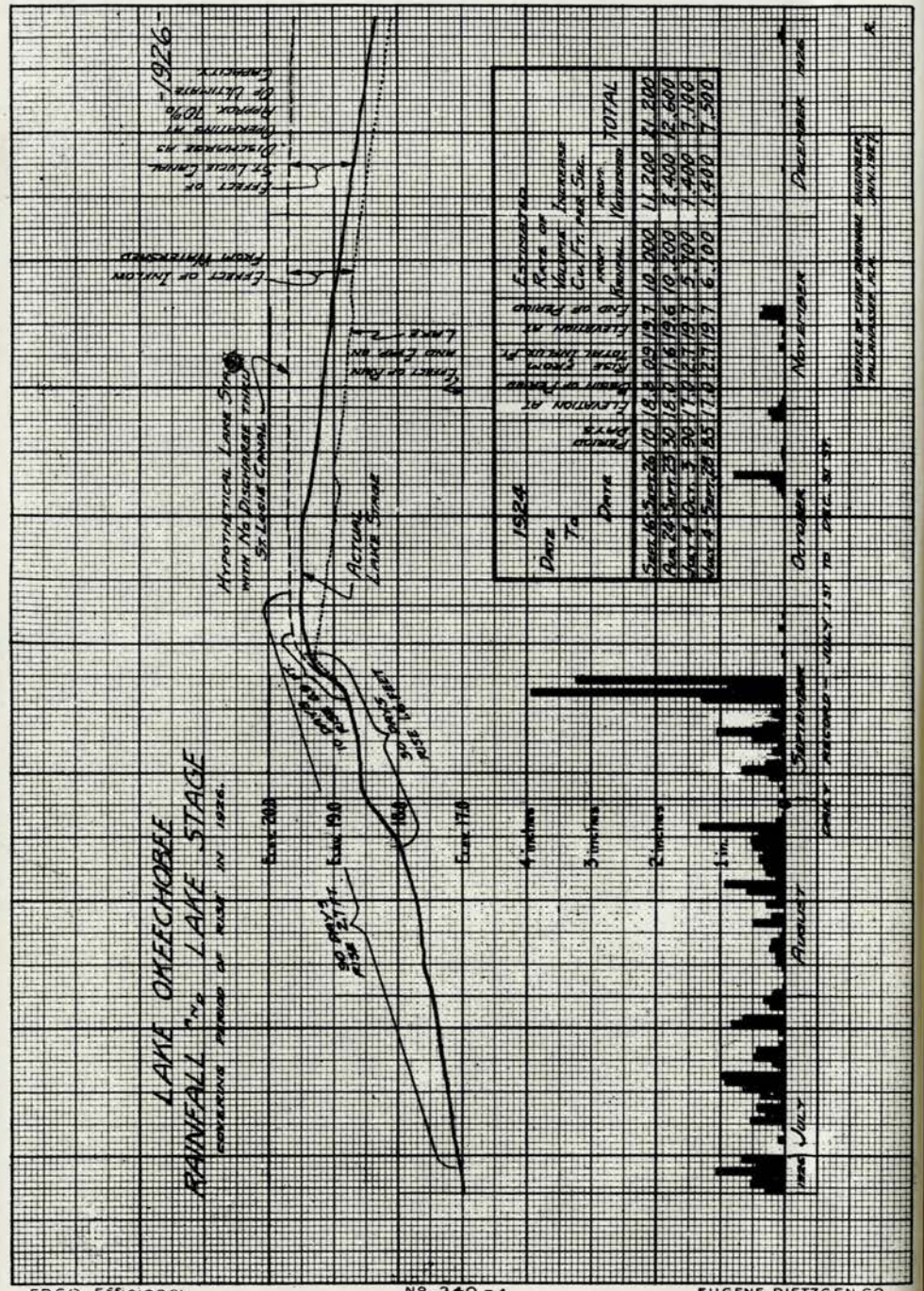


lake, therefore, as illustrated by the diagram, is based on beginning the rainy season with a lake level at about 15 feet and ending the rainy season with a lake level of about 16.5 feet. Such a program would have produced satisfactory conditions during the plentiful or excessive rainfall years, 1922 to 1926 inclusive. If, however, we apply this schedule of operations to the years 1915 to 1921 inclusive, there would have resulted periods when the lake would have been too low for convenience.

The Saint Lucie Canal provides the means by which the water of Lake Okeechobee can be drawn off for preventing undesirably high levels in time of flood. Thus the high level will be within control. But during a cycle of years of deficient rainfall, the lake will recede through evaporation losses alone, even with all canals completely closed, and the downward trend cannot be arrested until normal or above normal rain arrives. Hence the necessity for conserving such water in the lake as practice may indicate to be advisable for getting past the usual annual dry season. The control of the lake is primarily against overflow. Lowering the lake to prevent overflow will naturally tend to produce lower levels for extreme low water. It is to be expected, in fact it is inevitable, that low levels will be occasionally reached which will be a source of inconvenience and complaint in that territory. I wish to emphasize, however, that low levels are but a matter of temporary inconvenience, while floods are a matter of disaster. The sufficiency of the Saint Lucie Canal as a flood control outlet for Lake Okeechobee within the range of operations from elevation 15 feet to 18 feet is indicated by the diagram. Control within a margin of 3 feet between elevations 14 and 17, would be more advantageous and can be carried out. The same works will suffice. It merely means their application to the lower range.

Additional discharge from the lake will be afforded by the drainage canals proper, and this discharge will increase as the present canals are improved, and as others necessary for land drainage are provided, but no allowance has been made on account of them in the control plan.

The above is considered as a general plan only for regulating the lake and must be treated as flexible and subject

to such variations as conditions require. The regulation of Lake Okeechobee, or any other body of water, under wet or dry conditions such as prevail in South Florida, within a maximum fluctuation of 3 feet as the allowable limit, will prove no easy task, no matter how many or what capacity the canals may be. With a working limit of 5 feet for Lake Okeechobee, the proposition of control would be greatly simplified. Looking to the future of Lake Okeechobee and its regulation, the further subsidence of soil around the muck sections of the lake, together with increased flow which will come from the Kissimmee River Valley and other water sheds of the lake as these water sheds are improved by drainage, may bring about the necessity of increasing the working margin for the lake, and perhaps an increase in discharge capacity therefrom. If such increase becomes necessary, the changes affecting the lake will come about slowly. There will be ample opportunity of taking care of this condition should it arise. Increase of the working margin must be obtained at the bottom of the zone rather than at the top. The high level must not be increased. The working zone must be increased by reducing the low level. In other words, the working level of 15 feet must be reduced to 13 feet, or to such other level as future necessity requires. Any lowering of the level of Lake Okeechobee affects the navigability of the lake around its margins and its shallow places. This will require consideration of the navigation feature over which the United States maintains jurisdiction. The Board are familiar with this question and it is not necessary to deal with it here.

WATER POWER

As incident to the regulation of Lake Okeechobee, it has been urged by many that the water discharged from the lake through Saint Lucie Canal would afford valuable hydro-electric power and justify a development for that purpose. An examination of the lake diagram will go far in showing whether or not such is feasible. On this question the following is stated:

Since the opening of the Saint Lucie Canal in 1925 the discharge of water over the dam at Lock No. 2, as observed by many visitors at that lock, has prompted a number of

inquiries of this office in reference to developing a water power on the Saint Lucie Canal, and has been the cause of offers to the Board from more than one party to purchase a concession for power development. The sight of a large volume of water more than 200 feet across plunging over this dam through a fall of 10 to 14 feet, brought to many observers visions of light and power through the transformation of the water's potential energy into useful work for man's accommodation. The natural conclusion quickly suggesting itself to the observer is that a great quantity of power is going to waste which, if transformed into electrical energy would be of tremendous value for the great variety of purposes to which it is applicable. Such conclusions are perfectly natural, even though they may be in error. The head held prior to October, 1926, at the dam was by reason of the fact that the unfinished condition of the canal several miles above the dam limited the amount of water which the canal could carry, and permitted this high level at the dam without diminishing the flow through the upper canal from the lake. The higher level in the lower part of the canal provided more favorable conditions for the working of dredges. Otherwise, there would not have been the high waterfall at the dam which suggested to the observer the possibility of water power.

To be of economic value a water power must exist and be usable a sufficient length of time each year to earn a sum which will in a reasonable time pay the cost of installation, the fixed charges on same, other expenses, and afford a satisfactory return on the money invested. Furthermore, the power characteristics, if intermittent, must be such as to be susceptible of harmonizing with an auxiliary plant operated by steam, or otherwise, for supplying power during the time when the hydro-electric plant would be shut down, either from lack of water to produce sufficient volume, or for surplus water which might drown out the necessary head.

In August, 1913, the Chief Drainage Engineer submitted to the Board of Commissioners of Everglades Drainage District a report on the control of Lake Okeechobee, and stated, among other things, that it might be feasible to develop a substantial water power from the discharge of Lake Okeechobee. Also, in December, 1913, the Everglades Engineering Commission submitted a report to the Board of Commissioners of Everglades Drainage District in refer-

ence to the drainage of the Everglades, and embodied as a part of the report a recommendation for a power development on the then proposed Saint Lucie Canal. These two reports, to those who have read them, have been the cause of inquiry as to why a water power installation was not included in the construction of the present lock and dam.

Without going into a detailed discussion of the report of the Chief Drainage Engineer or of that of the Engineering Commission in reference to water power development on Saint Lucie Canal, it may be stated that the suggestions in the first and the conclusions in the second were based upon data and information collected through one season only, and furthermore, that such data were far from complete, even for that period. Since that time, from May 15th, 1915, to the present, this office has made daily observations and has kept daily records of rainfall, evaporation and water levels of Lake Okeechobee and it is not unreasonable in the light of these far more complete and extended data that the earlier suggestions and recommendations would be subject to modification.

The possibility of water power on Saint Lucie Canal depends on drawing water from Lake Okeechobee in sufficient quantity and for a sufficient time to make development of power a practical commercial proposition. Our records indicate that during the past 12 years there would have been seven consecutive years, from 1915 to 1921, inclusive, when water sufficient for power purposes would not have been discharged from Lake Okeechobee through Saint Lucie Canal, and that the last five years, from 1922 to 1926, inclusive, there would have been five periods, lasting a total of 405 days, during which water would have been discharged from Lake Okeechobee through this canal for regulating the said lake, and that of the 405 days, 190 days would have to be deducted, if considered from the power standpoint, because the flow through the canal would have been of such nature that no worth-while power could have been developed. Thus it is seen that for the past five years the canal as at present designed could have been operated 215 days for power purposes, or about 12½% of the five-year period.

Furthermore, when the water level conditions in the canal and the discharge characteristics at the dam are understood, it will be appreciated that even when water is being discharged through the canal and over the dam

in large quantities, there may be no power possibilities attendant. The dam at Saint Lucie Lock No. 2 is of the adjustable type. That is to say, the crest of the dam can be raised or lowered so as to discharge a small or large quantity of water according to needs. When the canal is called upon to carry the maximum amount of water (when Lake Okeechobee is at high stage), the gates at the dam will be wide open and the water in the canal will pass the dam with scarcely more than a pronounced increase in velocity as it flows between the piers of the structure. The appearance will be like that of a stream passing turbulently between the piers of a bridge. There will be no water fall anything like sufficient for the development of power. The low water level at the dam is for producing a swift current in the canal so as to discharge a maximum amount of water from Lake Okeechobee. This adjustment at the dam of practically no head, or of head entirely too small for power purposes, would be maintained so long as Lake Okeechobee remained above desirable level. These occasions, however, would be usually followed by short periods when the lake is at a safe level and with water flowing in from its water shed in sufficient quantity to maintain the lake at such level and at the same time afford sufficient water to be discharged through Saint Lucie Canal for power purposes. This favorable condition would exist usually for not more than 30 to 60 days following high lake levels.

The present flow characteristics of the canal could be so changed as to afford a fall of 9 to 10 feet at all times when water is available for power purposes and this could be done without reducing the discharge of Saint Lucie Canal as at present designed. To change the present flow characteristics to such as would be suitable for power development would require an increase in the size of the canal of approximately 75%, at an estimated cost around $2,000,000.00. There would also be the cost of hydro-electric installation, and in addition, steam electric or other auxiliary not included in the above figures. Contemplation of such cost in relation to uncertain and intermittent water power, available but for a small fraction of time during favorable years, and for no time at all during unfavorable years, places the development of

hydro-electric power of commercial character on this canal beyond practicable consideration at this time.

Aside from its consideration as a business enterprise, there is another phase of the subject.

When the rainy season is over, there would be the complication of storing a surplus of water in the lake for the following dry season, and at the same time drawing off water for power purposes.

Evaporation from the lake ordinarily amounts to about 55 inches per year, with variations between 49 inches in 1922, a year of heavy rainfall, and 61 inches in 1918, a year of light rainfall. Between rainy seasons, ordinarily November 1st to May 1st following, the amount of water added to Lake Okeechobee from combined rainfall and inflow from its water shed is usually less than the amount removed by evaporation. Hence the lake may fall, even with no water running out through the canals. Consequently, it is necessary to carry over a surplus to compensate for evaporation losses during the dry season to prevent Lake Okeechobee, in so far as is practicable, from going too low.

Lake Okeechobee being a comparatively shallow body and having low banks and flat shores, the allowable margin of fluctuation is very limited. This fact does not lend itself favorably to a wide range of regulations for drainage, irrigation, navigation, domestic supply, or power, and an unlimited exploitation of the lake toward any one of these features without due regard to others or to conditions governing its behavior, would be unwise, would complicate the problem of control, and prevent the regulation of the lake for the greatest general benefit of the Everglades as a whole.

Therefore, the feasibility of developing a hydro-electric power of commercial value on Saint Lucie Canal, based upon discharge from Lake Okeechobee, is so improbable that there can be no justification for enlarging the canal and for constructing a plant at this time. Observation of discharge at the dam for the next three or four years will settle this question beyond any possibility of doubt, and it is almost certain to be settled negatively.

LATERAL CANALS

The great importance of the lateral system in connection with the main system and the effect which the secondary works have upon the main system in affording satisfactory drainage, justifies reference to the subject.

The main drainage canals are for the purpose of providing outlet for the waters of the Everglades. In order that the main outlet canals may function properly, it is necessary that there be lateral canals for collecting the water and bringing it to the main. Main canals constructed approximately six miles apart, as is planned, through the Everglades, cannot collect the water between them. Their effect without laterals can extend by a short distance each side of the canal. The main can have no material effect insofar as satisfactory farm drainage is concerned, for more than one-fourth of a mile from it during heavy rainfall periods. Without lateral systems the main canals would fail. During the rainy season the following would happen:

Assume that the distance between canals is six miles. Suppose that at the beginning of the rainy season the water table between main canals averages 3 feet; heavy rains begin. The result is that precipitation soaks into the soil and there it stays, there being no way for it to escape except by evaporation, which, during such times, is so inconsequential as not even to be considered. The rain thus falling and soaking in, gradually accumulates day by day until the storage capacity of the soil in the 3-foot depth assumed, representing 6 to 7 inches of rainfall, is all used up. Finally, when the soil has become saturated, further rainfall stands upon the surface and the land is flooded. Not until this condition has been reached is there any appreciable runoff to the main canals. When this condition is arrived at, however, the water flowing over the surface from the flooded areas comes to the canals for all practical purposes as rapidly as it falls, bringing a tremendous amount of water suddenly to the mains, which must of necessity fail to carry it. It is beyond all economic possibility to provide main canals able to carry any such quantity of water suddenly dumped into them.

On the other hand, take the operation of the canals in conjunction with a complete lateral system. Let the

assumption for water table and for rainfall be as before. The rain falling upon the land soaks into it. By seepage through short distances it finds its way to the farm ditches, thence to the laterals, and through the laterals to the main. Thus the rain of today promptly begins its way toward the main canals and to the sea. The water is drawn off and the storage capacity of the soil is restored, thus preparing it for the reception of succeeding rains. The water thus carried to the main canals by degrees permits the canal to remove the surplus little by little and not delay the time until flood stage has been reached before beginning their operation. Only in this way will it be possible for the main canals to serve their tributary areas.

A further examination might be made as to the function of the main canals in the general scheme of drainage. The main canals might be likened to the sewer main of a city, and the laterals and farm ditches might be likened to the piping system for the buildings of the town. No one would expect service from the main system through the street until his premises and his building had been properly piped and connected with such main. This reasoning is applicable in degree to the main and secondary works of a drainage system. This is especially and emphatically true in the Everglades area where no natural water courses exist and where the slope of the land toward the main canals is insignificant. These statements are not expressed as a theory, but are set down as facts from actual observation of the conditions which have at times existed in the Everglades. There have been occasions where rains of considerable intensity, 2 inches to 3 inches or more in as many days, have produced no appreciable effect upon the canals because there was no way for the water to get to them. Instances have been observed where water actually stood on the ground within 50 feet of the canal with the canal 3 feet below banks. The effect upon the canal was negligible until water reached the point where it overflowed into the canal. Then there followed almost immediately bank full and finally flood conditions.

This office has made careful investigations and studies in reference to the lateral systems, and information and data collected through several years in the form of reports is available to any sub-drainage district desiring them.

The intimate relation between main and lateral canals brings us to a further consideration. The building of a secondary system for a small part of the area tributary to a main canal, will not afford full protection to the small area if the local works of the remaining area should not also have been, at least in principal part, completed. This is for the reason that when the heavy rainy season comes on the large area will reach a flooded condition before beginning to contribute water to the main, and after this condition shall have been attained, the situation will be like that already described where the secondary system does not exist. Hence, if good use is to be made of the main canals prior to the construction of the complete lateral system, the area which they serve should be confined to those only where a substantial part of the secondary system shall have been provided, and other areas must be completely divorced from the main canals during flood periods. Therefore, dykes or levees across the land must be constructed by the sub-drainage district to protect their local areas and controlling works must be provided in the main canals which will separate outside unimproved areas, or areas having no lateral systems, from those having constructed their lateral systems. As new areas have their lateral systems completed, such areas can be added from time to time to those already taken in, and satisfactory service from the mains and from the laterals can then be expected.

The progressive advancement of drainage can in this way be carried out, but this progressive advancement must be carried out as conditions permit. It will not generally be practicable to take in isolated areas separated by wide expanses of unimproved territory from sections already taken in and improved. It is desirable that new areas be taken in in an orderly and systematic method of progression. Not only is this arrangement advisable from the standpoint already above described, but also from the standpoint of preventing conflict among other areas in the use of the main canals and the infringement of the rights of one area against another in taking advantage of the drainage works of the district.

The Law under which Everglades Drainage District operates, provides for the construction of the main drainage works, and it is the policy of the Drainage Board to

confine the works of the district to those of major character. It is not the province of the district to provide the lateral systems, but since the lateral systems and the main systems are so intimately related, and taken together are absolutely essential to drainage, it is a wise provision of the Law that the Board have control and jurisdiction over the lateral systems and local works to such extent as the said local works affect the main canals of Everglades Drainage District. Authority is vested in the Board by Law for carrying out such regulation in this regard as seems, in their judgment, necessary. This is an important subject in the administration of the affairs of the district.

EXTENSION OF THE BOUNDARIES OF EVERGLADES DRAINAGE DISTRICT

Northerly and Northwesterly.

It has been suggested by many and urged by some that the boundaries of Everglades Drainage District should be extended to Northward and Northwestward to include all of the area tributary to Lake Okeechobee. In other words, that the water sheds of the Kissimmee River and Fisheating Creek should be included within the district and the drainage works of Everglades Drainage District extended into the added area. The subject of extending the drainage area of the district into far off territory not benefited by the works of the District as at present existing, presents a different aspect from extending the boundaries of the district into nearby territory already benefited, and to be further benefited, such as the strip along the East Coast and area adjacent to the Caloosahatchee River. The extension of the boundaries of the district to include the latter mentioned areas will be discussed elsewhere in this report. The boundaries of Everglades Drainage District on the North and Northwest already extend about as far into this region as the benefits from the drainage works in Everglades Drainage District will reach under the present plan for drainage. Hence from the standpoint of benefits from the works as now planned, either direct or indirect, there is no good reason for including these large and remote areas to the Northward and Northwestward. It is true that the Northern and Northwestern

areas suggested for addition to the district constitute a large part of the water shed of Lake Okeechobee, flowing into the said lake through the Kissimmee River, Fisheating Creek, and minor tributaries. It is true that these areas contribute large quantities of water to Lake Okeechobee during the rainy season, having material influence toward producing flood conditions. But the present effect which these areas have upon Lake Okeechobee is a natural one, just as the rainfall upon the Lake and lands of the Everglades is a natural phenomenon with both of which the works of Everglades Drainage District are compelled to deal. The control of Lake Okeechobee is based upon discharging sufficient water therefrom through the Saint Lucie Canal to prevent overflow under storm conditions similar to those which have been experienced from 1912 until the present day. The natural flow to the Lake from the Northerly water sheds has been taken into consideration in working out the control plan adopted. There does not appear to be necessity for changing the present control plan so long as these conditions remain substantially as they are now. That is to say, until systematic drainage work has been undertaken in the Kissimmee River and Fisheating Creek areas outside of the district. This subject is touched upon in a report of the Chief Drainage Engineer on the control of Lake Okeechobee submitted in 1913, with the following comment:

> "At some future time the drainage of the Kissimmee River Valley will undoubtedly be improved. Canals and ditches will be constructed for carrying overflow waters from the valley to the river and the river will also be improved. Any improvement to the river tending to increase its flow and drainage work done in the valley would cause flood waters to be transported more rapidly to the lake, causing a greater influx and more rapid rise in a given time therein than now occurs. The amount of water actually received by the lake from the Kissimmee valley would also be increased to some extent, as the water brought more quickly would not be subjected to as great loss by evaporation as now obtains. The building of drainage works in the territory to the Northward of the

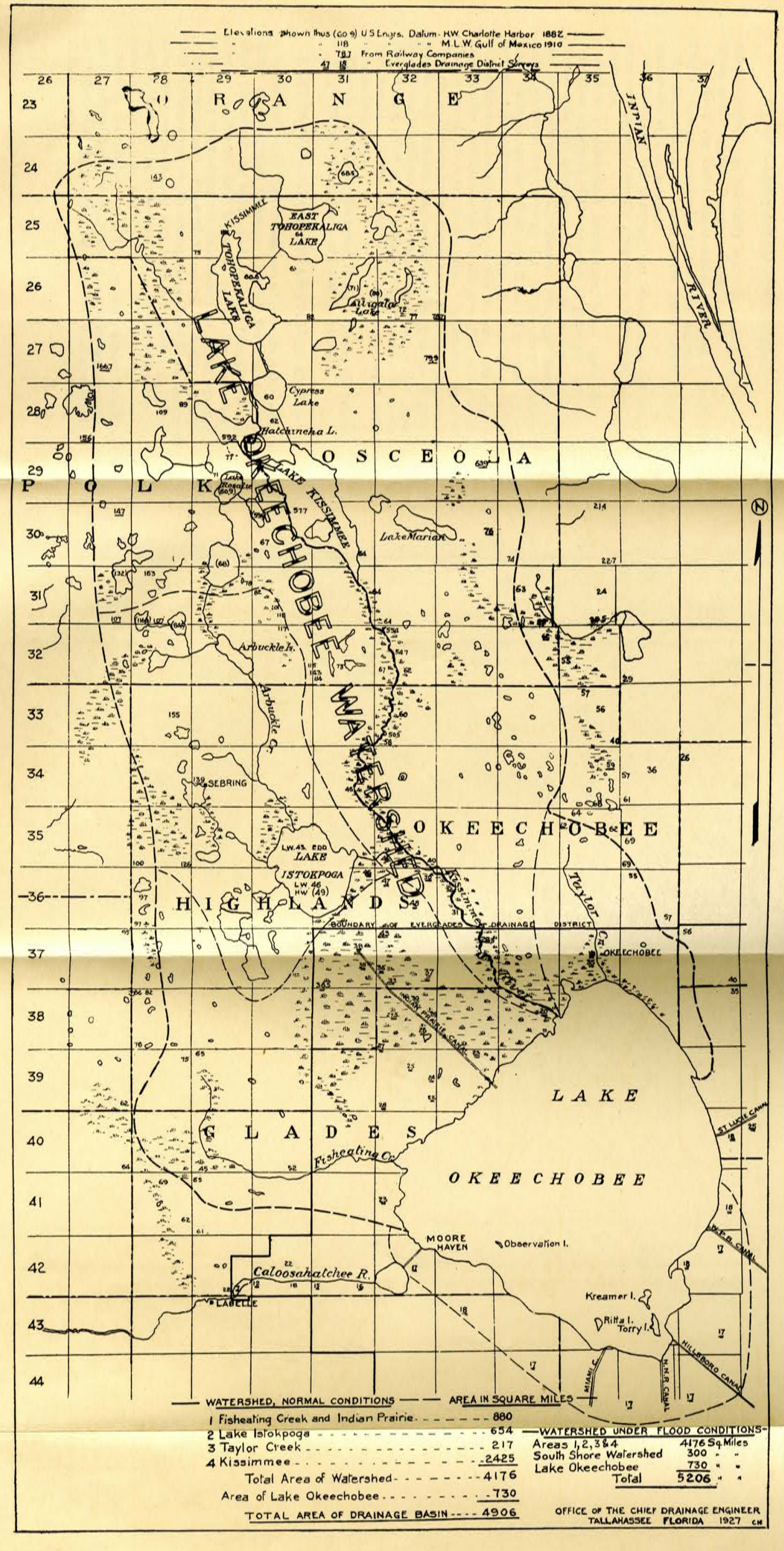
> lake will therefore aggravate lake flood to some extent. The same reasoning applies to other territory adjacent to the lake. Consequently, the discharge from the lake would possibly have to be increased to meet new drainage conditions which will come about through future development . . . . These future conditions should be realized and appreciated now, but can be provided for when needed and would be a part of the natural progressive development of the project."

The question presented to the Board seems to be whether or not the time has now come for undertaking this progressive development of the project. If it is considered that the beginning of a comprehensive drainage program for reclaiming the lands of the Kissimmee River and related sheds should be undertaken at this time, then this is the time to extend the district to include these water sheds and this is the ground upon which the same should be annexed. If the area is taken into the district with such end in view, then it should be understood that the 1 mill ad valorem tax which has been suggested by proponents of the extension plan, will be sufficient only for making surveys and drainage investigations, but cannot be considered as sufficient with which to even begin works in the area. When the area is ready to begin with its construction work, then additional drainage taxes in the shape of acreage assessments against land must be imposed for providing money therefor, similar to the plan in operation for Everglades Drainage District.

In the event that the boundaries of Everglades Drainage District shall be extended by the Legislature to include the Northerly water sheds, a tax of 1 mill as proposed could be levied, the proceeds from which would go toward paying the cost of necessary surveys, drainage investigations, and the preparation of plans. After the plans have been developed and the probable cost ascertained, the owners of property in the area will be in position to determine whether or not they will proceed with drainage at this time. If so, then it would be proper for the Legislature to impose the usual acreage drainage tax in amount to be ascertained.

The necessary preliminary Legislative steps are:

1. Extend the boundaries of Everglades Drainage Dis-



WATERSHED, NORMAL CONDITIONS	AREA IN SQUARE MILES
1 Fisheating Creek and Indian Prairie	880
2 Lake Istokpoga	654
3 Taylor Creek	217
4 Kissimmee	2425
Total Area of Watershed	4176
Area of Lake Okeechobee	730
TOTAL AREA OF DRAINAGE BASIN	4906

WATERSHED UNDER FLOOD CONDITIONS	
Areas 1, 2, 3 & 4	4176 Sq. Miles
South Shore Watershed	300 " "
Lake Okeechobee	730 " "
Total	5206 " "

OFFICE OF THE CHIEF DRAINAGE ENGINEER
TALLAHASSEE FLORIDA 1927 CH

trict to include the Northerly water sheds and annex these areas to Everglades Drainage District.

2. Make the Laws under which Everglades Drainage District operates applicable to the area annexed.

3. Impose a tax of 1 mill on the dollar on all property within the area so annexed.

4. Authorize the carrying out of drainage investigations and surveys from the proceeds to be derived from the above tax.

And at a subsequent Legislature, based upon the information obtained, if the decision of property owners is for carrying out drainage works, levy an acreage tax along the lines followed by Everglades Drainage District and make provision for carrying out the necessary construction. In so far as the effect upon Lake Okeechobee is concerned of improving this territory, it is not necessary to give immediate consideration to this feature. In fact, to intelligently anticipate what the effect will be will require knowledge of the work to be done. Improving lakes of the area as holding basins would tend to reduce maximum runoff, while constructing canals or enlarging the Kissimmee River would tend to increase the runoff. But what the ultimate effect of the combined works would be is not determinable till the works to be constructed shall have been decided upon.

There is attached to this report a map showing the extent of the Northerly water sheds of Lake Okeechobee.

EAST COAST AND CALOOSAHATCHEE AREAS

As differentiated from the subject of extending the boundaries of Everglades Drainage District Northward to include the remaining water sheds of Lake Okeechobee, the proposal to extend the District to include the East Coast strip and a strip along the Caloosahatchee River presents a different aspect. First, there can be no doubt but that both of these areas, the Coastal strip and the Caloosahatchee area, have received, and will hereafter receive in larger degree, drainage benefits from reducing water levels over much of this section, and

Second, that there is manifest certain indirect benefits not strictly of a drainage nature or not from actually taking water off of the ground, but nevertheless of great value to these areas.

A consideration of the benefits conferred upon such areas justifies extending the boundaries of the District to include them. The reason for including such areas within the District has been discussed thoroughly and at length during the past four or five years. The two principal considerations from the standpoint of Everglades Drainage District are the securing of additional property within the District and the addition of large population thereto, both of prime importance in financing the works of the District to successful completion. There is urgent necessity for their inclusion from the standpoint of financing and ample justification for such inclusion from the standpoint of benefits which the area proposed to be annexed have already had and will continue to receive.

While the plan of extending the boundaries of Everglades Drainage District as above referred to undoubtedly affords the best method of placing the District in position for financing the work to final and successful completion, yet the extension of the boundaries to include these areas depends upon the wishes and desires of the people living therein. Though the plan for annexing these areas and the imposition of a 1-mill tax on property therein, accompanied by the making of such property exempt from the Everglades acreage drainage tax, and though, as above stated, there is no question but that benefits have been received and will hereafter be received by such areas, there has been and there still is strong opposition to include such territory, while on the other hand there is considerable support to the proposed measure. The Legislature has twice declined, or has at least failed, to enact the necessary law for extending the boundaries of the district. Whether or not the desired legislation can be passed at the next session is a matter of conjecture. If it does not, or if it does not seem wise in the judgment of the Board to press the passage of such an Act, there is the alternative of continuing along the lines followed in the past, and while progress of drainage cannot be as rapid as would be possible under the extension plan, still substantial progress can be made. By laying out a modified schedule of work designed to take care of definite, though restricted, areas, considerable land can be provided with the necessary main canals for affording outlet. In case of necessity, as an alternative, the following is suggested:

RESTRICTED AREA PLAN

Select those areas where the remaining main drainage works can be completed at least cost, bearing in mind the suitability of such areas for early settlement and cultivation.

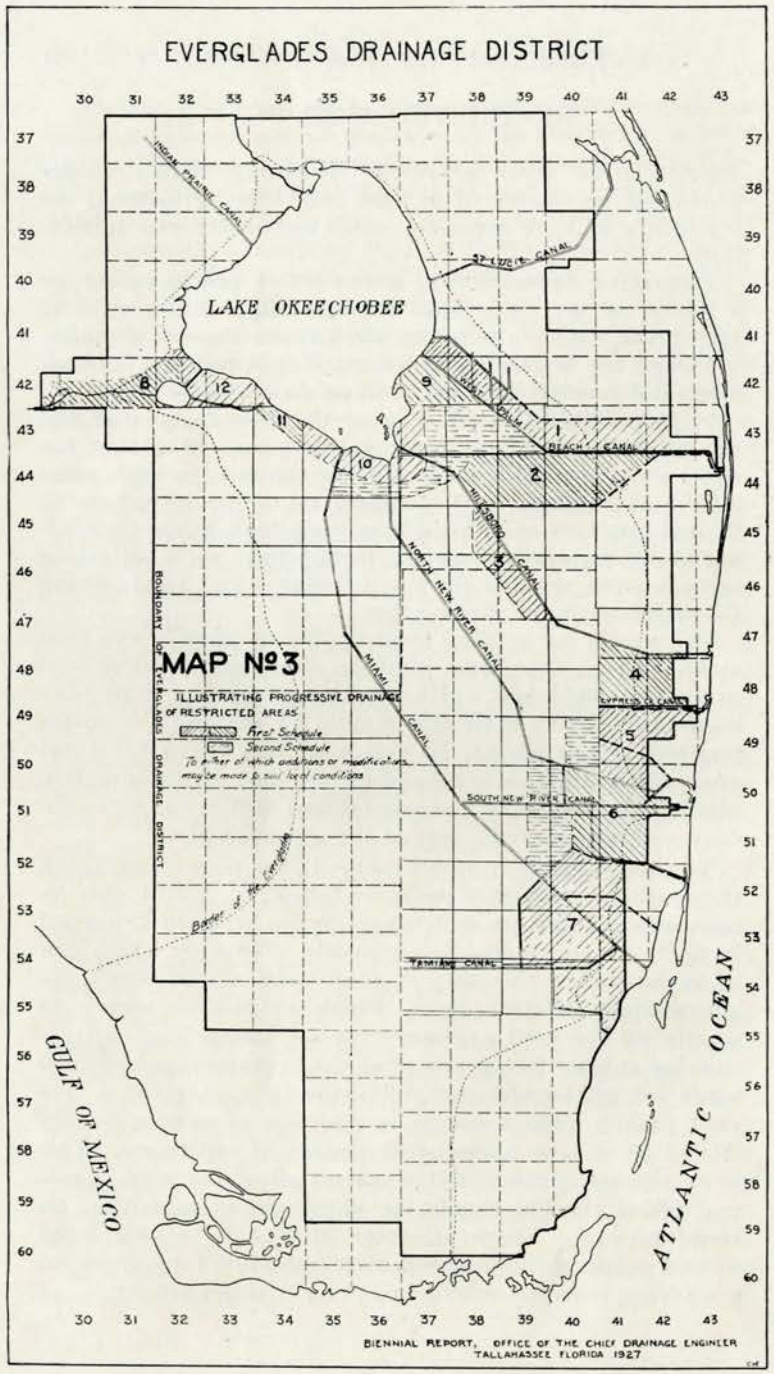
Determine the amount of money which can be raised for a period of say four years for carrying out the work in such areas, and the taxes required to be assessed therefor.

Design the works for providing main drainage for such areas and proceed with the work on such basis.

If such plan be decided upon, the area designated and the works required laid out, it will be essential that the work and expenditures therefor be confined to such areas and to the budget for them until all of the work for the limited territory shall have been completed before proceeding to other areas. There is attached Map No. 3 indicating certain areas selected by way of suggestion, and showing the main canals for serving them.

The canals for serving these areas are parts of the final system except that some of them would not be excavated to the full depth and width required when they shall have been extended to their full length for serving the entire territory along them. In this way the works for local areas will harmonize with and form a part of the complete plan for draining the Everglades and will in no way conflict with the carrying out of the ultimate plan.

The above refers to new canals. If the plan of confining the work to restricted areas is followed, it will also be necessary to limit present canals to the areas to be served in part by the proposed new outlets. The area which can be reclaimed in this way in four years would reach approximately 400,000 acres, which should be ample to supply all the land necessary for settlement and cultivation for at least five years, or at the average rate of 80,000 acres for settlement and cultivation per year for a five year period. The above is in addition to approximately 90,000 acres now under some degree of settlement. This is on the assumption that work on all of the new canals and all of the old canals for improvement is carried on simultaneously. Some of these units can be completed in two years, while others will require full four years on a working schedule which financing will permit.



The affording of satisfactory drainage for such restricted areas will depend not only on the main outlets, but also upon the organization of sub-drainage districts and the construction of the necessary lateral systems by them for taking advantage of the mains. Some of these areas are already within sub-drainage districts which are on an operating basis and in legal shape to proceed with their lateral systems.

These areas are referred to in units. Cost of completing the main works in each unit is tabulated. The arrangement and areas of these units are susceptible of considerable variation to suit requirements. The units shown are by way of illustration and suggestion on map No. 3.

AREA No. 1.

	Acres.	Cost.	Cost.
Completion of levee and canal 30 ft. x 6.5 ft.—21 miles, 801,000 cu. yds. at 15c		$120,150.00	
Half of West Palm Beach Canal Improvement — 1,500,000 cu. yds. at 15c		225,000.00	
Half of improvement to Dam No. 2.....		40,000.00	
Total	63,000		$385,150.00

AREA No. 2.

	Acres.	Cost.	Cost.
Canal A, 2-3 ultimate size, 65 ft. x 15.5 ft. —24 ft. x 8.5 ft.— 23.2 miles. Earth and muck, 1,514,000 cu. yds. at 15c. ..... Rock, shell, hardpan, 382,000 cu. yds. at 50c.		387,820.00	
Half of West Palm Beach Canal Improvement, 1,500,000 cu. yds. at 15c.		225,000.00	

	Acres.	Cost.	Cost.
Half of improvement to Dam No. 2		40,000.00	
Total	73,600		$652,820.00

AREA No. 3.

	Acres.	Cost.	Cost.
Improvement to Hillsboro Canal for areas 3 and 4—half of total —1,917,400 cu. yds. at 25c.	26,800	$479,350.00	$479,350.00

AREA No. 4

	Acres.	Cost.	Cost.
Improvement to Hillsboro Canal for areas 3 and 4—½ of total —1,917,400 cu. yds. at 25c		$479,350.00	
Improvement to Cypress Creek Canal, ½ of total required for areas 4 and 5, average 40 ft. x 10 ft. —50 ft. x 10 ft. Less ½ Cypress Creek Canal already excavated, for 8.18 miles, 389,000 cu. yds. at 25c		97,250.00	
Total	35,800		$576,600.00

AREA No. 5.

	Acres.	Cost.	Cost.
Improvement to Cypress Creek Canal ½ of total required for areas 4 and 5, average 40 ft. x 10 ft.—50 ft. x 10 ft. less ½ Cypress Creek Canal already excavated, for 8.18 miles 389,000 cu. yds. at 25c..		$ 97,250.00	
Canal New River, north fork as required for the area, 25 ft. x 10 ft.—40 ft. x 10 ft. 625,000 cu. yds. at 30c		187,500.00	
Total	37,500		$284,750.00

AREA No. 6.

	Acres.	Cost.	Cost.
Improvement of Snake Creek Canal for areas 6 and 7. ½ for this area average 44 ft. x 9 ft. less excavation from present Snapper Creek Canal. Rock, 324,500 cu. yds. at 50c; earth, 51,500 cu. yds. at 15c	42,800		$169,975.00

AREA No. 7.

	Acres.	Cost.	Cost
Improvement to Snake Creek Canal for areas 6 and 7. Canal average 44 ft. by 9 ft. less excavation from present Snake Creek Canal. ½ for this area. Rock 324,500 cu. yds. at 50c. Earth 51,500 cu. yds. at 15c.....		$169,975.00	
Improvement of Snapper Creek Canal 3.9 miles to provide canal 33 ft. by 6 ft., 44 ft. by 8 ft., 70,000 cu. yds. at 40c.....		28,000.00	
Total	108,000		$197,975.00

AREA No. 8.

	Acres.	Cost.	Cost.
The work for number 8 will consist of the improvement proposed for Caloosahatchee Canal between Lake Hicpochee and Fort Thompson, representing the excavation of approximately 1,200,000 cu. yds., at 25c.		$300,000.00	

	Acres.	Cost.	Cost.
Permanent construction at Lock and Dam No. 2.....		60,000.00	
This cost does not take into consideration the probability of improvement of this outlet by the United States as appears probable under recent Act of Congress authorizing a survey of this section, together with a section of Lake Okeechobee, in the interest of Flood Control and for navigation, for which survey an appropriation of $45,000.00 has been made available by Congress. It may be reasonably anticipated that at least some work will be done by the United States in this channel, which will reduce the cost of this improvement in the interest of drainage by Everglades Drainage District ..			
Total	30,700		$360,000.00

AREAS NOS. 9 TO 12 INCLUSIVE

	Acres.	Cost.	Cost.
In addition to areas Numbers 1 to 8 inclusive, there are also areas Numbers 9, 10, 11 and 12 bordering upon Lake Okeechobee, remaining drainage for which is of local character and is being provided by local sub-districts ..	75,000		

For all areas there must be included the cost of protective works around Lake Okeechobee and of completing St. Lucie Canal.

LAKE OKEECHOBEE LEVEE

	Acres.	Cost.	Cost.
Estimated cost—total $1,581,098.00 of which ½ is assessed to Everglades Drainage District and ½ to Trustees of the Internal Improvement Fund			$790,549.00

COMPLETION OF ST. LUCIE CANAL

	Acres.	Cost.	Cost.
1,809,700 cu. yds. material at 40c			$723,900.00
Total acres for which main drainage work will be provided in four years under above schedule is..	493,400		
And the total estimated cost is			$4,621,069.00
Or, at the rate of $9.37 per acre.			

A part of the work, such as the Okeechobee Levee and Saint Lucie Canal, is of general nature affecting the entire District, hence the expense proper to distribute against the area is about $7.00 per acre.

After work shall have been completed in these areas, the various canals may be extended further and additional areas made ready as requirements dictate. The foregoing will probably provide a considerable excess of land over and above that which will be placed under but even moderate degree of settlement and cultivation within the next five years.

The 1926 Everglades Drainage District acreage tax now in effect amounts to a total of $1,570,632.00 per annum, which is sufficient to support bonds to the extent of approximately $17,000,000.00 or $18,000,000.00. There are now outstanding $10,255,000.00 in bonds. In addition to the above the Legislature in 1925 authorized the issuance of $3,000,000.00 in bonds, and these bonds are now on hand subject to sale. The remaining amount in bonds which can be issued upon the present drainage tax is consequently about $3,750,000.00 to perhaps $5,000,000.00, making a total of say $7,500,000.00, which, if bonds are sold, will be ample to provide for the work above described. Hence, following the plan of selecting restricted areas and of completing the works for such areas, as has just been described, has the advantage that no increase in taxes need be resorted to for financing the work through this stage. It would be advisable, however, to rearrange the schedule of taxes to apply equitably to the areas which will be improved and benefited as differentiated from those areas which will receive but little benefit through the carrying out of the restricted work.

Finance Support of bonds

RATE OF DRAINAGE

The draining of lands of Everglades Drainage District is but a part of the ultimate problem of its final reclamation. After drainage has been accomplished there comes the subject of colonization, or settling the lands and bringing the same under cultivation. In fact, this is the ultimate purpose of drainage. Perhaps this feature in connection with the Everglades has not been as generally gone into or as thoroughly analyzed as that of drainage,

but its bearing upon the drainage of the land is an important matter. The Board have before them plans for draining the areas, but they have not before them information on which they can accurately determine or forecast the probable rate at which the lands will be settled and cultivated. In my judgment, the area which can be brought under settlement and cultivation each year is not so large as the common opinion indicates to be possible or desirable. The completion of drainage for an area of 2,300,000 acres within eight years would mean that to keep up with the rate of land drainage, settlement and cultivation must proceed at a rate approaching the rate of drainage. To think of settling and cultivating even sparsely a practically untouched area of 2,300,000 acres in eight years is setting expectations upon settlement and cultivation at a high limit. Judging by the rate at which land settlement and cultivation have gone on in this country, and also the rate at which certain sections of the Everglades have been settled and placed under cultivation, and making all possible allowances for difficulties and for vicissitudes from time to time which no doubt have militated against more rapid development, it seems to be that to bring under but a moderate degree of settlement and cultivation additional areas of 40,000 to 60,000 acres per annum would be making good progress in this direction. The completion of main drainage works in those areas of the Everglades where settlement and cultivation have already started, and the addition of perhaps a hundred thousand acres per year for a year or two would provide a reserve of drained land for near future needs, and after such reserve shall have been provided, the addition of more land to the reserve could proceed at a rate which will take care of any possible need for agricultural land, but without carrying any unnecessarily large excess. Such areas should be selected in reference to nearness to centers of population, accessibility to markets, facilities for ingress and egress, economy of drainage, and other considerations which might give such areas a sort of priority over others in drainage, settlement and cultivation. The drainage plan proposed to be carried out by the Board is of such nature as to be well adapted to a progressive development of the

above character. These are economic considerations in the advancement of the enterprise. On the other hand, there will doubtless be urged upon the Board the necessity for more and more drained land aside from that which will be required for satisfying the needs as confined to settlement and cultivation. There may be expected urgent demands for additional drained land in order to satisfy the desire for more land to sell. This has been experienced in the past and is to be expected in the future, but the consideration of land for sales purposes does not afford a sound basis on which to bring in large areas year by year with no possibility of putting them to use and bringing them into an earning state, or of enabling such areas to pay the increased tax burdens which must inevitably come by reason of expenditures for drainage purposes. Such would result in a large carrying charge upon the construction prior to its utilization, and the expense of maintenance for a considerable period after construction and prior to the time when such works would be brought into use, not to speak of danger of damage to the lands with no population to assist in controlling such danger and the added expense of protection.

An examination of Map No. 1 will disclose that a progressive development may be carried out under a wide range of selection.

This larger plan, in a general way is similar to the plan for restricted areas already discussed, but can be carried out on a much larger scale, involving larger annual expenditures requiring financing which the District can carry out, in my judgment, to very much better advantage by extending its boundaries into the East Coast and Caloosahatchee areas. The construction of drainage works necessary under this plan would be the excavating of the several canals to their full ultimate size and the provision of all of the controlling works necessary for them. Such plan would provide greater latitude in the selection of areas in number, size and location.

Whether the Board adopts the plan of the comparatively small restricted area development or the plan of almost unlimited area development will no doubt depend in great measure upon the ability to finance the work, resolving itself finally into:

1. *For the Larger Plan*: Extending the boundaries to include the East Coast and Caloosahatchee areas, as just and equitable and as advantageous for adequate financing, and

2. *For the Restricted Area Plan*: To continue financing as at present and proceed with the work on a restricted scale.

DRAINAGE OF THE SOUTHWESTERN SECTION.

Reference has been made to the drainage of the Southwestern section of the Everglades with the statement that the subject would be alluded to in a general way only.

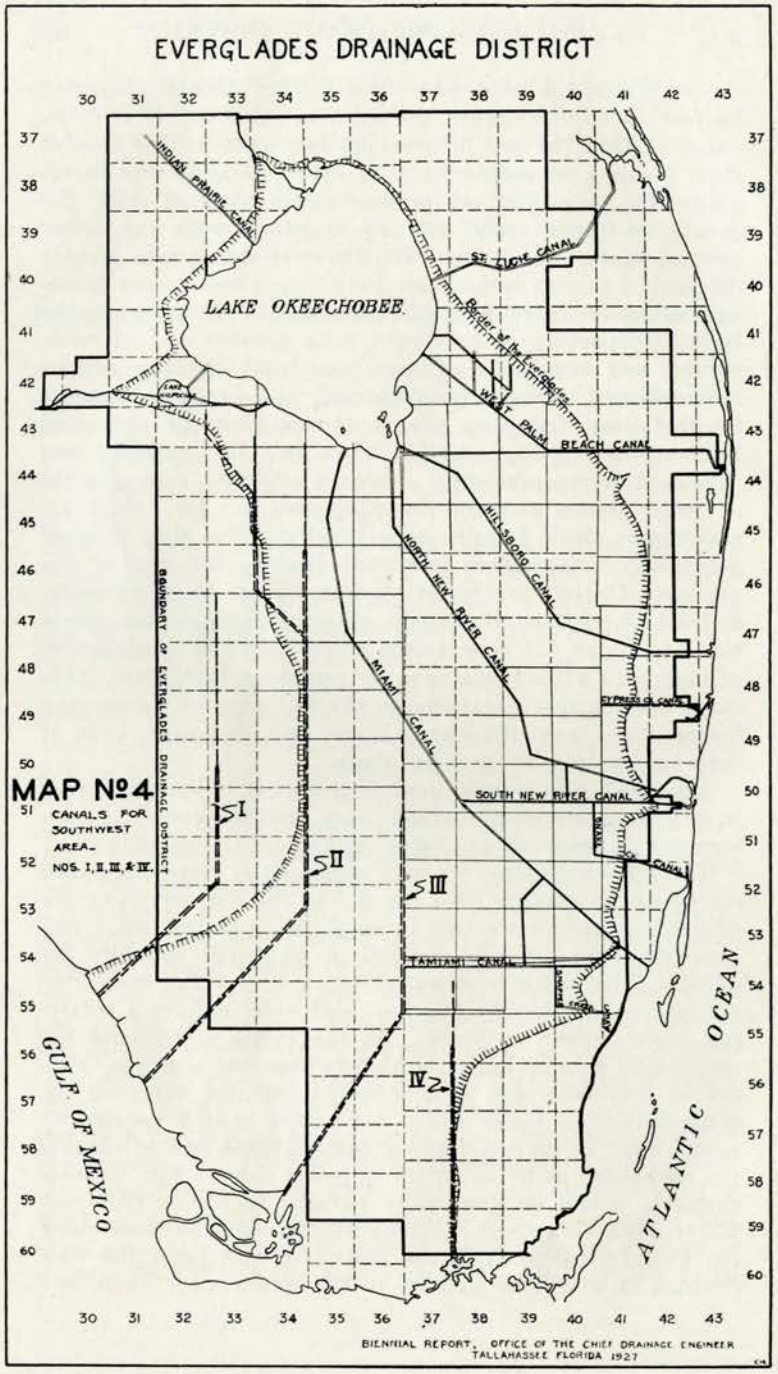
This section comprises the area lying generally West of the Miami Canal and South of Lake Okeechobee within Everglades Drainage District.

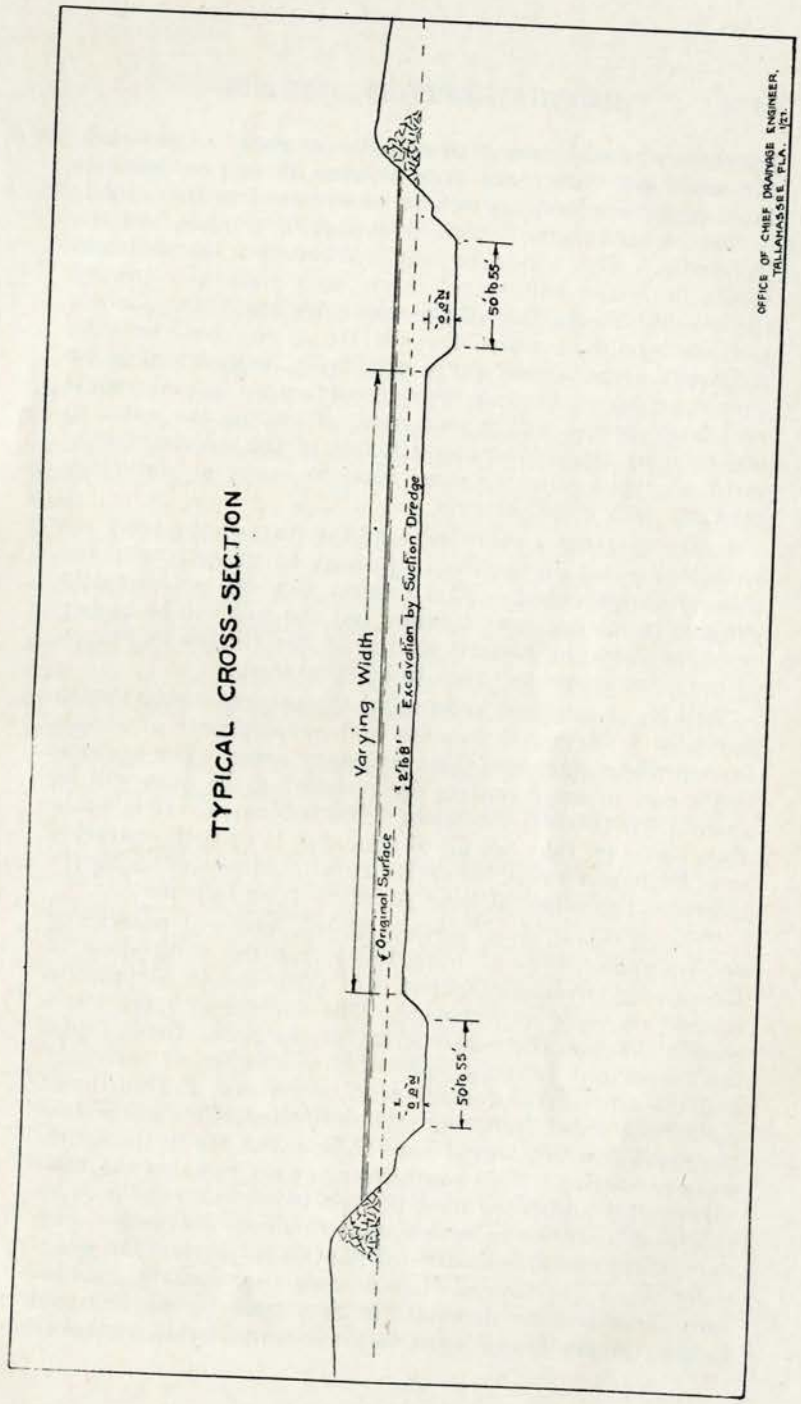
No drainage work of any important character has been undertaken by the District in the Western and Southwestern section. This section comprises a total of approximately 2,340 square miles, or nearly 1,500,000 acres. The character of the area, its distance from the sea, and its elevation warrants careful consideration in selecting the best and most economical method for providing the main drainage outlets for the territory. The area in general differs in three principal respects from that part of the Everglades where work is now going on and heretofore referred to. With the exception of the Northeastern portion of this area, the muck soil which predominates is thin, varying generally from 2 to 6 feet in thickness, and is underlain with the usual lime stone of the Everglades. Further to the Southward within the Everglades proper the soil is even thinner, and in areas of considerable size very little soil exists above rock formation. On the other hand, some of the very best land in the Everglades is in this area. Furthermore, its Southern location reduces frost danger, which is advantageous in growing high class winter crops and for some of the staples. Some of this section is destined to be among the best producing areas of the Everglades. In the Western portion of the district the Everglades marsh gives way to the predominating sand formation of flat pine woods, cypress swamps and open prairie. The elevation of the Southern portion is usually from 3 to 8 feet above sea level. The distance from

the middle of the tract where the surface elevation is about 15 feet, is approximately 60 miles to the sea. It is to be expected that the cost of draining this area will be greater than an area of similar size in other parts of the Everglades by reason of the greater proportion of rock, the greater distance from the sea, together with the lower ground surface elevation. The lower elevation and greater distance to the sea makes necessary longer and larger drainage canals for carrying a given amount of water, while the larger proportion of rock results in greater cost of excavation, and with all, it appears that local drainage can be accomplished to best advantage and with greatest economy by installing pumping plants for unwatering protected local areas. The probability that only by pumping can this area be economically drained, suggests arrangement of outlet canals with the pumping idea in view. Such arrangement would require departure from the plan of canal construction heretofore followed—that is, for gravity operation. Outlets for receiving water from local territory, at least during storm periods, must be through the operation of pumps. A comparison of costs in the construction of canals to afford drainage by pumping into them, indicates a much less cost through the adoption of a pumping system than any attempt to carry out drainage, even if such be feasible, by gravity alone.

Assuming that pumps must be resorted to by local areas in utilizing the main outlets, such outlets would be constructed in general according to the following plan:

The general location for such main outlet system is shown on the accompanying map, No. 4. In the northerly portion of the area the canals will be constructed in the usual way by excavating a single channel of sufficient capacity for carrying the water from its tributary area. The excavated material would be deposited on each side to form a retaining embankment or levee. As the canal approaches the sea, it will become impracticable to excavate a single channel of sufficient size at economical cost for carrying the large volume of water which must come to it, consequently resort must be had to digging two channels and of placing the excavated material on the opposite side of each. These channels would be practically parallel and vary from say 300 to 3.000 feet apart. The excavation from the east channel would be thrown to the eastward, and from the west channel it would be thrown to the westward. These em-


EVERGLADES DRAINAGE DISTRICT
LAKE OKEECHOBEE
INDIAN PRAIRIE CANAL
ST. LUCIE CANAL
Border of the Everglades
WEST PALM BEACH CANAL
HILLSBORO CANAL
NORTH NEW RIVER CANAL
MIAMI CANAL
CYPRESS CANAL
SOUTH NEW RIVER CANAL
TAMIAMI CANAL
BOUNDARY OF EVERGLADES DRAINAGE DISTRICT
MAP Nº 4
CANALS FOR SOUTHWEST AREA-
NOS. I, II, III, & IV.
I
II
III
IV
GULF OF MEXICO
ATLANTIC OCEAN
30 31 32 33 34 35 36 37 38 39 40 41 42 43
37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
BIENNIAL REPORT, OFFICE OF THE CHIEF DRAINAGE ENGINEER
TALLAHASSEE FLORIDA 1927


TYPICAL CROSS-SECTION
Varying Width
Original Surface
12'to 8' Excavation by Suction Dredge
1:2
50'to 55'
OFFICE OF CHIEF DRAINAGE ENGINEER,
TALLAHASSEE, FLA. 1927

bankments would consist principally of rock. Afterward, the muck soil within the area between these two channels must be pumped out, or otherwise removed to the outside of the embankments. Such will provide a wide, shallow waterway. The water impounded between the embankments or levees will travel down such waterway toward the sea, but the surface of the water, at least during storm periods, would be above the surface of the land outside. Adjacent areas would carry out their local drainage by providing levees around them, constructing lateral canals and farm ditches within such area, of leading the water to one or more central pumping plants at the canal embankment, and pumping the same into the space or waterway between such embankments.

In the extreme western edge of the district the land has sufficient elevation to afford drainage by gravity until the coast is approached. This section can be satisfactorily drained in the ordinary manner, but the cost will be higher per acre than the eastern section of the Glades by reason of the large amount of rock to be excavated.

Map No. 4 attached hereto and the accompanying sketch indicates a suggested location and arrangement of canals for affording service to their tributary areas. The approximate cost of main outlets for reclaiming the area will be around $26,000,000 for about 1,500,000 acres. It is probable, however, that not all of this area is of such character or of sufficient value for agricultural purposes as to justify intensive drainage, at least for some time to come.

Though this area, as already stated, has in it practically no drainage works of importance, yet the work done in Everglades Drainage District is of value and importance in connection with its drainage. The control of Lake Okeechobee through the construction of the Saint Lucie Canal has important bearing upon this southwestern territory, and the other canals constructed to the east and northeast deflect the water from that section of the Glades and reduce the amount which would have to be cared for in the southwestern section. This southwestern area remains the most inaccessible and is the most distant from centers of population and localities in which improvements are under way. Settlement and colonization of the Glades section will gradually reach out toward it, but some time must elapse before there will be demand for this land for agricultural needs. Hence the delayed improvement of this section of

the Everglades comes about naturally and is influenced by the advancing tide of development from other directions. Its final drainage, settlement and cultivation will come in the natural order of things, and its drainage should be considered with such in mind.

TAXATION AND FINANCING

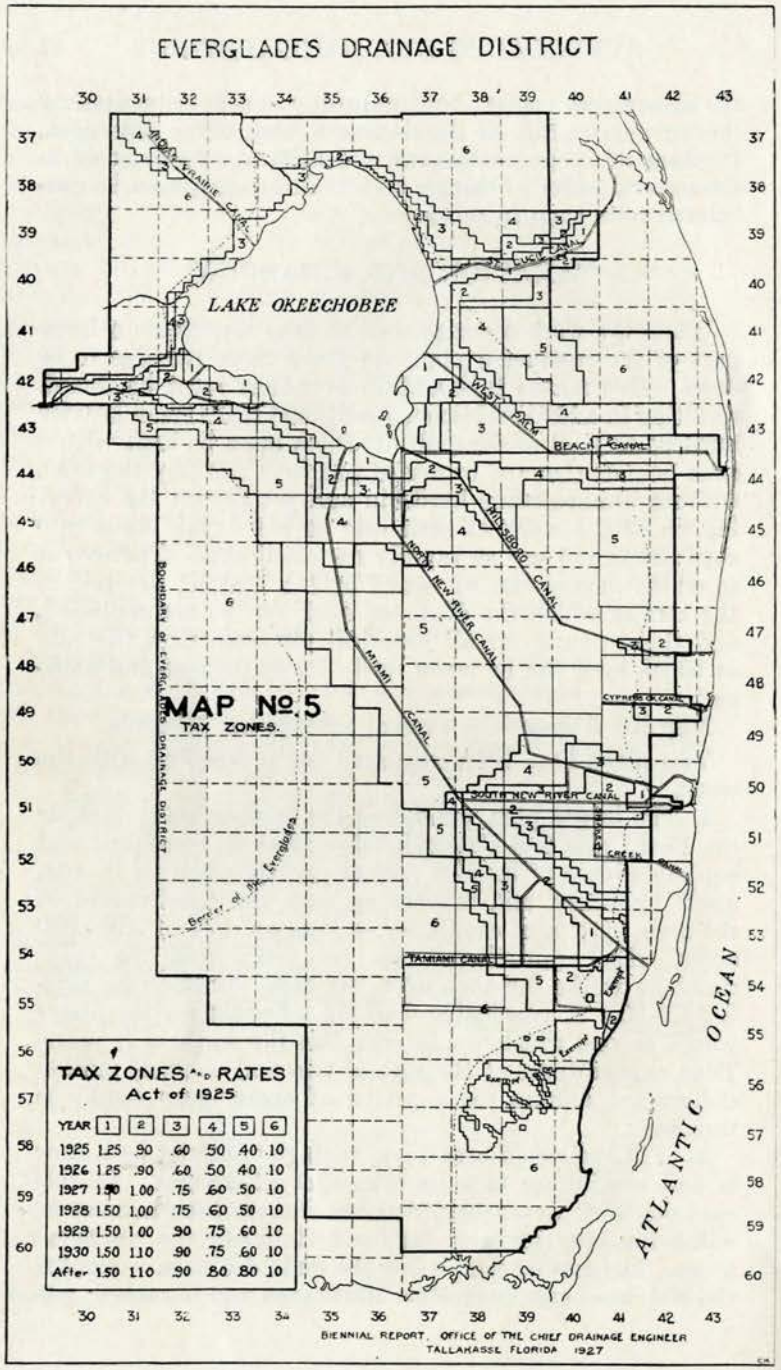
While the work accomplished to date represents a large part of the completed plan, yet much more remains to be done. This means that additional money must be raised, resulting in additional taxes. Additional taxes mean heavier burdens to land owners, all of which must be kept within such bounds that the owner of property can pay the same without unnnecessary hardship and yet permit the carrying on of the work at such rate as will bring lands into cultivation and use as rapidly as practicable. The extent to which money can be raised by the District determines the rate at which the drainage work can be accomplished, and this in turn for all practical purposes fixes the rate at which land can be made ready for settlement and cultivation.

Map No. 5 shows the present acreage tax schedule.

Two plans have been suggested for proceeding with the work.

1. The larger plan, extending the boundaries to include the East Coast and Caloosahatchee areas on some just and equitable basis of benefits and as greatly assisting in adequate financing, and proceeding with the construction of the main system of canals for serving an area of 2,300,000 acres. The approximate cost for completing the main drainage works for such area has been shown to be $20,583,438.00. A reasonable working schedule for the above would be one which would complete the work in 8 years. Thus expenditures at the rate of two and one-half million dollars per annum for a period of eight years would be necessary.

2. The restricted area plan, with the District as it now is and continuing to raise money as at present. In this case the work would be proceeded with in such manner as will bring into condition for use certain selected restricted areas. The cost of completing the main drainage works for the restricted area heretofore illustrated and discussed, was



shown to be approximately $4,531,000.00, and that 493,000 acres of land would be ready for use insofar as main drainage works are concerned as a result of such work. This plan can be carried out without material changes in the District as it now is. The completion of works for about half of these areas can be brought about in two years, and three years should suffice for completing the work in all of these units. Allowing an aditional year to complete their secondary systems would make the foregoing areas available in four years.

The carrying out of the restricted area plan appears to be ample for all reasonable needs of settlement and cultivation. The four-year schedule outlined can be carried out by the District as it now is, but the completion of the units suggested for the four-year schedule is by no means the completion of all work for the District and represents but approximately one-fourth of the expense for reclaiming the area in which work has already been done, amounting to approximately 2,300,000 acres. It does not seem likely that the District as it now is, with its low assessed valuation of property, small population and large proportion of non-producing area, can advantageously finance the whole work to completion. Hence the adoption and carrying out of the restricted area plan does not reduce the desirability or the justness of extending the boundaries of the District to the East Coast and to other sections. No matter what plan may be followed, the problem of financing the work will ever be at the forefront in importance. The benefits which have been and which will hereafter be received by the adjacent areas and their towns and cities, and the development of the Everglades as their back country, makes such inclusion in the district and the payment of a nominal tax such as 1 mill in the dollar of property, just and equitable beyond any sort of question. These are the real grounds for their inclusion. One of the results from such inclusion or as incident thereto, is the benefit or advantage to Everglades Drainage District in financing the work. Thus will advantages or benefits to each party come about in a reciprocal way, and not of a one-sided nature.

The following tables "H" and "I" indicate the amount of money necessary to be raised by taxation for supporting bonds issued to supply money for carrying out the work:

TABLE "H."

EVERGLADES DRAINAGE DISTRICT.

Suggested Taxing Schedule.
Acreage Tax.

Zone	Acres	Rate	27-28	Rate	29-30	Rate	31-32	Rate	33-34	Rate	35-36	Rate	37-38
1	186,000	$1.50	$ 279,000	$1.50	$ 279,000	$1.80	$ 334,800	$1.90	$ 353,400	$2.00	$ 372,000	$2.00	$ 372,000
2	311,700	1.00	311,700	1.10	342,870	1.30	405,210	1.40	436,380	1.40	436,380	1.50	467,550
3	350,000	.75	262,500	.90	315,000	1.10	385,000	1.20	420,000	1.20	420,000	1.30	455,000
4	392,000	.60	235,200	.75	294,000	.90	352,800	1.00	392,000	1.00	392,000	1.00	392,000
5	668,000	.50	334,000	.60	400,000	.75	501,000	.90	601,200	1.00	668,000	1.00	668,000
5a	206,000	.25	51,500	.40	82,400	.50	103,000	.60	123,600	.70	144,200	.75	154,500
6	2,000,000	.10	200,000	.10	200,000	.10	200,000	.10	200,000	.10	200,000	.10	200,000
Total ..	4,113,700		$1,673,900		$1,914,070		52,281,810		$2,526,580		$2,632,580		$2,709,050
Ad Valorem Tax —Everglades		1 Mill	$ 53,000	2 Mills	$ 110,000	3 Mills	$ 168,000	4 Mills	$ 228,000	5 Mills	$ 290,000	5 Mills	$ 300,000
Annexed Area		1 Mill	140,000	1 Mill	145,000	1 Mill	150,000	1 Mill	155,000	1 Mill	165,000	1 Mill	175,000
Grand Total.....			$ 1,866,900		$ 2,169,070		$ 2,599,810		$ 2,909,580		$ 3,087,580		$ 3,184,050
Bonds on Tax.....			$19,000,000		$22,000,000		$26,000,000		$29,000,000		$31,000,000		$33,000,000
Order of Issue (Including all previous issues)			$19,000,000		$23,000,000		$28,000,000		$33,000,000		.....		.....
Available for Work.			$ 4,000,000		$ 5,000,000		$ 5,000,000		$ 5,000,000				

This Table is by way of suggestion only.

TABLE "I."

EVERGLADES DRAINAGE DISTRICT.

(Present Taxing Schedule Acreage Tax.)

Zone	Acres	Rate	27-28.
1	186,000	$1.50	$ 279,000
2	311,700	1.00	311,700
3	350,000	.75	262,500
4	392,000	.60	235,200
5	668,000	.50	334,000
5-a	206,000	.10	20,600
6	2,000,000	.10	200,000
Total	4,113,700		$1,643,000
Ad Valorem Tax, Everglades 1926 assessment, 1 mill.....			$ 52,404
Grand Total.....			$1,695,404

TABLE "J."

VALUATION OF PROPERTY IN EVERGLADES DRAINAGE DISTRICT SUBJECT TO DRAINAGE TAXES—1926 ASSESSMENT.

Lands on which acreage tax is levied.....	$30,629,629.00
Lands exempt from acreage tax on which 1 Mill tax applies.....	19,975,147.00
Railroads and Telegraphs.....	1,636,610.00
Personal Priperty.....	163,030.00
Total	$52,404,416.00

The above does not include school lands and property not taxable—$353,690.00.

EVERGLADES DRAINAGE DISTRICT TAXES—1926.

I mill ad valorem tax, 1925 assessment.....	$ 32,429.58
Acreage Drainage Tax, 1926 assessment....	1,604,061.40
Total Tax Assessed.....	$1,636,490.98

The following is a brief general statement of the status of bonds sold, issued, or authorized by the Legislature to January 1, 1927:

Amount of bonds authorized by the Legislature $14,250,000
Amount of bonds disposed of for which money has been received, exclusive of refunding bonds 11,250,000
Amount of bonds matured and paid off..... 1,000,000
Amount of bonds outstanding..... 10,255,000
Made up of:
All issues except refunding.....$6,723,000
Refunding only..... 3,532,000
($5,000 more of refunding bonds were required to make up in part the difference between call and refund rates).
Amount of bonds on hand not disposed of.... 3,000,000
Amount of bonds available for raising money authorized by Legislature, 1925..... 3,000,000
Of which $1,250,000 5%, dated January 1, 1926, deposited with Park National Bank under agreement with Spitzer, Rorick & Company and $1,250,000 to be issued as of date January 1, 1927, and $500,000 to be issued as of date January 1, 1928.

The following amounts borrowed for paying cost of work are owed by the Drainage Board:

Amount of notes to The Arundel Corporation to January 1, 1927.....$497,862.23
Amount of notes to Trustees of the Internal Improvement Fund to January 1, 1927..... 298,000.00

COLLECTIONS.

The following is the statement of Everglades Drainage District taxes, 1926, as shown by records of the Tax Agent:

Amount of acreage drainage taxes, 1926.... $1,571,631.82
Amount of ad valorem taxes, 1926, on 1925 assessment 32,429.58

A financial set-up for Everglades Drainage District from the foregoing and from other data might be stated in a general way as follows:

Area of District—4,114.000 acres.
Assessed value, 1926—$52,404,000.00.

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Estimated value (suggested five times assessed value—$262,000,000.00.

Population (1925 census adjusted to 1927)—46,000.

Amount of District's drainage taxes, 1927—$1,674,000.00

Amount of Districts' ad valorem taxes, 1927—$52,404.00.

Total Everglades Drainage Taxes, 1927—$1,726,404.00.

Average collections after deducting delinquencies, 96% to 97%.

Delinquencies paid by Trustees of the Internal Improvement Fund as required by law, 3% to 4%.

Final collections to District, 100%.

Total bonds authorized by Legislature to January 1st, 1927—$14,250,000.00.

Total bonds issue and sold—$11,250,000 00.

Bonds on hand subject to sale—$3,000,000.00.

Bonds matured and paid—$1,000,000.00.

Bonds outstanding—$10,255,000.00. ($5,000 more of refunding bonds were required to make up in part the difference between call and refund rates).

Sinking fund required by law—2%.

Present debt not including bonds out covered by notes—$795,862.23.

Bonds are general obligation of Everglades Drainage District through authority from Legislature, Chapter 6456, Acts of 1913, and amendments.

Interest rates on bonds outstanding: Early issues at 6%. Middle issues at 5½%. Recent issues at 5%.

Bonds are serial maturing from present till 1959. Future issues will probably be at interest rates from 5% to 5½%.

Interest payable semi-annually.

No interest or principal payments have ever been postponed.

Refunding bonds authorized.

Refunding bonds issued $3,532,000 00
Which amount is included in outstanding bond statement. Proceeds from bonds are to be used in constructing canals and other drainage works for reclaiming the lands of the District.

Estimated cost of work for reclaiming 2,300,000 acres where work is now going on is as follows:		
Cost of work to date	$14,904,000.00	
Estimated cost of additional work	20,584,000.00	
Total		$35,488,000.00
Cost per acre work accomplished as charged against 2,300,000 acres (part of above is chargeable against remaining area of district when this area is developed)		6.48
Cost per acre for new work (a small part of this work must later be distributed against additional area)		8.95
Total cost per acre for Everglades Drainage District work on 2,300,000 acres		$15.48

Estimated value of land when drained—$50.00 to $500 00 per acre for agricultural purposes.

MONEY RECEIVED BY EVERGLADES DRAINAGE DISTRICT FROM VARIOUS SOURCES OTHER THAN BONDS AND TAXES

1925 and 1926

Machinery, equipment and supplies	$14,399.44
Rock and sand	19,087.78
Machine shop and equipment services	13,246.81
Lock tolls	3,931.18
Refunds on freight, material and supplies	603.99
Interest on notes	422.29
Miscellaneous, maps, blue prints, reports, etc.	101.60
Total	$51,793.09

CONCLUSION

In addition to the matter set forth in this report, there are numerous other reports, memoranda, many charts, diagrams and plans, and other date and information on practically every phase of the drainage project on file in the

office of the Chief Drainage Engineer, all of which are available at any time for the use of the Board. It was not deemed necessary to include the above in a report of this kind. Furthermore, much of the subject matter and some of the conclusions and opinions set down do not have the supporting data therefor, or in some cases, the reasons influencing such opinions. Such supporting data and detailed discussions of the subjects mentioned are also at hand for ready reference, if desired.

I do not know of any other drainage project in this State or out of it where so much information and data have been accumulated during a considerable period of years as upon the Everglades. The statement has been made many times by engineers and others visiting this office and making inquiry or seeking information on general or special subjects relating to the Everglades, that they had no idea there was so much information, so much data, or such complete records on the subject. These data, records, reports, studies and investigations cover:

Temperature, evaporation, percolation, soil storage, run-off experiments, storage reservoirs, and topography.

Soil characteristics as affecting drainage and other hydrological phenomena.

Information in reference to design, construction and costs of locks, dams, and other controlling works.

Costs of excavating canals, of building levees, and other works of the district, both by contract and as undertaken directly by the Board, information and costs on drilling and blasting.

Classification of various materials encountered in canal construction, including muck, sand, marl and rock in its various stages of hardness, and charting such areas.

The subsidence of muck and its effect upon drainage, water storage and percolation;

Approved and tested method of land surveys and the cost of the same;

Instructions, rules and regulations for the use of the employees of the District, as engineers, inspectors, members of survey parties, in the operation of dredges, the use of cars and other vehicles, operation of locks and dams for navigation and for water regulation;

Maintenance, upkeep and depreciation of plant and

equipment, together with maintenance of works constructed; subsistence and housing of employees;

Information in reference to bonds, taxes levied for supporting the same, and for providing money for carrying on the work;

The ascertaining and determining of benefits upon which are designated zones for the levy of the differential drainage taxes.

The imposition of the ad valorem tax, extension of the boundaries of the District, financing and other economic considerations;

The keeping and analyses of costs and accounts and the distribution of expenses toward various projects and operating units carrying on the District's work, such as boats, barges, dredges, machine shop, motor vehicles, and other equipment, producing power from various fuels, lubricating oil tests, insurance such as indemnity, liability, accident, vehicle and other coverage, employees' accident risks and ratio;

Information in reference to sub-drainage districts, their works and their relation to Everglades Drainage District, digest of various laws affecting the Everglades Drainage District and the many sub-drainage districts existing therein, and the construction which has been placed upon them, and

Practically every other subject entering into or having bearing upon the project.

These data, records and other information have been carefully kept, are trustworthy, and are of constant value to this office in carrying out its work.

With all this wealth of data upon almost every conceivable subject in reference to the Everglades drainage project in its many aspects, it seems to me that it would not be out of place to compile and print the same for more convenient use of the District and for the information of the public. There would be some expense attached thereto, but the cost would be moderate and, in my opinion, justified by the value of the information thus made available.

Respectfully submitted,

F. C. ELLIOT,
Chief Drainage Engineer.

January 1, 1927.