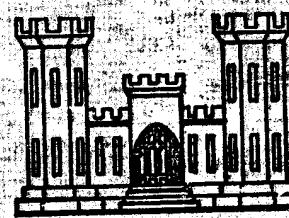


OPERATION AND MAINTENANCE MANUAL

FLOOD CONTROL WORKS

YAKIMA RIVER
AT
YAKIMA, WASHINGTON



CORPS OF ENGINEERS, U. S. ARMY
SEATTLE DISTRICT, SEATTLE, WASHINGTON

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PREPARED BY

SEATTLE DISTRICT
CORPS OF ENGINEERS, U. S. ARMY
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FEBRUARY 1955

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SECTION I. - INTRODUCTION

1.01. Authorization. - Construction of the project was authorized by the Flood Control Act, approved 28 June 1938 (Public No. 761), the applicable portion of which is quoted as follows:

"Sec. 4. That the following works of improvement for the benefit of navigation and the control of destructive floodwaters and other purposes are hereby adopted and authorized to be prosecuted under the direction of the Secretary of War and supervision of the Chief of Engineers in accordance with the plans in the respective reports hereinafter designated.

* * * * *

YAKIMA RIVER, WASHINGTON

"The plan for protection of the city of Yakima, Washington, on the Yakima River, by means of levees as set forth in House Document numbered 579, Seventy-fifth Congress, third session, is approved and for the execution of this plan there is hereby authorized \$163,000."

1.02. Location. - The project is located, primarily, on the Yakima River at Yakima, Washington, and extends from the Northern Pacific Bridge over the Naches River, a short distance upstream from its confluence with the Yakima River, to the Moxee Highway Bridge, as shown on the attached drawings, Appendix III.

1.03. Description of project. - This project provides for a series of earth levees to protect the city of Yakima, Washington and adjacent suburban areas, from floods, together with the necessary collateral works. Approximately 25,000 feet of levee has been constructed along the right bank, extending from the Northern Pacific Railway main line bridge downstream to the Moxee Highway bridge, and on the left bank approximately 9,300 feet from the Terrace Heights bridge downstream to the same point. In addition to the left bank levee, a low levee, 1,400 feet in length, was constructed along the embankment of the Northern Pacific Railway Moxee branch line. Collateral works are built on the right bank of the Naches River, consisting of stop-plank structures at the Hubbard Canal, in the Pacific Power and Light Company Canal, and in the underpass in the Northern Pacific Railway main line embankment. A headworks structure approximately 1,800 feet downstream from the U. S. Highway 97 bridge, erected as a part of the project, regulates the flow in the Cascade Lumber Company Canal. Not included in the project, but considered to be subsidiary to the project and of value in preventing floods in the vicinity of Yakima, are levees along the left bank of the Yakima River constructed by the Bureau of Reclamation for protection of the Rosa irrigation canal Wasteway No. 2, and a levee constructed by local interests along the right bank of Cowiche Creek, upstream from Highway U. S. No. 410.

1.04. Protection provided. - The project provides protection from Yakima and Naches River floods equivalent to the flood which occurred along these streams in 1933.

1.05. Construction history. - Construction was initiated 15 July 1947, by contract with J. A. Terteling and Sons, Inc. (Contract No. W45-108-eng-1784, dated 23 April 1947), and reported complete as of 26 March 1948. However, unusual flood conditions during the next three months, which resulted in considerable berm erosion and loss of levee in several sections, necessitated emergency repair work in the form of additional riprap placement and other protective work. These operations were completed 23 June 1948. Additional maintenance was later performed under the authority of Public Laws 138 and 318, Seventy-eighth Congress; Public Law 75, Seventy-ninth Congress, and Public Law 102 Eightieth Congress, by J. A. Terteling and Sons, Inc. (Contract No. W-45-108-eng-2073) during the period September 1948 to March 1949. Surveys and engineering studies indicated that sediment deposits and channel changes caused by the 1948 Spring flood would result in raised flood stage profiles and that a corresponding raising of the levees, along the Yakima River was necessary. This work was accomplished under the authority of Section 208 of the 1948 Flood Control Act by J. A. Terteling and Sons Inc. (Contract No. W-45-108-eng-2343) during the period June to December 1949.

SECTION II. - LOCAL COOPERATION REQUIREMENTS

2.01. Applicable portions of flood control acts. - Requirements of the Federal Government for local cooperation applicable to the completed flood control project at Yakima, Washington, are embodied in Section 3 of the Flood Control Act approved 22 June 1936 (Public No. 738), which requirements are made applicable to the Yakima River Flood Control Project by Section 2 of the Flood Control Act approved 28 June 1938 (Public No. 761). The applicable portion of the above-cited Section 3 is as follows:

"Sec. 3. That hereafter no money appropriated under authority of this Act shall be expended on the construction of any project until States, political subdivisions thereof, or other responsible local agencies have given assurances satisfactory to the Secretary of War that they will (a) provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project, except as otherwise provided herein; (b) hold and save the United States free from damages due to the construction works; (c) maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of War: * * *"

2.02. Project document. - Reference is made to House Document No. 579, Seventy-fifth Congress, third session, which contains the recommendations of the Chief of Engineers, and is referred to in the law authorizing the construction of the project, as quoted in part in paragraph 1.01 herein. These recommendations are stated on page 3 of the document in copy of letter dated 23 March 1938, from the Chief of Engineers to the Secretary of War, subject, "Partial Report on Yakima River and its Tributaries, Washington," in which construction of the project is recommended provided responsible local agencies give assurances satisfactory to the Secretary of War that they will maintain and operate all the works after completion in accordance with the regulations prescribed by the Secretary of War.

2.03. Assurances provided by local interests. - Yakima County has given assurances of local cooperation as required by items (a), (b), and (c) of Section 3 of the 1936 Flood Control Act, by resolution dated 21 February 1946, and has presented the necessary documentary evidence of its legal and financial ability to do so. The foregoing assurances were approved by the Secretary of War, 28 March 1946. Following is a copy of the resolution:

BOARD OF COUNTY COMMISSIONERS

IN THE MATTER OF FLOOD CONTROL)
IN YAKIMA COUNTY)
) RESOLUTION TO ASSUME OBLIGATIONS
REQUIRED BY UNITED STATES FOR
CONSTRUCTION OF FLOOD CONTROL WORKS

WHEREAS, the United States Government has by act of Congress appropriated funds for flood control work in Yakima County subject to the following requirements of the law adopting the project - "That hereafter no money appropriated under authority of this Act shall be expended on the construction of any project until States, political subdivisions thereof, or other responsible local agencies have given assurance satisfactory to the Secretary of War that they will (a) provide without cost to the United States all lands, easements, and rights-of-way necessary for the construction of the project, except as otherwise provided herein; (b) hold and save the United States free from damages due to the construction works; (c) maintain and operate all the works after completion in accordance with regulations prescribed by the Secretary of War"

AND WHEREAS, it is the judgment of the Board of County Commissioners that it is to the advantage of Yakima County that said flood control works should be constructed and that Yakima County will be able to comply with the conditions required by the United States.

AND WHEREAS, Yakima County is a duly organized county of the State of Washington.

AND WHEREAS, the Laws of the State of Washington according to Remington's Revised Statutes Section 4057-1, 4057-2, and 4057-3 empower Counties of the State of Washington to perform the acts and assume the obligations required by the act.

THEREFORE IT IS HEREBY RESOLVED by the Board of County Commissioners of Yakima County that Yakima County is willing to assume the obligations involved for cooperation with the United States in the construction of said flood control work.

DONE this 21st day of February 1946.

/s/ Len Evans
Chairman

/s/ Fred G. Redman
Commissioner

ATTEST

/s/ Andy B. Wallace
Commissioner

Harold Purdin
County Auditor and Ex-officio
Clerk of the Board

Constituting the Board of County
Commissioners of Yakima County,
Washington

By /s/ Maude Fisher
Deputy Auditor and Deputy Clerk

2.04. As the sponsoring agency, Yakima County is responsible for the operation and maintenance of this project, and the county authorities must comply with the regulations prescribed by the Secretary of War to the end that the flood protection works will provide the maximum benefits to be derived from the project. The interest of the United States is confined to seeing that the obligations assumed by local authorities are carried out.

SECTION III. - GENERAL PROCEDURES

3.01. Approved regulations. - Regulations for operation and maintenance of local flood control projects which have been approved by the Secretary of War in accordance with authority contained in Section 3 of the Flood Control Act of 22 June 1936, Public Law No. 738, Seventy-fourth Congress, as amended and supplemented, were entered in the Federal Register as FR Doc. 44-12285, on 16 August 1944 and published 17 August 1944. These War Department Regulations are hereinafter referred to as the "Regulations," a copy of which is bound in this volume as Appendix I. The sections of the "Regulations" applicable to the Yakima project are as follows:

- (a) General.
- (b) Levees.
- (d) Drainage structures.
- (e) Closure structures.
- (g) Channels and floodways.

3.02. Purpose of manual. - The purpose of this manual is to present detailed information to be used as a guide in complying with the Regulations. In executing assurances of local cooperation, Yakima County has agreed to maintain and operate the completed works in accordance with those regulations. The Regulations are intended to cover all local protection projects constructed by the Corps of Engineers throughout the United States. They are general in nature, and obviously cannot give detailed instructions for the maintenance and operation of a specific project. The details set forth in this manual for maintenance and operation of the project are intended to supplement the Regulations to permit obtaining all the benefits and protection against floods for which the project was designed. Failure to maintain and operate the project, as required by the Regulations and as detailed herein, can cause severe property damage and loss of life and can result in irreparable loss of confidence in the flood protection system by citizens who have invested their funds on the basis of the protection it provides.

3.03. Description of terms. - In Appendix I and all quotations therefrom in this manual, the words "Secretary of War" shall mean "Secretary of the Army" and the words "War Department" shall mean "Department of the Army", in accordance with Section 205 of the National Security Act of 1947, approved July 26, 1947, Public Law No. 253, Eightieth Congress.

3.04. General rules and procedures. - The general rules for maintenance and operation of local flood control works are stated in subparagraph 208.10(a) of the Regulations, as follows:

"(1) The structures and facilities constructed by the United States for local flood protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits.

"(2) The State, Political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood-control works in accordance with regulations prescribed by the Secretary of War, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the 'Superintendent', who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all of the structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States.

"(3) A reserve supply of materials needed during a flood emergency shall be kept on hand at all times.

"(4) No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the rights-of-way for the protective facilities.

"(5) No improvement shall be passed over, under, or through the walls, levees, improved channels or floodways, nor shall any excavation or construction be permitted within the limits of the project right-of-way, nor shall any change be made in any feature of the works without prior determination by the District Engineer of the War Department or his authorized representative that such improvement, excavation, construction, or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations as may be found to be desirable and permissible under the above determination shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable under standard engineering practice shall be obtained from the District Engineer or, if otherwise obtained, shall be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished the District Engineer after completion of the work.

"(6) It shall be the duty of the superintendent to submit a semianual report to the District Engineer covering inspection, maintenance, and operation of the protective works.

"(7) The District Engineer or his authorized representatives shall have access at all times to all portions of the protective works.

"(8) Maintenance measures or repairs which the District Engineer deems necessary shall be promptly taken or made.

"(9) Appropriate measures shall be taken by local authorities to insure that the activities of all local organizations operating

public or private facilities connected with the protective works are coordinated with those of the superintendent's organization during flood periods.

"(10) The War Department will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in carrying out their obligations under these regulations."

3.05. Most of the general duties outlined above are self-explanatory and need no further discussion. There are, however, certain features in connection with items (2), (4), (5), and (6) that require further clarification, as covered by the following paragraphs.

3.06. Duties of Superintendent. - In compliance with subparagraph 208.10(a)(2) of the Regulations quoted above, Yakima County shall appoint a permanent committee consisting of or headed by an official hereinafter designated as the Superintendent, to have charge of the operation and maintenance of the project. Details of the Superintendent's duties will be developed in other portions of the manual. The general duties shall include the training of key personnel in such a manner that all contingencies may be handled in the most expeditious manner. The Superintendent should have addresses and telephone numbers of all of his key men and a reasonable number of substitutes therefor. These key men should, in turn, have similar data on all of the men that will be necessary for assistance in the discharge of their duties. The District Engineer, Seattle, Washington, shall be kept advised of the names of the Superintendent and his committeemen at all times. The key men should include the following:

a. An assistant to act in the Superintendent's place in cases of his absence or indisposition.

b. Sector Foremen in sufficient number to lead maintenance and patrol of all the levees during flood fighting operations.

The Superintendent should ascertain that all of his key men have read the portions of the operation and maintenance manual pertaining to their duties.

3.07. Trespass on rights-of-way. - Attention is directed to the provisions of subparagraphs 208.10 (a)(4) and (5) of the Regulations, cited above, relative to encroachment, trespass, alterations or improvements affecting the flood protection works. It shall be the duty of the Superintendent to prohibit such trespass or encroachment. Before any improvements or alterations to the levee or appurtenant structures are made, drawings or prints of proposed changes should be submitted to the District Engineer, Corps of Engineers, Department of the Army, Seattle, Washington, sufficiently in advance of the proposed construction to permit adequate study and consideration of the work. Drawings or prints, in duplicate, showing any improvements or alterations as finally constructed should be furnished the District Engineer after the work.

3.08. Semiannual report. - The semiannual report required by subparagraph 208.10(a)(6) of the Regulations and covering inspection, maintenance and operation of the protective works should include all logs of operations and dated copies of inspection check lists made during the period of the report. An outline of the semi-annual report of the Superintendent to the District Engineer is shown in Appendix II. The nature, date of construction, and date of removal of all temporary repairs, should also be included in this report. Other items and suggestions relative to public cooperation with the maintenance and operation of the levee, public sentiment on the project, and other allied subjects, are considered pertinent and desirable data for inclusion in the report, but are not required.

3.09. Periodic inspections. - Periodic inspections as required by the Regulations and as detailed in this manual for each respective feature of the protective works should be made by the Superintendent at the following times:

- a. Immediately prior to the beginning of the major flood season.
- b. Immediately following each major high-water period.
- c. Otherwise at periods not exceeding 90 days.
- d. Intermediate times as necessary.

3.10. Check lists. - The Superintendent shall prepare check lists covering all features of the project for use on each inspection to insure that no feature of the protective system is overlooked. Items requiring maintenance should be noted thereon. If items are satisfactory, they may be so indicated by check.

3.11. Sequence of Operations. - Floods may be expected at any time during the months of November through June. During these months, the Superintendent shall conduct such inspections of personnel, equipment and materials, and hold such practice drills as are necessary to insure immediate and efficient flood fighting operations, outlined in Sections IV and V. Periods of low flow during these months should be utilized to inspect the levees for possible flood damage and accomplish necessary repairs. The summer and early fall months should be utilized to the fullest extent possible for the maintenance of all parts of the protective works.

SECTION IV - PROJECT FEATURES

4.01. Project Plans. - Locations and details of the works described or referred to in this section are shown in Appendixes III, IV and V. Appendix III was prepared especially for use in this manual and contains information consolidated from the following construction plans which have been furnished the Yakima County Engineer's Office for reference:

a. "Yakima, Yakima River, Wash., Protective Works," file No. D-8-4-28 in 14 sheets, revised as constructed, 28 May 1948.

b. "Yakima River at Yakima, Wash., Restoration of Flood Control Work," file No. D-8-4-95 in 5 sheets, revised as-built September 1949.

c. "Yakima River at Yakima, Wash., Levee and Channel Improvement," file No. D-8-4-116 in 6 sheets, revised as built 26 May 1950.

Appendix V contains the applicable construction drawings prepared by the Bureau of Reclamation for the construction of Wasteway No. 2 of the Rosa Irrigation Project.

LEVEES

4.02. Description. - Right Bank Levees. - The first (upstream) unit of the right bank levee system extends 1,593 feet along the right bank of the Naches River joining the Northern Pacific Railway embankment at the upstream end and the U. S. No. 97 Highway embankment at the downstream end. The second unit extends approximately 6,200 feet from the U. S. No. 97 Highway embankment downstream along the right bank of the Naches and Yakima Rivers and ends near a low, swampy area in the vicinity of the Cascade Lumber Company. The upstream end of the third unit lies approximately 700 feet landward of the downstream end of the second unit and includes a 900-foot length of retaining levee along the Cascade Lumber Company log pond. The third unit extends a total length of about 8,600 feet along the right bank of the Yakima River to the Terrace Heights highway bridge abutment, including approximately 3,800 feet of levee constructed under the W.P.A. Program which has been raised to project height. The fourth unit, including about 300 feet of W.P.A. levee, extends approximately 8,500 feet downstream from the Terrace Heights highway bridge abutment to the Moxee Highway bridge abutment, the downstream end of the project.

4.03. Left Bank Levees. - The first (upstream) unit of the left bank system is a levee constructed by the Bureau of Reclamation for protection of Wasteway No. 2 of the Rosa Irrigation Project. This levee extends from high ground at the upstream end approximately 2,700 feet along the left bank of the Yakima River to the Northern Pacific Railway Moxee Branch line bridge abutment at the downstream end. The second unit extends to the left or eastward from the downstream end of the first unit to the upstream end of the Wasteway No. 2 right bank levee. It incorporates approximately 700 lineal feet of railway

embankment and 1,400 lineal feet of levee constructed parallel to the Northern Pacific Railway Moxee Branch line. The Wasteway No. 2 levees form the principal portion of the third unit. They extend approximately 3,400 feet to the left bank of the Yakima River. A low levee of unknown origin, approximately 250 feet in length, connects the Wasteway No. 2 left bank levee and the Terrace Heights Bridge abutment, thus completing the third unit. The fourth unit extends about 9,300 feet along the left bank of the Yakima River from the Terrace Heights highway bridge approach to the Moxee Highway Bridge approach, the downstream end of the project.

4.04. Cowiche Creek Levee. - In addition to the main levee system described in the preceding paragraphs, a privately-owned levee prevents Cowiche Creek flood waters from flowing into the City of Yakima. This levee is approximately 4 feet high and extends from the right (southwest) abutment of the U. S. Highway No. 410 bridge over Cowiche Creek in a southerly direction approximately 400 feet to high ground.

4.05. The levee construction is not uniform because of W.P.A. levees and other flood protective works which were incorporated in the projects. Also, extensive repairs and improvements, accomplished after the 1948 flood, resulted in extensive changes in the original project and further variations in construction. Generally, the levee section is an earth embankment having a crown width of 12 feet and side slopes of 1 (vertical) on 2 to 3 (horizontal). Portions of the levee subject to erosion by river currents have been protected with rock riprap along the riverward face.

4.06. Operation. - Paragraph b(2) of the Regulations governing operation of the levees is quoted below:

"(2) Operation. During flood periods the levee shall be patrolled continuously to locate possible sand boils or unusual wetness of the landward slope and to be certain that:

- (i) There are no indications of slides or sloughs developing;
- (ii) Wave wash or scouring action is not occurring;
- (iii) No low reaches of levee exist which may be overtopped;
- (iv) No other conditions exist which might endanger the structure.

Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section."

The Superintendent shall be responsible for patrol of the levee during the flood period and removal of any drift lodged against it. Special attention

shall be given to the removal of drift in the vicinity of bridge piers and headworks of the Cascade Lumber Co. Canal and the left bank irrigation canal, located about 1/2 mile upstream from the Moxee Highway.

4.07. Emergency repairs. - Emergency levee repairs as described in the following paragraphs, may be required during high river stages. These repairs are independent of those that may be required as the result of the routine inspection referred to in paragraph a(2) of the Regulations quoted in paragraph 3.04 of this manual.

4.08. Scour. - With the high stream velocities prevailing along the Naches and Yakima Rivers within the project limits, the greatest threat of levee failure and consequent flood damage is from bank erosion or scour. Close observation should be given the river side of the levee along all reaches where the current is more than 2 feet per second and no special protection has been provided. If any sign of scour is observed at any point, soundings should be taken, if possible, to determine the extent and progress of the scour. Undermining of the toe of a levee will be indicated by sloughing cracks and must usually be taken care of immediately if a failure is to be avoided. If velocities are not too great, effective use can be made of brush, trees, fencing, etc., to divert the force of the current from the bank. Where scour has advanced to a dangerous stage and velocities are high, the use of dumped rock groins or complete coverage of the bank with rock may be the only means of preventing failure. In general, under flood-fighting conditions, groins will take more rock than a continuous blanket of dumped riprap. Care must be exercised in the use of deflection groins or dikes to avoid the causing of dangerous scour at other points. To be effective, the rock must be of adequate size to be stable against the velocities obtaining. The following tabulation gives the size of loose rock required to withstand various velocities:

<u>Velocity in feet per second</u>	<u>Weight of rock in pounds</u>
7	20
8	45
9	85
10	160
11	280
12	480
13	750
14	1,200
15	1,800
16	2,700
17	4,000

It is not necessary that all rock dumped exceed the above weights, but there must be sufficient large rock to give a stable anchorage for the smaller rock that can fill in the voids.

4.09. Seepage. - Because of the coarse nature of the material used in many sections of the levees, damage resulting from seepage will probably not

be a major problem during flood periods. However, some sections of the levees may have been constructed using silty soils which will erode easily. Any seepage which moves material from the levee or levee foundation will endanger the structure and require immediate control measures. Drainage of seepage water should be done by means of small ditches cut in the levee slope. Crews should be organized to cut seep drains at all places on the levee when seepage occurs. The drains should be V-shaped, no deeper than necessary, and never more than 6 inches deep. Care must be taken to avoid the unnecessary cutting of the sod. In all instances, drains should be cut straight down the levee slope or nearly so. Near the toe of the slope, the small drains should be Y'd together and lead into larger drains which should lead into any existing roadside ditches or sumps.

4.10. Sloughs. - There always exists a possibility that prolonged high stages of the river may so saturate certain sections of the levee as to cause sloughing to occur on the landward slopes. Should such a condition develop, all soft areas should be thoroughly drained as described in paragraph 4.09 above, after which a single layer of willow brush, small trees, or limbs should be placed up and down the slope, laying the butts up and the tops down and weighted with sacks, as shown on Sketch No. 1. If the slope begins to slough downward, a buttress of sacks should be built starting on the levee toe and extending up the slope. Sacks should not be placed more than two-thirds of the way up from the toe of the slope to the fault of the slough. If bulldozing equipment is available, and especially if extensive areas are involved requiring speedy action, the method shown on Sketch No. 2 should be used.

4.11. Sandboils. - These danger spots are serious if sand and other material is carried in suspension by the discharging water and especially so if they are located within a distance of 100 feet from the landward toe of the levee. Sketch No. 3 of Appendix VII is a graphic illustration of the common method of handling sandboils by walling up a watertight sack ring around the boil until the water within the ring has attained sufficient head to stop the movement of the material. If a single boil is noted that indicates the displacement of excessive material, a small sack ring should be built around it, taking care to make the ring sufficiently large to avoid the defective area immediately surrounding the boil. If several boils with sufficient force to discharge material are observed at points where sub-levees have not been provided, and if any considerable number of them are within 100 feet of the toe of the levee, a sack or earth sub-levee should be built around the entire nest of boils to such a height that none of the boils will discharge with enough force to carry material. If, at any time, sandboils either inside or outside of protection levees discharge with increasing force, indicating that considerable material is being displaced, preparation must be made to raise the counter-water level. The counter-water level is the water level in the pool between the main levee and the sub-levee. To raise the counter-water level the sub-levee spillway may have to be raised. To expedite filling of the pool to the required level, it may also be necessary to use siphons or other means of discharging across the main levee. If sand and gravel is plentifully available, it can be dumped directly onto boils to provide a weighted filler without the use of sandbags.

4.12. Heavy sod behind levees has been responsible in some cases for the concentration of hydrostatic pressure and the causing of sandboils. Where this condition exists, the sod should be perforated over a wide area to allow gradual relief of pressure. A crowbar may be used to make holes about 2 inches in diameter and spaced at 2 feet more or less on centers as required. Care should be taken not to destroy the strength of the sod root system for holding the soil in place.

4.13. Topping. - During flood periods, immediate consideration should be given the grade line of each levee by comparison of existing grades with the profiles on Plate 2 of Appendix III, or Plates 1 and 4 of Appendix V. If any reaches of the levees are substantially below the design grade, they should be raised to conform to the design grade. Shifting channels and the formation of bars may raise the flood profile in some sections so that levee grades must be raised to maintain protection. For this reason, the levee free-board must be watched at all points and not taken for granted on the basis of a single observation. The topping may be done by using sacked earth, as shown on Sketch No. 9 or other methods shown on Sketches 10, 11 and 12 of Appendix VII. The sacks should be laid stretcher-wise or along the levee for the first layer, cross wise for the second layer, and so on. Sacks should be lapped at least one-third either way and well mauled into place. When properly sacked and tamped, one sack will give about 3 to 4 inches of topping.

4.14. Traffic on levees. - Heavy equipment must not be operated on levees during high water except in emergency. Continued operation of loaded hauling equipment results in accelerated saturation and over-stressing of the embankment. All vehicular traffic over levees should be restricted to that which is absolutely essential.

4.15. Maintenance. - Applicable portions of Section (b)(1) of the Regulations are quoted below, followed by pertinent comments.

"(1) Maintenance. The Superintendent shall provide at all times such maintenance as may be required to insure serviceability of the structures in time of flood. Measures shall be taken to promote the growth of sod, exterminate burrowing animals, and to provide for routine mowing of the grass and weeds, removal of wild growth and drift deposits, and repair of damage caused by erosion or other forces. Where practicable, measures shall be taken to retard bank erosion by planting of willows or other suitable growth on areas riverward of the levees. Periodic inspections shall be made by the Superintendent to insure that the above maintenance measures are being effectively carried out and, further, to be certain that:

"(i) No unusual settlement, sloughing, or material loss of grade or levee cross section has taken place;

- "(ii) No caving has occurred on either the land side or the river side of the levee which might affect the stability of the levee section;
- "(iii) No seepage, saturated areas, or sand boils are occurring;
- "(v) Drains through the levees and gates on said drains are in good working condition;
- "(vi) No revetment work or riprap has been displaced, washed out, or removed;
- "(vii) No action is being taken, such as burning grass and weeds during inappropriate seasons, which will retard or destroy the growth of sod;
- "(viii) Access roads to and on the levee are being properly maintained;
- "(ix) Cattle guards and gates are in good condition;
- "(x) Crown of levee is shaped so as to drain readily, and roadway thereon, if any, is well shaped and maintained;
- "(xi) There is no unauthorized grazing or vehicular traffic on the levees;
- "(xii) Encroachments are not being made on the levee right-of-way which might endanger the structure or hinder its proper and efficient functioning during times of emergency.

"Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days, and such intermediate times as may be necessary to insure the best possible care of the levee. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accomplished during the appropriate season as scheduled by the Superintendent."

4.16. For compliance with paragraph (1), the need for thorough inspection after each flood is important. Particular attention should be given to evidence of damage to rock riprap and to unusual settlement, sloughing, caving, seepage, saturated areas or sand boils in the vicinity of canal headworks and culverts, and bridge piers. Attention should also be given to evidence of sloughing or erosion damage to the landside levee toe along that portion of the Cascade Lumber Co. canal, which lies adjacent to the levee. Repairs should be made as soon as possible to prevent enlargement of damaged areas and possible destruction of the levee during the next high river stage. As grasses and small willows provide protection to levee slopes, their growth should be encouraged along portions of the embankment not otherwise protected by rock riprap. However, when trunks of willows become larger than 2 inches, they should be cut off above the ground, leaving the stumps to form new sprouts. The growth of other types of brush and trees should be prevented as they will inhibit the formation of a

good sod and their shallow root growth will provide little protection to the embankment. Large trees on or adjacent to the levee should be removed as their collapse will form large holes, which will leave riverward slopes vulnerable to erosion, and seepage channels through the levee will form along their roots. The growth of trees and brush along ripraped portions of the levee face should be prevented, as it could result in the displacement of rock riprap, impediment of inspection and access to the levee face, and impairment of the flow characteristics of the channel.

4.17. In order to carry out the requirements of paragraph (i), the Superintendent shall have a survey made each year of the top of the levee to determine if settlement has occurred. Any levee which is sufficiently below grade to be unsafe during a high flood shall be raised to the required height as shown on Plate 2, Appendix III, and Plates 1 and 4, Appendix V. The bench mark on which surveys for the Corps of Engineers project were based is in the center of the west end of the stone pier of the Northern Pacific Railroad Bridge at the upstream end of the right bank levee system. The bench mark consists of a copper plug stamped "1090T" (elevation 1090.493 feet, Mean Sea Level).

4.18. Inspection as directed in paragraph (xii) shall cover any changes made by the county or others such as breaching of the embankment for installation of culverts or pipes, or the removal or rearrangement of canal headworks. (Regulations regarding such changes are covered in paragraph 3.04.) Attention should be given to roads adjacent to the levee to insure that no cutting or encroachment on the levee toe is permitted in the maintenance of such roads. Water pipes on top of the levee or levee slopes, or hydrants of any sort, are sources of great potential danger and should therefore be prohibited. The availability of an unobstructed roadway along the levee is of primary importance for flood fighting and emergency repairs during high river stages. The construction of permanent obstructions other than gates across the levee should be prohibited, as the roadway along the top of the levee is the only means of access to the major portion of the project. If the construction of a minimum number of gates is permitted for the protection of private property along the levee, keys to all locked gates shall be obtained by the Superintendent. Each key shall be tagged, to identify the corresponding gate, and deposited in such a place that it may be available at any time.

DRAINAGE AND IRRIGATION STRUCTURES

4.19. Description. - The location and description of drainage and irrigation structures included in the project are contained in the following tabulation.

<u>Location</u>	<u>Description</u>	<u>Appendix</u>	<u>Plate</u>
<u>RIGHT BANK</u>			
Culvert #1 Station 184/06.5, about 500' downstream from U.S. Highway 97.	1 - 24" dia., 14-gage, galvanized, corrugated metal pipe with circular automatic drainage gate.	III	1,2 & 4

<u>Location</u>	<u>Description</u>	<u>Appendix</u>	<u>Plate</u>
RIGHT BANK			
Cascade Lumber Co. Canal headworks, Sta. 196 ⁴⁷ .8, about 1800' downstream from U.S. Highway 97.	2 - 36"x48" reinf. conc. culverts with rectangular hand-operated slide gates. A forebay formed by rock riprap protected gravel bar approx. 700' long directs water into headworks.	III	1,2 & 5
Culvert No. 7, Sta. 211 ⁷ .94, about 3400' downstream from U.S. Highway 97.	1 - 24" dia. 12-gage galv. corr. metal pipe.	III	1,2 & 3
Cascade Lumber Co. log pond outlet works. Approx. Sta. 245 ⁰⁰ .	Wooden outlet works and Tainter gate with metal chain and worm screw operating mechanism.	(Installed by Cascade Lumber Co. No details aval.)	
Culvert No. 2, Sta. 280 ¹⁷ , about 1650' downstream from NP Ry Moxee Branch Line.	2 - 36" dia. 12 gage, galv. corr. metal pipes w/circular automatic drainage gates.	III	1,2 & 3
Culvert No. 3, Sta. 282 ⁸⁵ , about 1900' downstream from NP Ry Moxee Branch Line.	2 - 36" dia. 12-gage, galv. corr. metal pipes w/circular automatic drainage gates.	III	1,2 & 3
Culvert No. 4, Sta. 376 ^{30.2} , about 3100' upstream from Moxee Highway.	1 - 36" dia. 12-gage, galv., corr. metal pipe w/circular automatic drainage gate.	III	1,2 & 3
Unnumbered culvert, Sta. 398 ⁰⁶ , about 950' upstream from Moxee Highway.	1 - 6" dia. galv. spiral, 18-gage corr. metal pipe.	III	1 & 2
Culvert No. 6, Sta. 401 ⁵⁸ , about 580' upstream from Moxee Highway.	1 - 36" dia. 12-gage, galv., corr. metal pipe w/circular automatic drainage gate.	III	1,2 & 7
Culvert No. 5, Sta. 406 ^{61.1} , about 80' upstream from Moxee Highway.	1 - 36" dia. 12-gage, galv., corr. metal pipe w/circular automatic drainage gate.	III	1,2 & 3
LEFT BANK			
Moxee Co. irrigation canal culvert at the upstream end of the Bureau of Reclamation protection dike for Wasteway No. 2.	1 - 48"x72" reinf. conc. culvert w/two 36"x48" hand-operated screw lift gates. Installed by Bureau of Reclamation.	III	1 1 & 2

<u>Location</u>	<u>Description</u>	<u>Appendix</u>	<u>Plate</u>
<u>LEFT BANK</u>			
Union Gap irrigation canal culvert approx. 800' from the upstream end of Bureau of Reclamation protection dike for Wasteway No. 2	1 - 36"x48" reinf. conc. culvert with 36"x48" slide gate w/hand-operated geared hoist. Installed by Bureau of Reclamation.	III V	1 1 & 3
Unnumbered culvert thru the embankment of NP Ry Moxee Branch Line about 350' east of trestle.	1 - 36" dia. reinf. conc. culvert installed by NP Ry Co. w/automatic circular gate installed by Corps of Engineers	III	1 & 3
Culvert for Richartz Ditch Crossing through Bureau of Reclamation wasteway dikes approx. 400' downstream from NP Ry.	1 - 36" conc. culvert extends under dike and 1 - 36" dia. steel pipe crosses wasteway. Headworks fitted with 36"x36" hand-operated screw lift gate. Installed by Bureau of Reclamation.	III V	1 4 & 6
Culvert approx. 200' upstream from Terrace Heights Bridge. Invert about 9 $\frac{1}{2}$ ' below levee crown at river end.	1 - 10" dia. steel sewer pipe.	Surveyed location not available.	
Two culverts approx. 100' upstream from Terrace Heights Bridge. Inverts about 9' below levee crown at river end.	1 - 12" dia. steel sewer pipe. 1 - 12" dia. conc. T&G pipe.	Surveyed location not available.	
Culvert at upstream edge of Terrace Heights Bridge. Invert about 4' below levee crown at land end.	1 - 12" dia. corr. metal pipe on river end, 12" dia. conc. T&G on land end.	Surveyed location not available.	
Unnumbered culvert Sta. 6 $\frac{1}{2}$ 51, about 685' downstream from Terrace Heights highway.	1 - 8" dia. conc. T&G drainage culvert. (Buried at each end and could not be located by Yakima County Engineer, Sept., 1954.)	III	1 & 2
Unnumbered culvert Sta. 15 $\frac{1}{2}$ 40, about 1575' downstream from Terrace Heights highway.	1 - 24" dia. conc. T&G waste culvert.	III	1 & 2
Unnumbered culvert, Sta. 26 $\frac{1}{2}$ 69, about 2700' downstream from Terrace Heights highway.	1 - 6" dia. conc. T&G drainage culvert.	III	1 & 2
Unnumbered culvert, Sta. 35 $\frac{1}{2}$ 01, about 3535' downstream from Terrace Heights highway.	1 - 12" dia. corr. metal drainage culvert with circular automatic gate.	III	1 & 2

<u>Location</u>	<u>Description</u>	<u>Appendix</u>	<u>Plate</u>
<u>LEFT BANK</u>			
Unnumbered culvert, Sta. 43 7 /26 about 4360' downstream from Terrace Heights highway.	1 - 18" dia. 14-gage galv., corr. metal pipe with circular automatic gate.	III	1 & 2
Unnumbered culvert, Sta. 50 7 /68, about 5100' downstream from Terrace Heights highway.	1 - 18" dia. corr. metal pipe w/circular automatic gate.	III	1 & 2
Irrigation canal headworks, Sta. 71 7 /30, about 7200' downstream from Terrace Heights highway.	1 - 36" dia. 12-gage, galv., corr. metal pipe with hand-operated circular slide gate.	III	1, 2 & 7

4.20. In addition to the above listed structures, culverts installed in the left bank levees at Stations 25~~7~~/74 and 29~~7~~/96.5 were plugged in 1949.

4.21. Operation. - Attention is directed to Para. (d)(2) of the Regulations for operation of drainage structures quoted below:

"(d)(2) Operation. Whenever high water conditions impend, all gates will be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gate shall be removed. Automatic gates shall be closely observed until it has been ascertained that they are securely closed. Manually operated gates and valves shall be closed as necessary to prevent inflow of flood water. All drainage structures in levees shall be inspected frequently during floods to ascertain whether seepage is taking place along the lines of their contact with the embankment. Immediate steps shall be taken to correct any adverse condition."

In compliance with the first part of the above quoted paragraph, the Superintendent shall, during the flood season, arrange for the inspection of all drainage and irrigation structures immediately following each heavy rain or freshet for the purpose of removing any debris which may have lodged in or adjacent to the structure to insure the proper operation of the closure device, in the event of a severe flood. It is of primary importance that these inspections are performed at low river stages because the riverward ends of most of the structures will be covered during relatively small flows corresponding to readings of 3 to 8 feet on the Corps of Engineers gage. (See paragraph 4.29). As the water surface rises, it will become increasingly difficult to remove any lodged material from the gates. Seepage could occur along the plugged culverts, described in paragraph 4.20. These should also be inspected for seepage. During flood periods, special attention should be given to the following culverts which are ungated: Right bank culverts No. 7 and at Sta. 398~~7~~/06 and left bank culverts at Stations 6~~7~~/51, 15~~7~~/40 and 26~~7~~/69. The Superintendent should be prepared to take immediate preventive measures if back flow through these culverts becomes excessive.

4.22. Maintenance. - Drainage and irrigation structures shall be maintained as directed in paragraph (d)(1), of the Regulations quoted below:

"(d)(1) Maintenance. Adequate measures shall be taken to insure that inlet and outlet channels are kept open and that trash, drift, or debris is not allowed to accumulate near drainage structures. Flap gates and manually operated gates and valves on drainage structures shall be examined, oiled, and trial operated at least once every 90 days. Where drainage structures are provided with stop log or other emergency closures, the condition of the equipment and its housing shall be inspected regularly and a trial installation of the emergency closure shall be made at least once each year. Periodic inspections shall be made by the Superintendent to be certain that:

"(i) Pipes, gates, operating mechanism, riprap and headwalls are in good condition;

"(ii) Inlet and outlet channels are open;

"(iii) Care is being exercised to prevent the accumulation of trash and debris near the structures and that no fires are being built near bituminous coated pipes;

"(iv) Erosion is not occurring adjacent to the structure which might endanger its water tightness or stability.

"Immediate steps will be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspections."

The Superintendent shall obtain keys to all locked irrigation culvert gates, have them tagged to identify the corresponding gate, and deposit them in a place where they will be available at all times during flood seasons.

CLOSURE STRUCTURES

4.23. Description. - Hubbard Canal. - A closure structure is provided in the Hubbard Canal at the upstream (north) end of the culvert under U. S. Highway No. 410, approximately 1 2/3 miles northwest of the intersection of Franklin Avenue and U. S. Highway No. 410, and approximately 1/5 mile southwest of the U. S. Highway No. 410 bridge across the Naches River. Steel stop-plank guides have been attached to the concrete culvert wingwalls with expansion bolts. A concrete apron exists in the bottom of the canal between the wingwalls. A storage box for stop planks is located approximately 30 feet from the structure between the highway and the Northern Pacific Railway (Naches Branch) track. Five 6" x 10" x 9' -9 $\frac{1}{2}$ " long stop planks and one specially made top stop plank 14 feet long are provided. Details of this structure are shown on Plate 4, Appendix III, and Plate 1, Appendix VI.

4.24. Pacific Power & Light Company Canal. - A closure structure is provided in the Pacific Power & Light Company Canal midway between the U. S. Highway No. 410 and Northern Pacific Railway (Naches Branch) bridges, approximately one-half mile northwest of the intersection of Franklin Avenue and U. S. Highway No. 410. This structure is of reinforced concrete with short earth levee wings which connect to the highway embankment to prevent outflanking by floodwaters. Hand placed rock riprap at each end of the structure serves to retain the levee fill material. The structure is supported by a reinforced concrete slab at the bottom of the canal, $9\frac{1}{2}$ feet below the walkway. Vertical slots on the upstream (north) face of the structure are provided for the insertion of stop planks. A storage house for the stop planks is located near the west end of the structure between the levee wing and the highway embankment. Twenty-four stop planks are provided, each being 6"x10"x10' -0" long. Details of this opening are shown on Plate 1, Appendix III and Plate 1, Appendix VI.

4.25. Northern Pacific Railway (Main Line) Underpass. - A closure structure is provided at the Northern Pacific Railway (Main Line) underpass approximately one-half mile north of the Yakima City limits, and approximately 500 feet south of the bridge across the Naches River. The structure consists of steel stop plank guides attached to the concrete wingwalls of the underpass structure with expansion bolts. A reinforced concrete cut-off wall 9 inches thick by $2\frac{1}{2}$ feet high has been constructed across the opening at the stop plank guides, approximately $\frac{1}{2}$ foot below the level of the roadway. A storage box for stop planks is located on the railroad embankment near the southwest wingwall of the underpass. Nine stop planks, 8"x10"x14'-11" long are provided. Details of this opening are shown on Plate 4, Appendix III and Plate 2, Appendix VI.

4.26. Union Canal. - The Union Canal will be closed with sandbags at a point immediately upstream (north) of U. S. Highway 410 at North 9th Avenue near the Yakima City limits. No structural modifications of the canal, or storage facilities, have been provided for this closure. The canal at this point is lined with concrete and is approximately $3\frac{1}{2}$ feet deep by $5\frac{1}{2}$ feet wide. The recommended dimensions of this closure are shown on Plate 1, Appendix IV.

4.27. County Highway Crossing, Wasteway No. 2. - The County Road crossing of the right bank dike of Wasteway No. 2, approximately 400 feet downstream from the Northern Pacific Railway Moxee Branch line is below the elevation of anticipated maximum flood heights. Therefore, during times of extreme flood, this opening must be closed with sandbags. Plate 2, Appendix IV illustrates the recommended method of constructing this closure.

4.28. Operation. - Closure structure operation is described in paragraph (e)(2) of the Regulations quoted below:

"(e)(2) Operation. Erection of each movable closure shall be started in sufficient time to permit completion before floodwaters reach the top of the structure sill. Information regarding the proper method

of erecting each individual closure structure, together with an estimate of the time required by an experienced crew to complete its erection will be given in the Operation and Maintenance Manual, which will be furnished local interests upon completion of the project. Closure structures will be inspected frequently during flood periods to ascertain that no undue leakage is occurring and that drains provided to care for ordinary leakage are functioning properly. Boats or floating plant shall not be allowed to tie up to closure structures or to discharge passengers or cargo over them."

4.29. During flood periods the Corps of Engineers gage (see Plate 1, Appendix III) located on the downstream side of the right (south) abutment of the U. S. Highway No. 97 bridge across the Naches River shall be read hourly. Erection of the closure barriers shall be commenced when the river stage reaches the gage heights indicated in the following tabulation and a continued river rise is forecast.

<u>Closure Structure Location</u>	<u>Gage Height*</u> <u>(Start Erection)</u>	<u>Suggested Crew, Equipment and Materials</u>	<u>Special Requirements</u>	<u>Estimated Erection Time (Hrs)</u>
Pacific Power & Light Co. Canal (Stop plank structure)	6.0	4 men 2 carrying bars 2 - $\frac{1}{2}$ " ropes, 50' long 2 long handled shovels	All sediment should be removed from the vicinity of the stop log slots to obtain a firm bearing for the first timber. The stop planks should be lowered into place, using the two ropes.	4
Hubbard Canal (Stop plank structure)	8.5	4 men 2 carrying bars 1 long handled shovel	All sediment should be removed from the vicinity of the stop log slot to obtain a firm bearing for the first timber. The stop planks may be lowered into place and removed, using two iron hooks made of reinforcing steel, and stored with the stop planks.	2
Northern Pacific Railway Underpass (Stop plank structure)	9.0	6 men 3 carrying bars 1 block & tackle 2 picks 2 shovels	The roadway surfacing should be removed until the top of the cut-off wall is completely uncovered to obtain a firm bearing for the first timber. The block & tackle should be attached to the railway bridge and used to lift the stop logs into place.	3

<u>Closure Structure Location</u>	<u>Gage Height*</u> (Start Erection)	<u>Suggested Crew, Equipment and Materials</u>	<u>Special Requirements</u>	<u>Estimated Erection Time (Hrs)</u>
Union Canal (Sandbag closure)	9.0	4 men 2 long handled shovels 200 sand bags	Each bag should be filled half full of soil, and laid over the unfilled portion of the previous sack in the manner indicated on Plate 1, Appendix IV. Bags should be thoroughly tamped in place.	3
County Highway Crossing, Waste-way No. 2 (Sand bag closure)	**	8 men (for maximum protection) 4 long handled shovels Sandbags (see Appendix IV, Plate No. 2)	Each bag should be filled half full of soil, and laid over the unfilled portion of the previous sack in the manner indicated in Plate 2, Appendix IV. Bags should be thoroughly tamped in place.	6

* Zero of gage = Elevation 1,066.62 feet.

** Start erection when water surface is one foot lower than the roadway and still rising.

4.30. Maintenance. - The following instructions governing the maintenance of closure openings are quoted from paragraph (e)(1) of the Regulations:

"(e)(1) Maintenance. Closure structures for traffic openings shall be inspected by the Superintendent every 90 days to be certain that:

- (i) No parts are missing;
- (ii) Metal parts are adequately covered with paint;
- (iii) All movable parts are in satisfactory working order;
- (iv) Proper closure can be made promptly when necessary;
- (v) Sufficient materials are on hand for the erection of sandbag closures and that the location of such materials will be readily accessible in times of emergency.

"Tools and parts shall not be removed for other use. Trial erections of one or more closure structures shall be made once each year, alternating the structures chosen so that each gate will be erected at least once in each 3-year period. Trial erection of all closure structures shall be made whenever a change is made in key

operating personnel. Where railroad operation makes trial erection of a closure structure infeasible, rigorous inspection and drill of operating personnel may be substituted therefor. Trial erection of sandbag closures is not required. Closure materials will be carefully checked prior to and following flood periods, and damaged or missing parts shall be repaired or replaced immediately."

The stop plank storage structures should be regularly inspected, repaired, painted and maintained. Locks should be regularly oiled and at least one set of keys deposited in such a place that it will be available at any time. Storage structures should be kept locked. Soil should be kept clear of and sloped away from foundation timbers and mud sills. Brush and grass should be cleared from the vicinity of the stop plank storage structures at regular intervals to prevent their destruction by fire. The source of supply for bags should be investigated immediately prior to the flood season to insure the availability of a sufficient number of bags on short notice. The source of fill material should also be determined.

CHANNELS AND FLOODWAYS

4.31. Description. - Floodway. - The overflow channel or floodway of the Yakima River consists of the area lying between the right and left bank levee systems, and varies in width, approximately from 500 feet to 3,000 feet. This area includes the normal river channel, islands and wooded or brushy areas. A sparsely populated residential area lying between the left river bank and the Wasteway No. 2 levee downstream from the Northern Pacific Railway Moxee Branch Line is also within the floodway and will be inundated during high flood stages. Overbank clearing was accomplished in the areas indicated on Plate 1, Appendix III, to increase the floodway capacity for the purpose of reducing stream velocities adjacent to the levees, and to remove material which might cause future debris jams at bridges and other restricted points.

4.32. River Channel. - The river channel lies within the floodway described in paragraph 4.31. Its location will normally change gradually from year to year as a result of bank erosion, deposition of sediments, formation of debris jams, etc. During the project construction, a limited amount of channel excavation was accomplished to replace a portion of the river channel which was cut off by the levee. Also, rock riprap has been placed along areas of the river bank lying near or adjacent to the levee.

4.33. Operation. - Paragraph g(2) of the Regulations governing operation of channels and floodways is quoted below:

"(g)(2) Operation. Both banks of the channel shall be patrolled during periods of high water, and measures shall be taken to protect those reaches being attacked by the current or by wave wash. Appropriate measures shall be taken to prevent the formation of jams of ice or debris. Large objects which become lodged against the bank shall be removed. The improved channel or floodway shall be thoroughly inspected immediately

following each major high water period. As soon as practicable thereafter, all snags and other debris shall be removed and all damage to banks, riprap, deflection dikes and walls, drainage outlets, or other flood control structures repaired."

4.34. Maintenance. - Paragraph g(1) of the Regulations, covering maintenance of channels and floodways, is quoted below:

"(g) Channels and floodways - (1) Maintenance. Periodic inspections of improved channels and floodways shall be made by the Superintendent to be certain that:

(i) The channel or floodway is clear of debris, weeds, and wild growth;

(ii) The channel or floodway is not being restricted by the depositing of waste materials, building of unauthorized structures or other encroachments;

(iii) The capacity of the channel or floodway is not being reduced by the formation of shoals;

(iv) Banks are not being damaged by rain or wave wash, and that no sloughing in banks has occurred;

(v) Riprap sections and deflection dikes and walls are in good condition;

(vi) Approach and egress channels adjacent to the improved channel or floodway are sufficiently clear of obstructions and debris to permit proper functioning of the project works.

Such inspections shall be made prior to the beginning of the flood season and otherwise at intervals not to exceed 90 days. Immediate steps will be taken to remedy any adverse conditions disclosed by such inspections. Measures will be taken by the Superintendent to promote the growth of grass on bank slopes and earth deflection dikes. The Superintendent shall provide for periodic repair and cleaning of debris basins, check dams, and related structures as may be necessary."

4.35. Channel Clearing. - Maintenance of the cleared channel area shown on Plate 1, Appendix III is considered to be essential to provide adequate channel capacity for the effective operation of the project during high flood stages. Annual removal of trees, brush and debris jams from this area is necessary to meet the requirements of paragraph (g)(1)(i) of the Regulations.

4.36. Removal of gravel bars. - Because of the high velocities which are attained on the Yakima River, and the accompanying movement of river bed material, the control or maintenance of the position of the river channel is not considered to be feasible. However, protective measures such as the placement of rock riprap

should be taken, where necessary, to prevent undermining the levee toe through bank erosion. Annual observations of flood profiles should also be made to determine any appreciable changes in channel capacity which could result from the movement and formation of gravel bars, particularly during high flood stages. If it is determined that the channel has become seriously restricted, the deposited material shall be removed or the levees shall be raised to compensate for the increased flood profile.

SECTION V

SPECIAL REQUIREMENTS DURING HIGH WATER PERIODS

5.01. General. - This part of the manual is supplementary in nature and presents principles and procedures that are particularly applicable during high water periods with a view to emphasizing the importance of certain procedures covered elsewhere in the manual.

5.02. Earthen Levees. - An earthen levee is in danger whenever there is water against it. This danger is directly proportional to the height of the water, duration of the flood stage, and the intensity of either the current or wave action. The danger is inversely proportional to the width of the levee, and the degree of maintenance. A well-constructed levee of proper section should, if maintained and not overtapped, hold throughout any major flood. However, foundation troubles resulting in sandboils or a sinking levee, local seepage resulting in slides and sloughs, and bank erosion resulting in changing river channels and undermining of the levee may cause a break. Such threatened failures can be prevented if prompt action is taken and proper methods of treatment are used. Wave wash is to be expected whenever the levee is exposed to a wide stretch of open water and is serious if permitted to continue over a considerable length of time.

5.03. Premeditated Damage. The Superintendent should continually guard against premeditated damage to the levee. In the event of an extraordinary flood requiring a fight over large areas, there is a natural tendency to relieve the strain by breaking the levee in an attempt to reduce flooding at other locations.

5.04. Human Element. - Panic does not directly endanger the levee, but psychological fear due to ignorance of actual conditions may seriously affect the high-water fight during a critical moment. This fact should be considered in organization for emergency work. Confidence, engendered by an efficient organization free from local jealousies, is the best guard against panic.

5.05. Flood Warning and Prediction Facilities. - The United States Weather Bureau will prepare and issue flood forecasts for the Yakima River at Yakima, Washington, referenced to the Corps of Engineers gage described in paragraph 4.29. These forecasts may be obtained from the Weather Bureau Office at Yakima during flood seasons.

5.06. Procedures to be Initiated at Certain River Stages. - Instructions for making gage readings and initiating the erection of closure structures are contained in paragraph 4.29. Should a rise in the water surface above a gage reading of 6 feet be indicated, the Superintendent shall alert key personnel, inspect all culverts to ensure that all gates are closed and functioning properly, and arrange for assembly of trucks, cars and other mechanical equipment required for flood fighting and check for mechanical defects. When the gage reading reaches 10.0 feet in elevation, and a continued river rise is forecast, the Superintendent shall take the following steps:

a. Assign personnel at a central station on 24-hour duty to receive telephone and other calls and to dispatch men and equipment.

b. Assign Key personnel (sector foremen) to patrol duty covering the entire levee system including the reach of the Naches River between the stop-plank structure on the Hubbard Canal and the Northern Pacific Railway bridge and the Cowiche Creek levee. As his initial activity, each sector foreman should go over his entire sector and parts of adjacent sectors, making a detailed inspection, particularly with reference to the following matters:

(1) Sector limits; ascertain that the dividing line between sectors is plainly determined and, if necessary, marked.

(2) Condition of new levee and recent repairs.

(3) Condition of culverts, flap gates, slide gates, and closure structures.

(4) Condition of access roads and bridges.

(5) Available transportation facilities.

(6) Material supply, quantity, location, and condition.

(7) Communications; locate and check all necessary telephones in the sector.

5.07. After the initial inspection, each Sector Foreman should recruit a labor gang with the necessary equipment and perform the following work immediately:

a. Fill holes or washes in the levee crown and slopes.

b. Repair gaps where road crossings have been worn down and the levee is below grade. In filling the road crossings it may be necessary to obtain material from landside borrow pits in which case, excavation for the material should be kept at least 50 feet from the levee toe. Any filling done in this connection should be tamped in place, and if in an exposed area subject to wave wash, the new section should be faced with bags of sand.

c. Check all flap gates on culverts and see that they are seated properly. (As stated in paragraph 4.21, many of the culverts will be covered by flows equivalent to a gage reading of 10.0)

d. Ascertain that all slide gates are closed and that installation of closure structures is commenced and completed in accordance with the instructions contained in paragraph 4.29.

e. Ascertain that all roads to and along the levee are in a good state of repair, and that all gates and barriers are unlocked or removed.

f. Locate necessary tools and materials (quarry rock, sandbags, brush, lumber, lights, etc.) and distribute and store them at points where active maintenance is anticipated.

g. Check and obtain the repair of all telephone lines necessary for the operation; obtain lists of all earth-moving equipment, trucks and automobiles that can be made available.

h. Make thorough arrangements with reliable citizens of the community for the supply, transportation, subsistence and shelter for the necessary labor.

i. Communicate directly with owners of all stock pastured on the levee and direct that all stock be removed from the levee right-of-way.

j. Investigate all drainage ditches on the landside of the levee and open these drains when obstructions exist.

k. Remove all dynamite and explosives of any kind from the vicinity of the levee.

5.08. The Flood Emergency Manual. - The Flood Emergency Manual is prepared by the Seattle District, Corps of Engineers, and issued revised once each year to Counties and other affected agencies. Its purpose is to provide information which will assist local authorities in preventive, rescue, relief and protective efforts. The Flood Emergency Manual is general in nature and does not apply specifically to any one project. However, the Superintendent should become familiar with it to insure that full cooperation for an effective flood fight may be obtained from other agencies during an emergency. Applicable portions of its maintenance and emergency repair procedures are covered under paragraphs 4.08 through 4.14 herein.

**TITLE 33—NAVIGATION AND
NAVIGABLE WATERS**

**Chapter II—Corps of Engineers, War
Department**

PART 208—FLOOD CONTROL REGULATIONS

**MAINTENANCE AND OPERATION OF FLOOD
CONTROL WORKS**

Pursuant to the provisions of section 3 of the Act of Congress approved June 22, 1936, as amended and supplemented (49 Stat. 1571; 50 Stat. 877; and 55 Stat. 638; 33 U. S. C. 701c; 701c-1), the following regulations are hereby prescribed to govern the maintenance and operation of flood control works:

§ 208.10 Local flood protection works; maintenance and operation of structures and facilities—(a) General. (1) The structures and facilities constructed by the United States for local flood protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits.

(2) The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of War, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the "Superintendent," who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all of the structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States.

(3) A reserve supply of materials needed during a flood emergency shall be kept on hand at all times.

(4) No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the rights-of-way for the protective facilities.

(5) No improvement shall be passed over, under, or through the walls, levees, improved channels or floodways, nor shall any excavation or construction be permitted within the limits of the project right-of-way, nor shall any change be made in any feature of the works without prior determination by the District Engineer of the War Department or his authorized representative that such improvement, excavation, construction or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations as may be found to be desirable and permissible under the above determination shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable under standard engineering practice shall be obtained from the District Engineer or, if otherwise obtained, shall be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished the District Engineer after completion of the work.

(6) It shall be the duty of the superintendent to submit a semiannual report to the District Engineer covering inspection, maintenance, and operation of the protective works.

(7) The District Engineer or his authorized representatives shall have access at all times to all portions of the protective works.

(8) Maintenance measures or repairs which the District Engineer deems necessary shall be promptly taken or made.

(9) Appropriate measures shall be taken by local authorities to insure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the Superintendent's organization during flood periods.

(10) The War Department will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in carrying out their obligations under these regulations.

(b) **Levees—(1) Maintenance.** The Superintendent shall provide at all times such maintenance as may be required to insure serviceability of the structures in time of flood. Measures shall be taken to promote the growth of sod, exterminate burrowing animals, and to provide for routine mowing of the grass and weeds, removal of wild growth and drift deposits, and repair of damage caused by erosion or other forces. Where practicable, measures shall be taken to retard bank erosion by planting of willows or other suitable growth on areas riverward of the levees. Periodic inspections shall be made by the Superintendent to insure that the above maintenance measures are being effectively carried out and, further, to be certain that:

(i) No unusual settlement, sloughing, or material loss of grade or levee cross section has taken place;

(ii) No caving has occurred on either the land side or the river side of the levee which might affect the stability of the levee section;

(iii) No seepage, saturated areas, or sand boils are occurring;

(iv) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged;

(v) Drains through the levees and gates on said drains are in good working condition;

(vi) No revetment work or riprap has been displaced, washed out, or removed;

(vii) No action is being taken, such as burning grass and weeds during inappropriate seasons, which will retard or destroy the growth of sod;

(viii) Access roads to and on the levee are being properly maintained;

(ix) Cattle guards and gates are in good condition;

(x) Crown of levee is shaped so as to drain readily, and roadway thereon, if any, is well shaped and maintained;

(xi) There is no unauthorized grazing or vehicular traffic on the levees;

(xii) Encroachments are not being made on the levee right-of-way which might endanger the structure or hinder its proper and efficient functioning during times of emergency.

Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days; and such intermediate times as may be necessary to insure the best possible care of

the levee. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accomplished during the appropriate season as scheduled by the Superintendent.

(2) **Operation.** During flood periods the levee shall be patrolled continuously to locate possible sand boils or unusual wetness of the landward slope and to be certain that:

(i) There are no indications of slides or sloughs developing;

(ii) Wave wash or scouring action is not occurring;

(iii) No low reaches of levee exist which may be overtapped;

(iv) No other conditions exist which might endanger the structure.

Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section.

(c) **Flood walls.**—(1) **Maintenance.** Periodic inspections shall be made by the Superintendent to be certain that:

(i) No seepage, saturated areas, or sand boils are occurring;

(ii) No undue settlement has occurred which affects the stability of the wall or its water tightness;

(iii) No trees exist, the roots of which might extend under the wall and offer accelerated seepage paths;

(iv) The concrete has not undergone cracking, chipping, or breaking to an extent which might affect the stability of the wall or its water tightness;

(v) There are no encroachments upon the right-of-way which might endanger the structure or hinder its functioning in time of flood;

(vi) Care is being exercised to prevent accumulation of trash and debris adjacent to walls, and to insure that no fires are being built near them;

(vii) No bank caving conditions exist riverward of the wall which might endanger its stability;

(viii) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged.

Such inspections shall be made immediately prior to the beginning of the flood season, immediately following each major high water period, and otherwise at intervals not exceeding 90 days. Measures to eliminate encroachments and effect repairs found necessary by such inspections shall be undertaken immediately. All repairs shall be accomplished by methods acceptable in standard engineering practice.

(2) **Operation.** Continuous patrol of the wall shall be maintained during flood periods to locate possible leakage at monolithic joints or seepage underneath the wall. Floating plant or boats will not be allowed to lie against or tie up to the wall. Should it become necessary during a flood emergency to pass anchor cables over the wall, adequate measures shall be taken to protect the concrete and construction joints. Immediate steps shall be taken to correct any condition which endangers the stability of the wall.

(d) **Drainage structures.**—(1) **Maintenance.** Adequate measures shall be taken to insure that inlet and outlet channels are kept open and that trash, drift, or debris is not allowed to accumulate near drainage structures. Flap gates and manually operated gates and valves on

drainage structures shall be examined, oiled, and trial operated at least once every 90 days. Where drainage structures are provided with stop log or other emergency closures, the condition of the equipment and its housing shall be inspected regularly and a trial installation of the emergency closure shall be made at least once each year. Periodic inspections shall be made by the Superintendent to be certain that:

(i) Pipes, gates, operating mechanism, riprap, and headwalls are in good condition;

(ii) Inlet and outlet channels are open;

(iii) Care is being exercised to prevent the accumulation of trash and debris near the structures and that no fires are being built near bituminous coated pipes;

(iv) Erosion is not occurring adjacent to the structure which might endanger its water tightness or stability.

Immediate steps will be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspections.

(2) *Operation.* Whenever high water conditions impend, all gates will be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gate shall be removed. Automatic gates shall be closely observed until it has been ascertained that they are securely closed. Manually operated gates and valves shall be closed as necessary to prevent inflow of flood water. All drainage structures in levees shall be inspected frequently during floods to ascertain whether seepage is taking place along the lines of their contact with the embankment. Immediate steps shall be taken to correct any adverse condition.

(e) *Closure structures*—(1) *Maintenance.* Closure structures for traffic openings shall be inspected by the superintendent every 90 days to be certain that:

(i) No parts are missing;

(ii) Metal parts are adequately covered with paint;

(iii) All movable parts are in satisfactory working order;

(iv) Proper closure can be made promptly when necessary;

(v) Sufficient materials are on hand for the erection of sand bag closures and that the location of such materials will be readily accessible in times of emergency.

Tools and parts shall not be removed for other use. Trial erections of one or more closure structures shall be made once each year, alternating the structures chosen so that each gate will be erected at least once in each 3-year period. Trial erection of all closure structures shall be made whenever a change is made in key operating personnel. Where railroad operation makes trial erection of a closure structure infeasible, rigorous inspection and drill of operating personnel may be substituted therefor. Trial erection of sand bag closures is not required. Closure materials will be carefully checked prior to and following flood periods, and damaged or missing parts shall be repaired or replaced immediately.

(2) *Operation.* Erection of each movable closure shall be started in sufficient time to permit completion before flood waters reach the top of the structure sill. Information regarding the proper method of erecting each individual closure structure, together with an estimate of the time required by an experienced crew to complete its erection will be given

in the Operation and Maintenance Manual which will be furnished local interests upon completion of the project. Closure structures will be inspected frequently during flood periods to ascertain that no undue leakage is occurring and that drains provided to care for ordinary leakage are functioning properly. Boats or floating plant shall not be allowed to tie up to closure structures or to discharge passengers or cargo over them.

(f) *Pumping plants*—(1) *Maintenance.* Pumping plants shall be inspected by the Superintendent at intervals not to exceed 30 days during flood seasons and 90 days during off-flood seasons to insure that all equipment is in order for instant use. At regular intervals, proper measures shall be taken to provide for cleaning plant, buildings, and equipment, repainting as necessary, and lubricating all machinery. Adequate supplies of lubricants for all types of machines, fuel for gasoline or diesel powered equipment, and flash lights or lanterns for emergency lighting shall be kept on hand at all times. Telephone service shall be maintained at pumping plants. All equipment, including switch gear, transformers, motors, pumps, valves, and gates shall be trial operated and checked at least once every 90 days. Megger tests of all insulation shall be made whenever wiring has been subjected to undue dampness and otherwise at intervals not to exceed one year. A record shall be kept showing the results of such tests. Wiring disclosed to be in an unsatisfactory condition by such tests shall be brought to a satisfactory condition or shall be promptly replaced. Diesel and gasoline engines shall be started at such intervals and allowed to run for such length of time as may be necessary to insure their serviceability in times of emergency. Only skilled electricians and mechanics shall be employed on tests and reparts. Operating personnel for the plant shall be present during tests. Any equipment removed from the station for repair or replacement shall be returned or replaced as soon as practicable and shall be trial operated after reinstallation. Repairs requiring removal of equipment from the plant shall be made during off-flood seasons insofar as practicable.

(2) *Operation.* Competent operators shall be on duty at pumping plants whenever it appears that necessity for pump operation is imminent. The operator shall thoroughly inspect, trial operate, and place in readiness all plant equipment. The operator shall be familiar with the equipment manufacturers' instructions and drawings and with the "Operating Instructions" for each station. The equipment shall be operated in accordance with the above-mentioned "Operating Instructions" and care shall be exercised that proper lubrication is being supplied all equipment, and that no overheating, undue vibration or noise is occurring. Immediately upon final recession of flood waters, the pumping station shall be thoroughly cleaned, pump house sumps flushed, and equipment thoroughly inspected, oiled and greased. A record or log of pumping plant operation shall be kept for each station, a copy of which shall be furnished the District Engineer following each flood.

(g) *Channels and floodways*—(1) *Maintenance.* Periodic inspections of improved channels and floodways shall be made by the Superintendent to be certain that:

(i) The channel or floodway is clear of debris, weeds, and wild growth;

(ii) The channel or floodway is not being restricted by the depositing of waste materials, building of unauthorized structures or other encroachments;

(iii) The capacity of the channel or floodway is not being reduced by the formation of shoals;

(iv) Banks are not being damaged by rain or wave wash, and that no sloughing of banks has occurred;

(v) Riprap sections and deflection dikes and walls are in good condition;

(vi) Approach and egress channels adjacent to the improved channel or floodway are sufficiently clear of obstructions and debris to permit proper functioning of the project works.

Such inspections shall be made prior to the beginning of the flood season and otherwise at intervals not to exceed 90 days. Immediate steps will be taken to remedy any adverse conditions disclosed by such inspections. Measures will be taken by the Superintendent to promote the growth of grass on bank slopes and earth deflection dikes. The Superintendent shall provide for periodic repair and cleaning of debris basins, check dams, and related structures as may be necessary.

(2) *Operation.* Both banks of the channel shall be patrolled during periods of high water, and measures shall be taken to protect those reaches being attacked by the current or by wave wash. Appropriate measures shall be taken to prevent the formation of jams of ice or debris. Large objects which become lodged against the bank shall be removed. The improved channel or floodway shall be thoroughly inspected immediately following each major high water period. As soon as practicable thereafter, all snags and other debris shall be removed and all damage to banks, riprap, deflection dikes and walls, drainage outlets, or other flood control structures repaired.

(h) *Miscellaneous facilities*—(1) *Maintenance.* Miscellaneous structures and facilities constructed as a part of the protective works and other structures and facilities which function as a part of, or affect the efficient functioning of the protective works, shall be periodically inspected by the Superintendent and appropriate maintenance measures taken. Damaged or unserviceable parts shall be repaired or replaced without delay. Areas used for ponding in connection with pumping plants or for temporary storage of interior run-off during flood periods shall not be allowed to become filled with silt, debris, or dumped material. The Superintendent shall take proper steps to prevent restriction of bridge openings and, where practicable, shall provide for temporary raising during floods of bridges which restrict channel capacities during high flows.

(2) *Operation.* Miscellaneous facilities shall be operated to prevent or reduce flooding during periods of high water. Those facilities constructed as a part of the protective works shall not be used for purposes other than flood protection without approval of the District Engineer unless designed therefor. (49 Stat. 1571, 50 Stat. 877; and 55 Stat. 638; 33 U.S.C. 701c; 701c-1) (Regs. 9 August 1944, CE SPEWF)

[SEAL]

J. A. ULIO,
Major General,
The Adjutant General.

F. R. Doc. 44-12285; Filed, August 16, 1944;
9:44 a.m.]

APPENDIX I

SHEET 2 OF 2

APPENDIX II

Outline of Semi-Annual Report of Superintendent to District Engineer

1. General

- a. Date inspection is made.
- b. Names and official capacities of persons making inspection.

2. Levees

- a. Condition of vegetal growth on levees and action taken to remove excessive growth and to plant areas devoid of growth.
- b. Indication of bank erosion.
- c. Caving of riverward or landward levee slopes.
- d. Seepage, saturation areas or boils occurring after a flood.
- e. Accumulation of drift.
- f. Maintenance of established roadway on levees.
- g. Vehicular traffic on levees other than on established roadway.
- h. Encroachments by construction of culverts, pipe lines, etc.
- i. Results of levels taken at established points on the levees and condition of crown for drainage.
- j. Availability of keys for access to any gated portions of levees.
- k. Repairs made or other actions taken resulting from inspection of the foregoing items.

3. Closure Structures

- a. Stop-plank materials.
 - (1) Adequacy of parts.
 - (2) Condition of timbers as to freedom from decay, warping or damage which might render timbers unusable.
 - (3) Storage arrangements, such as provision for circulation of air around stop planks and arrangements to facilitate removal of planks from storage structure.

b. Storage structures.

(1) Condition of structure as to doors, locks, roof, siding and foundation with recommendations for repairs.

(2) Availability of keys.

c. Trial closure.

(1) Date of last closure.

(2) Time for complete closure.

(3) Man-hours required for complete closure.

d. Availability of sandbags for closure of the Union Canal upstream from highway U. S. No. 410, and the county road crossing of Wasteway No. 2. Bags to be obtained from _____.

e. Availability of labor and equipment to meet all contingencies.

f. Repairs made or other action taken resulting from inspection of the foregoing items.

4. Drainage and Irrigation Structures.

a. Accumulations of trash, drift or debris near inlets and outlets of each of the structures listed in paragraph 4.19 of the manual.

b. Condition of headwalls, riprap and pipes.

c. Flap gates oiled or greased, examined and trial operated once every 90 days.

d. Condition of operating mechanism for hand-operated gates.

e. Availability of keys for locked gates.

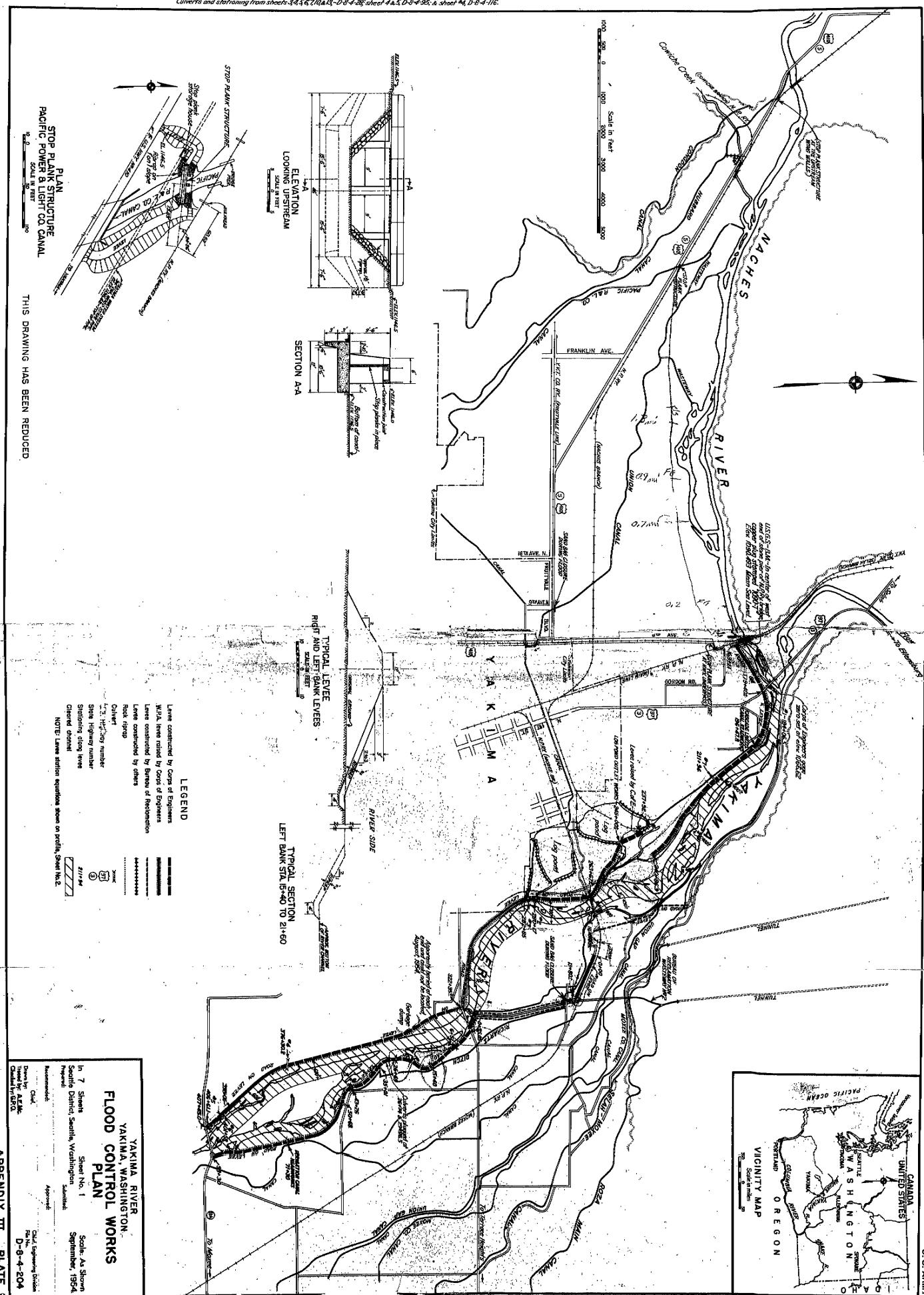
f. Repairs or other action taken from inspection of the foregoing items.

5. Conditions at Flood Period. - In the first semi-annual report following a flood period, the Superintendent shall give a complete log of operations accomplished before, during, and after the flood period, relating particularly to the following items:

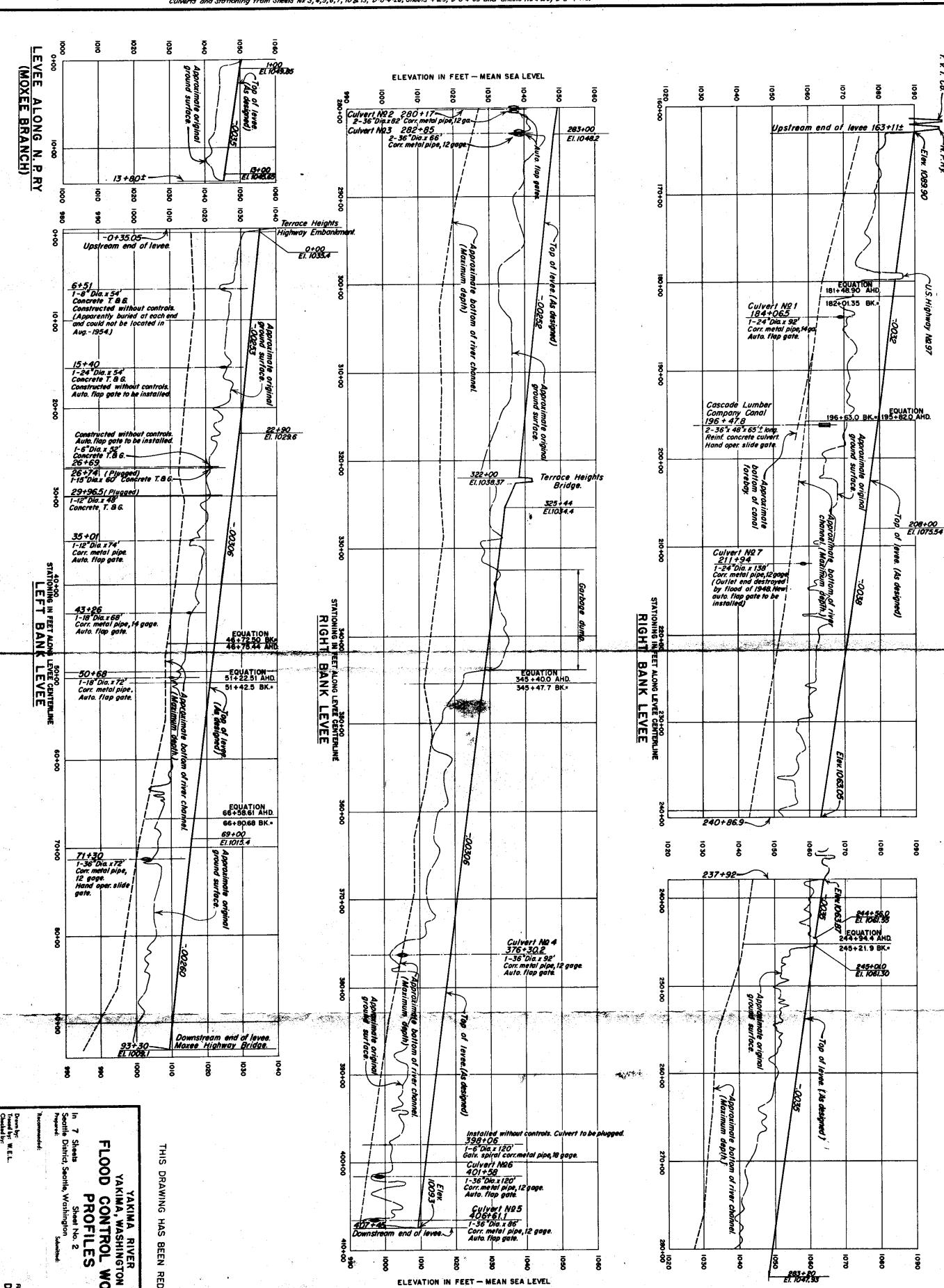
a. Inspections made immediately prior to the flood, during the flood, and after the flood.

- b. Record of personnel and equipment used in assembly of closure structures and time required for their erections.
- c. The continual patrolling of the flood control works during flood periods and a record of events during the flood.
- d. Record of water levels during the flood.
- e. Record of the effectiveness of all parts of the flood control works during the flood.
- f. Adequacy of personnel and equipment employed during the flood and detailed information on deficiencies.

Plan traced from Sheet No. 1, D-8-4-28.
Irrigation canals on left bank of Yakima River taken from Yakima Quad sheet #13, 136-SW.
Yakima River from reductions of sheets 24-3, D-8-4-16.
W. & G. Linn from Yakima Quad sheet 135-SW, D-8-4-192.
Shea plot line from Pacific Pal. Co. Plan done on a section from sheet D-8-4-25 & sheet #11, D-8-4-28.
Cultivars and status from Pacific Pal. Co. Plan done on a section from sheet D-8-4-25 & sheet #11, D-8-4-28.



*Left and right bank profiles from Sheet NB 6, D-8-4-116, & Sheet NB 8, D-8-4-28.
 Profile of levee along N.P.R.Y. (Moxee Branch) from Sheet NB 3, D-8-4-28.
 Culverts and stationing from Sheets NB 3, 4, 5, 6, 7, 10 & 13, D-8-4-28; Sheets 4 & 5, D-8-4-95 and Sheets NB 4 & 5, D-8-4-116.*

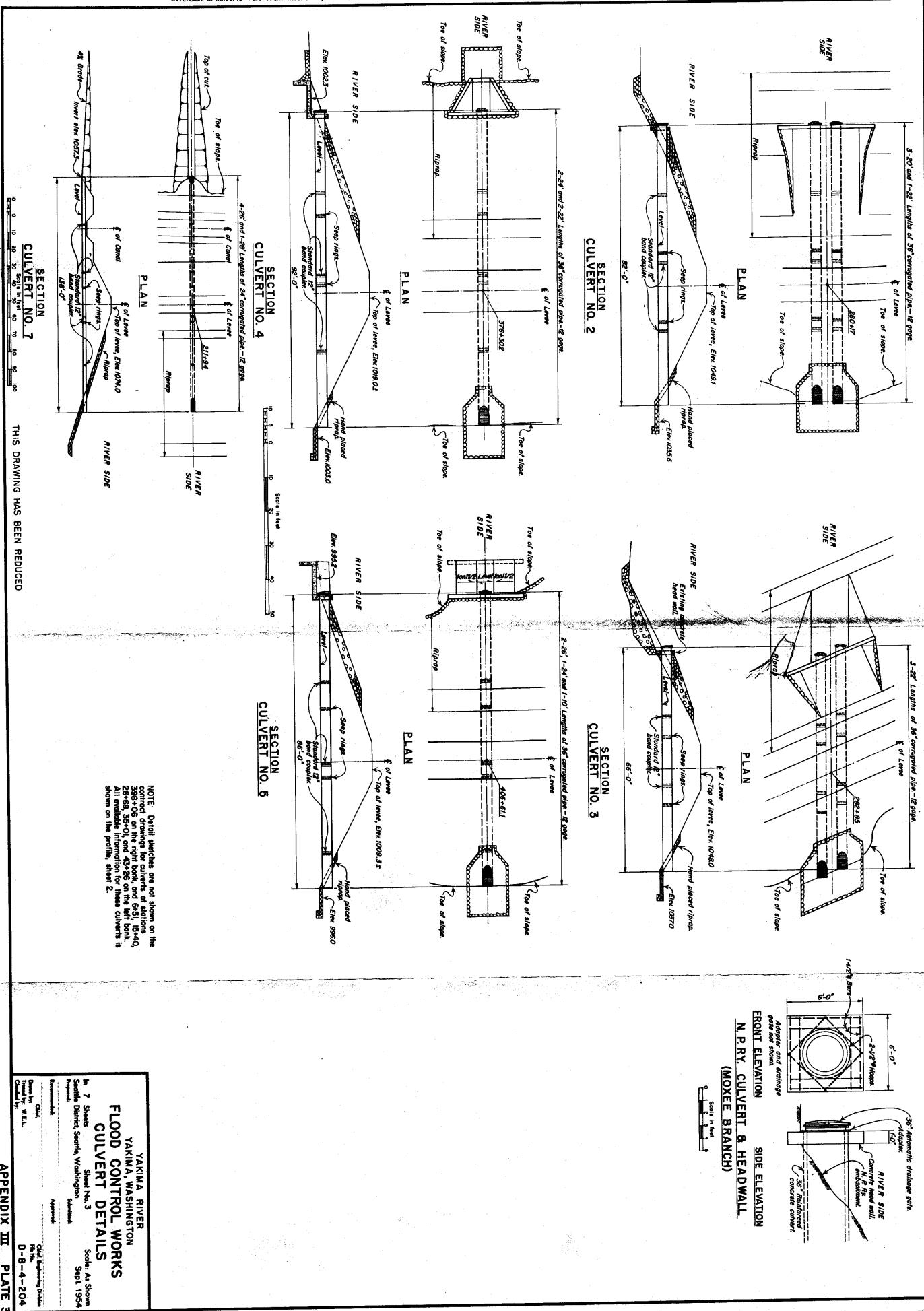


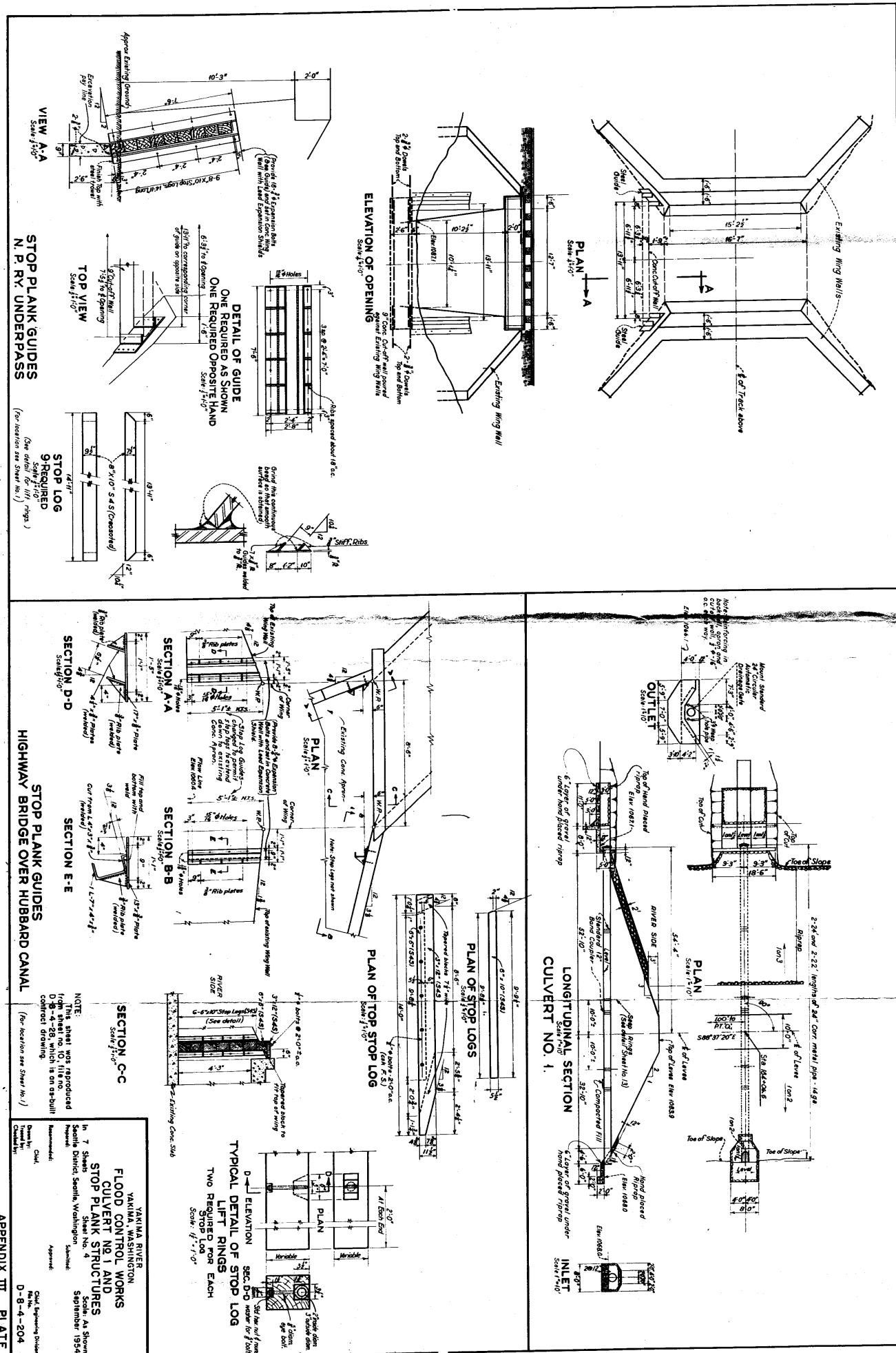
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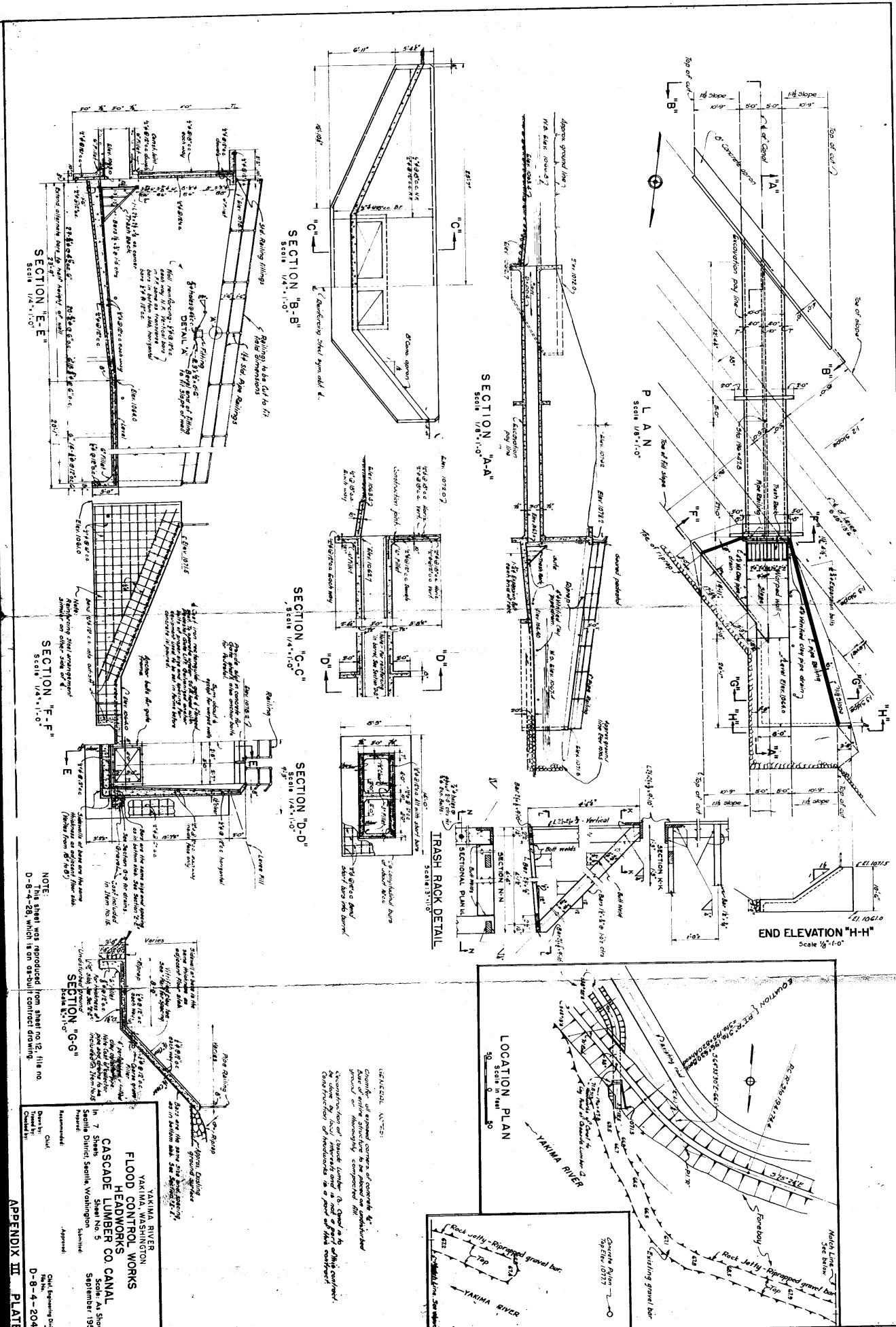
FLOOD CONTROL WORK YAKIMA RIVER YAKIMA, WASHINGTON PROFILES

Seattle District, Seattle, Washington
Prepared: **Subcommittee on Safety**
Recommended:

APPENDIX III PLATE 2

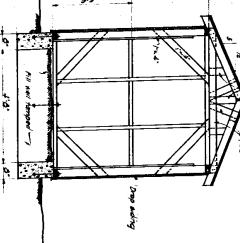




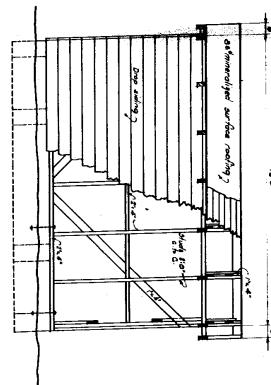


STORAGE HOUSE DETAIL
(1-BRDO. PACIFIC POWER & LIGHT CO. CONTRACT)

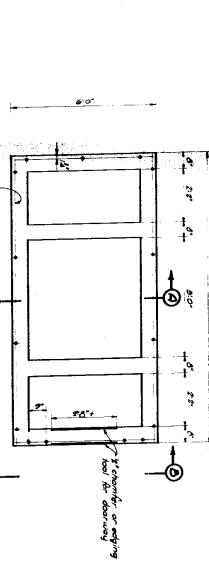
SECTION "A-A"



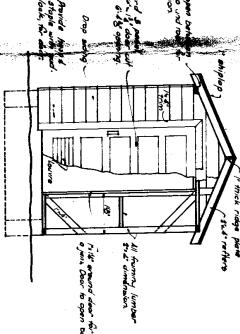
ELEVATION



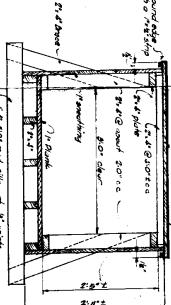
FOUNDATION PLAN



ELEVATION "B-B"



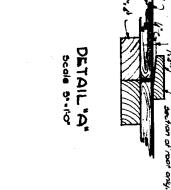
SECTION "C-C"



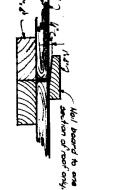
STOP-LOG BOX DETAIL

(1-BRDO. N.P.P.C. UNPUBLISHED)
(1-BRDO. H.W. BROWN, CHIEF, HUBBARD CONTRACT)

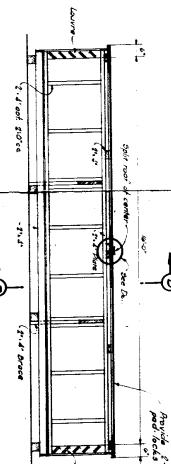
SECTION "D-D"



DETAIL "A"

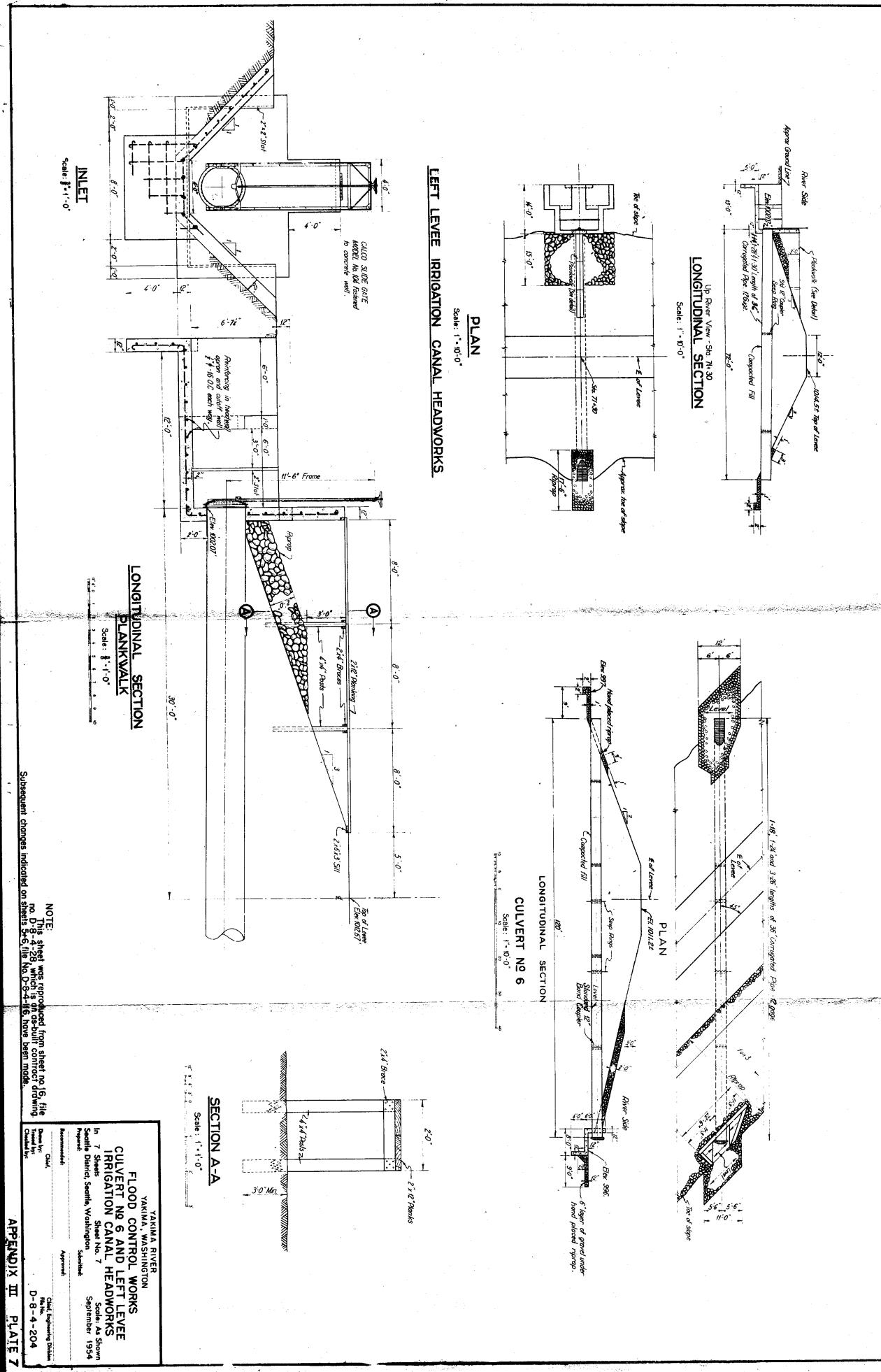


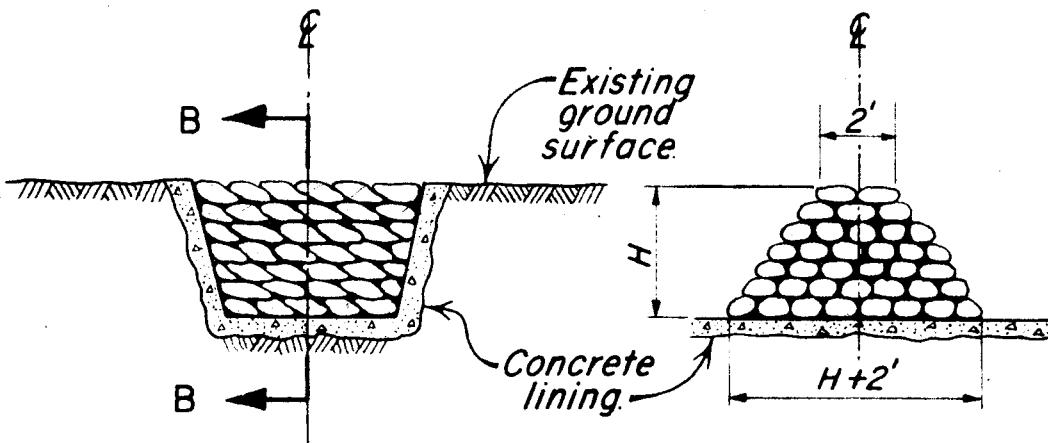
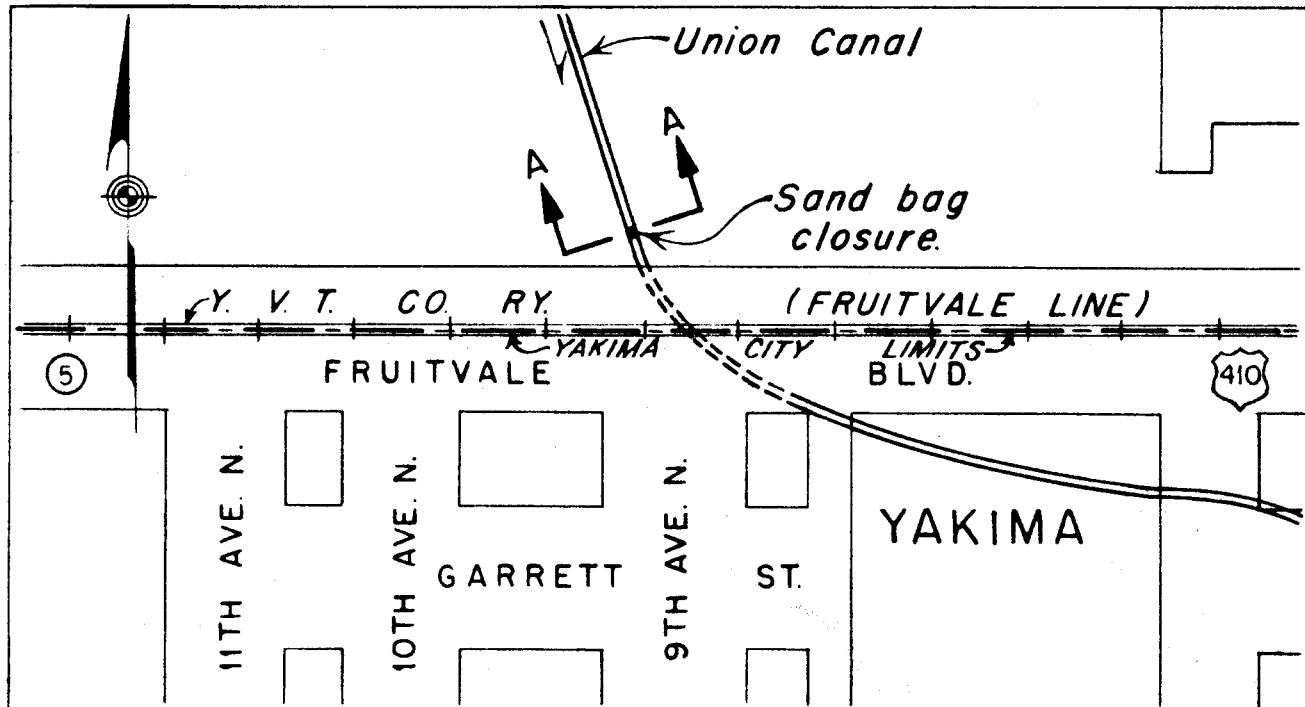
END VIEW



NOTE:
This sheet was reproduced from sheet no. 14,
file no. D-9-4-28, which is an as-built contract
drawing.

YAKIMA RIVER
YAKIMA, WASHINGTON
FLOOD CONTROL WORKS
STOP PLANK STORAGE
In 7 Sheets
Sheet No. 6
Drawing Office, Seattle, Washington
Submitted
Revised
Drawn by: Chas. F. Smith
Drawn by: Chas. F. Smith
Approved:
Chief Engineer's Division
File No. D-9-4-204

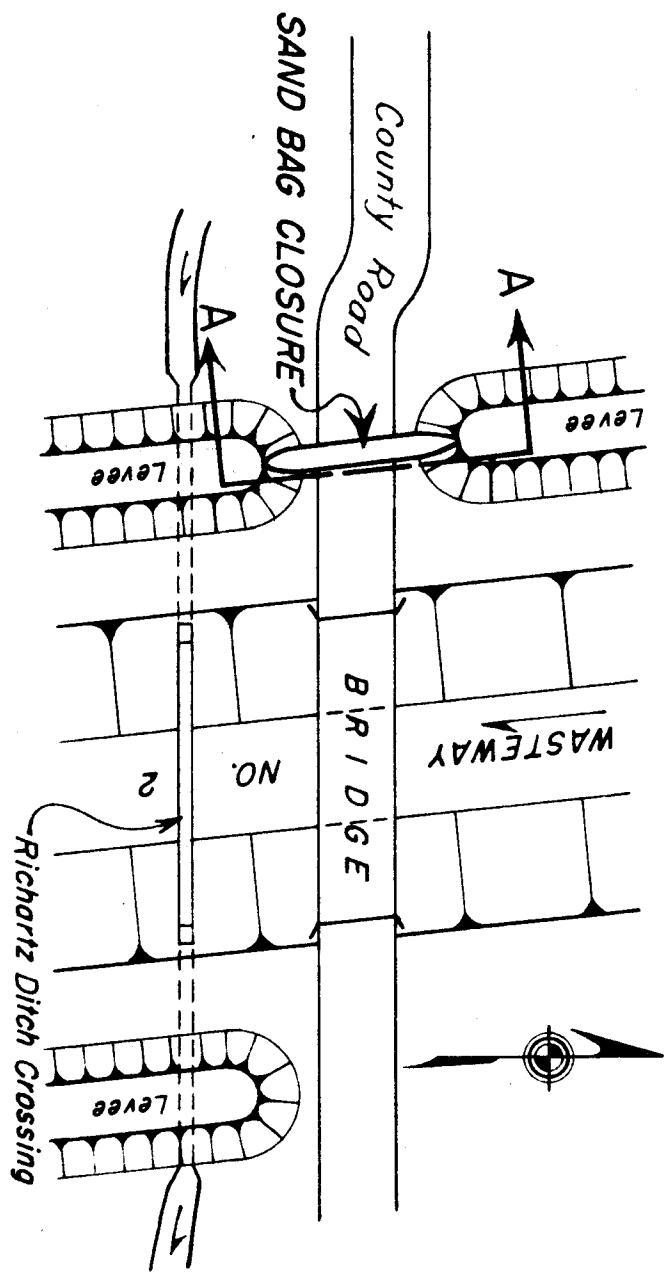




SAND BAG CLOSURE

Scale: 1" = 5'-0"

YAKIMA RIVER
YAKIMA, WASHINGTON
SAND BAG CLOSURE
UNION CANAL
Sheet 1 of 2 Scale as shown
Seattle District, Seattle, Wash.
Dwn: G.P.O. Sept. 1954
Trd: W.E.L.
Chkd: A.E.M.C. File No D-8-4-205

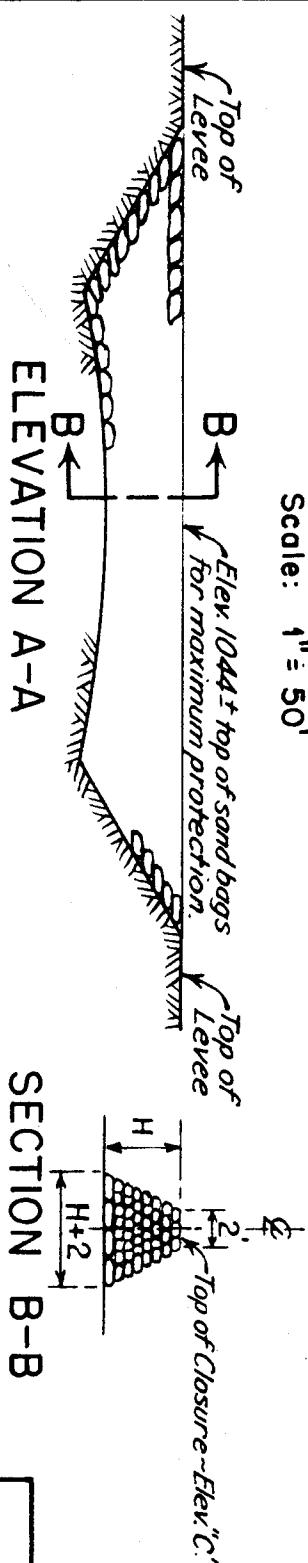


NOTES

1. Alternate direction of bags with bottom layer lengthwise across road, next layer along road.
2. Lap unfilled portion under next bag.
3. Tying or sewing of bags not necessary.
4. Tamp thoroughly in place.
5. Bags should be approx. $\frac{1}{2}$ full of clay, silt or sand.

LOCATION PLAN

Scale: 1" = 50'



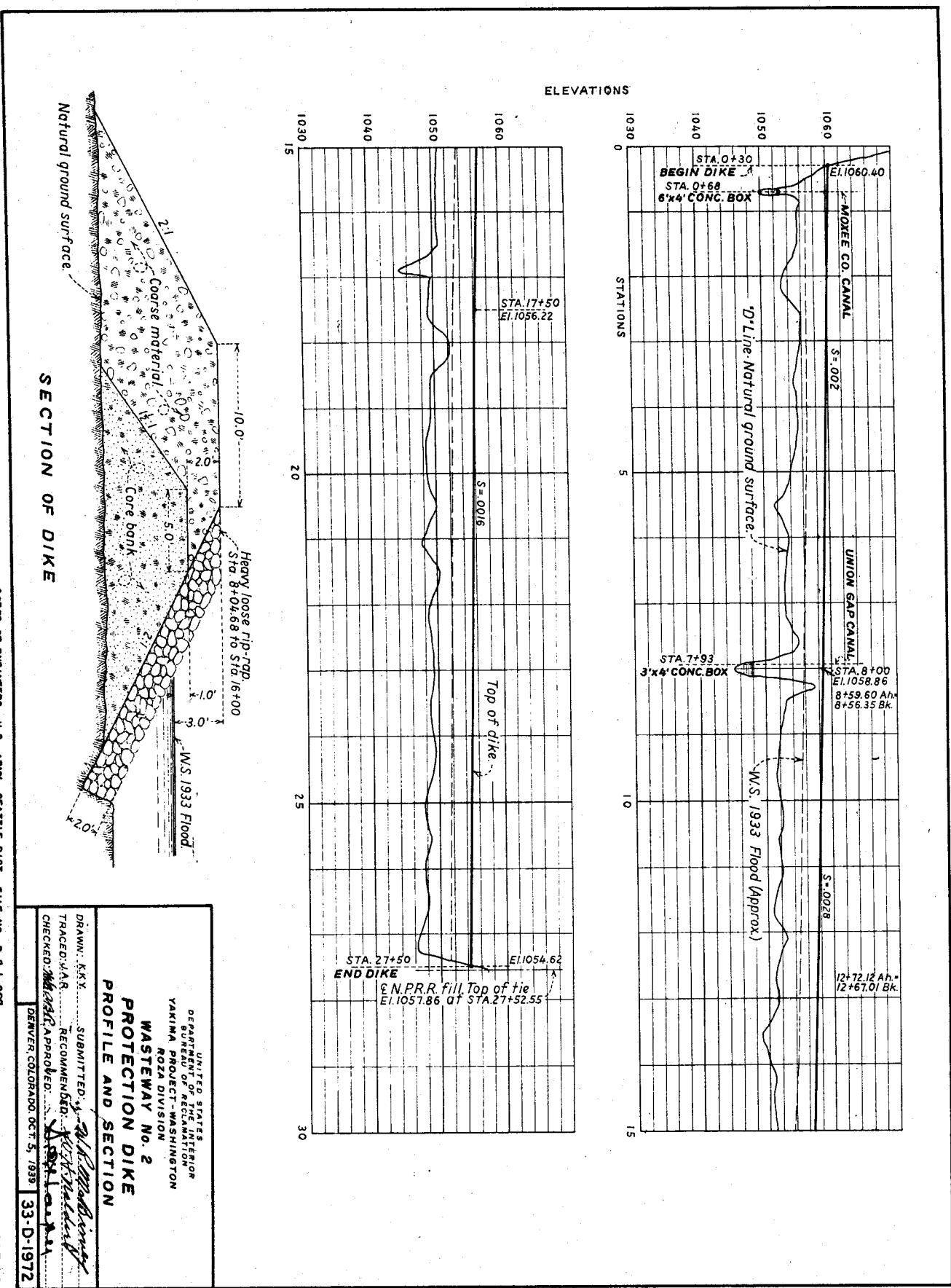
MATERIAL REQUIRED
(Approximate)

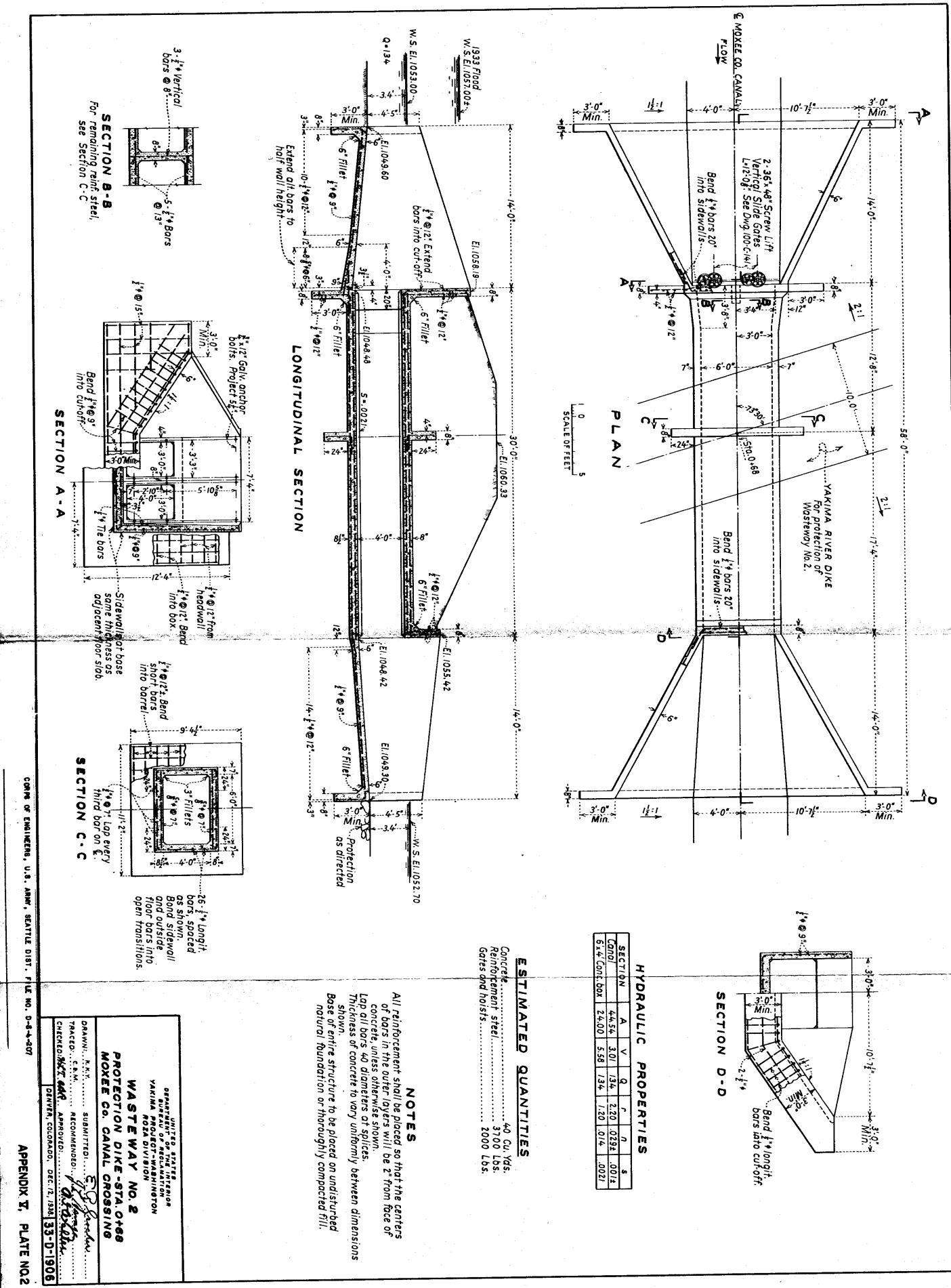
ELEV. "C"	NO. BAGS	EARTH-Cu.yds.
1044	1050	21
1043	650	13
1042	350	7

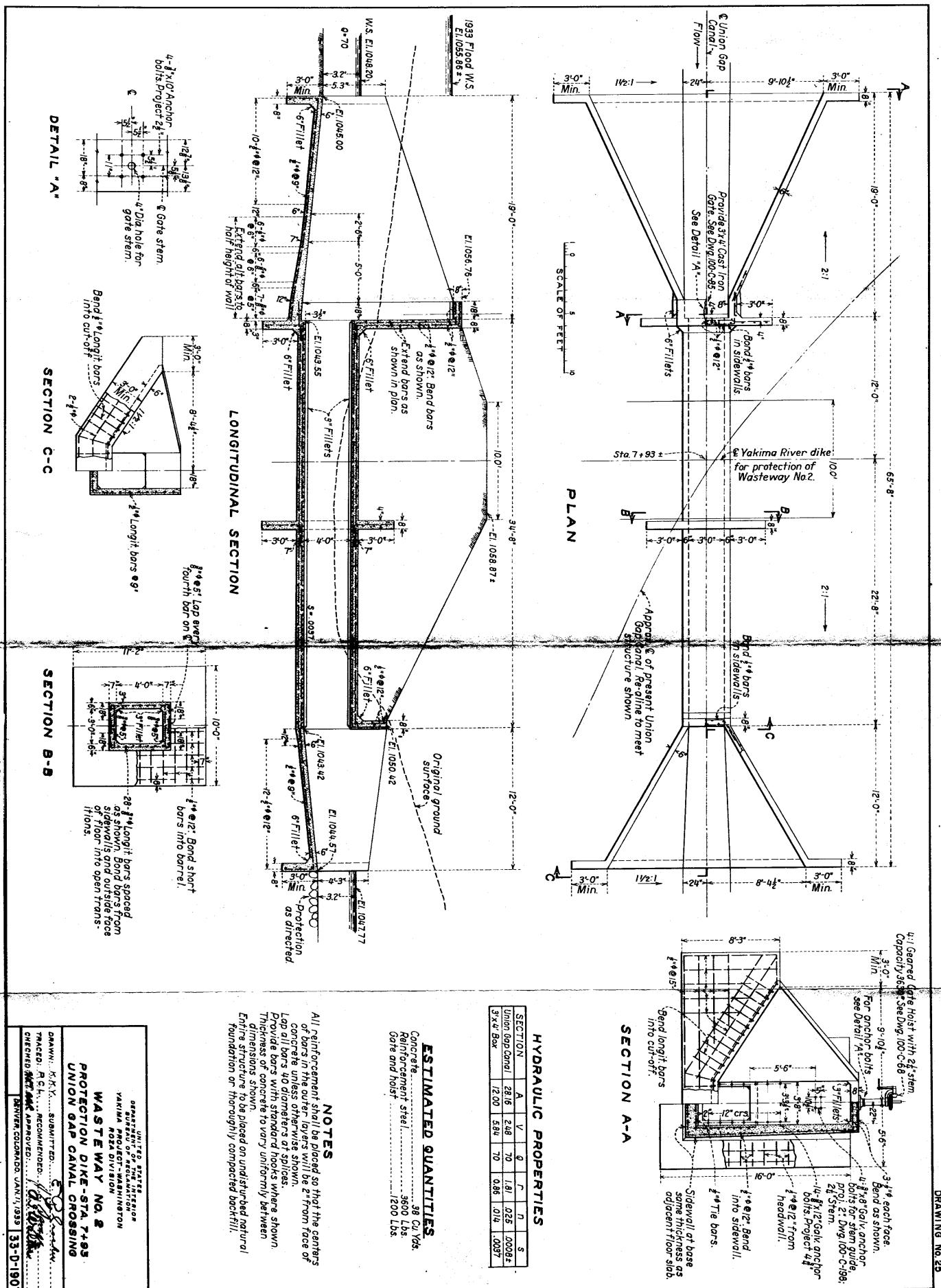
ELEVATION A-A
SAND BAG CLOSURE

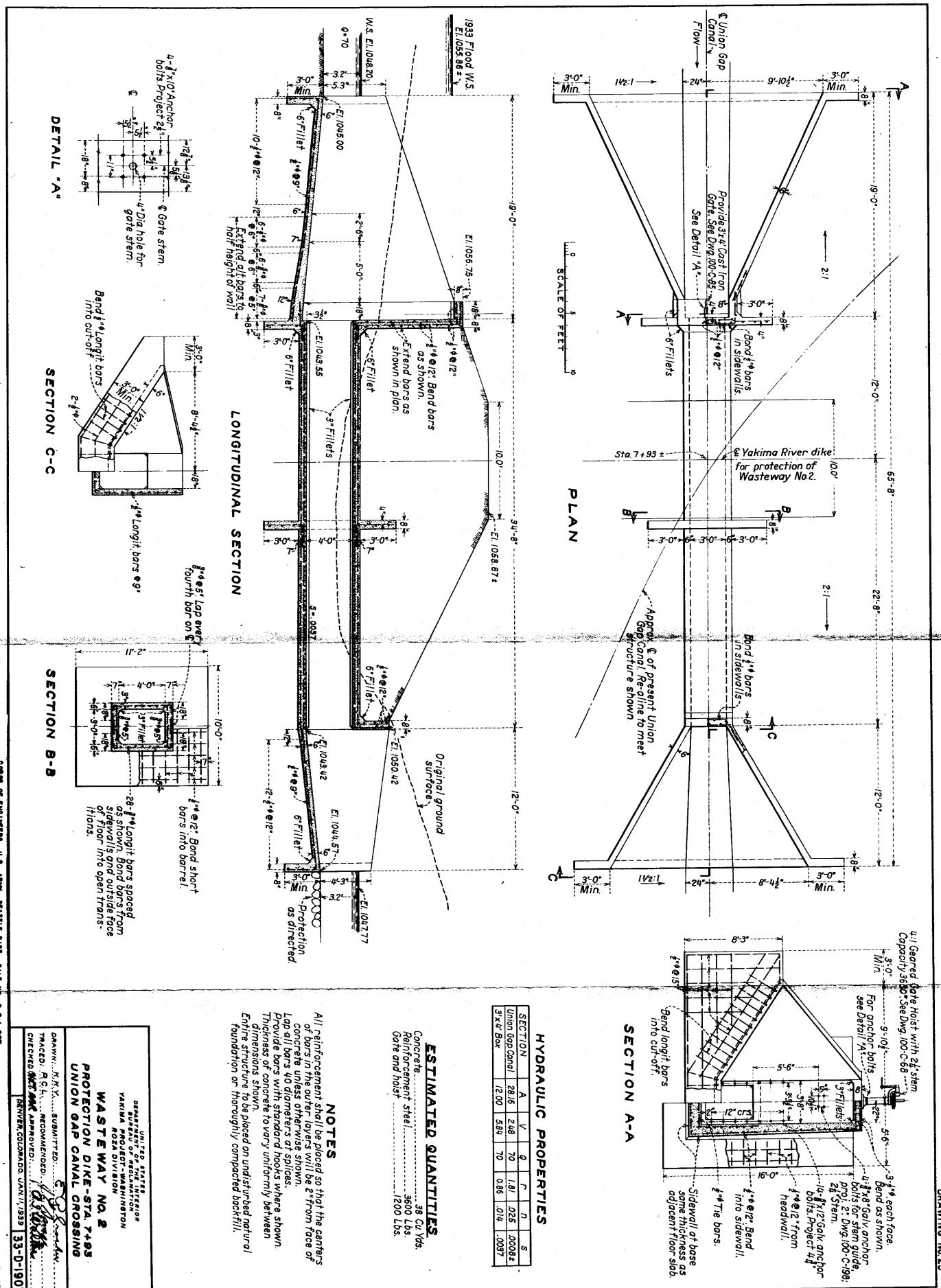
Scale: 1" = 10'

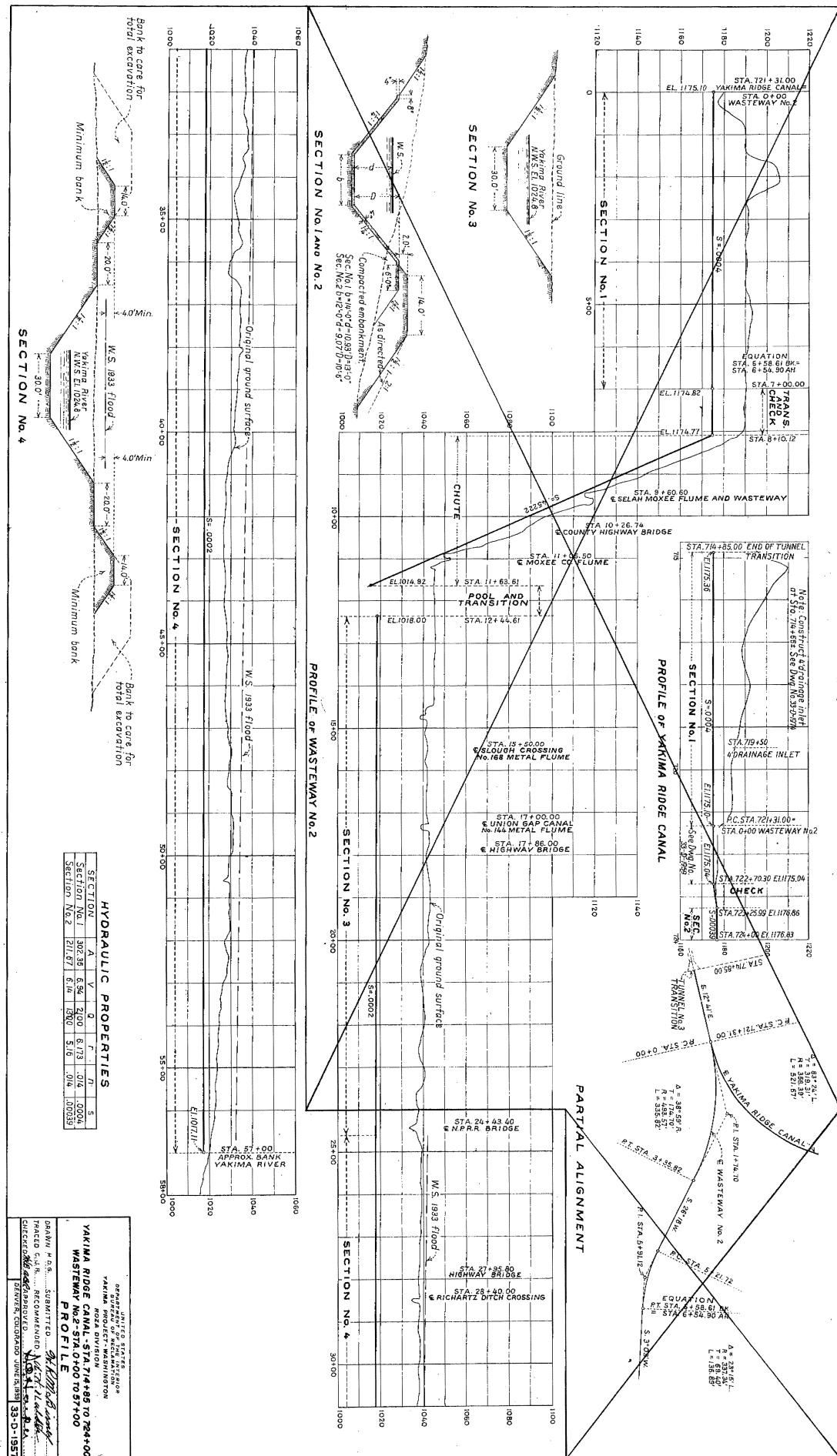
YAKIMA RIVER
YAKIMA, WASHINGTON
SAND BAG CLOSURE
COUNTY ROAD AT
WASTEWAY NO. 2 CROSSING
Sheet 2 of 2 Scale: As shown
Seattle District, Seattle, Wash.
Drawn: G.P.O.
Trd: A.E.M.
Chkd: G.P.O. File No D-84-205

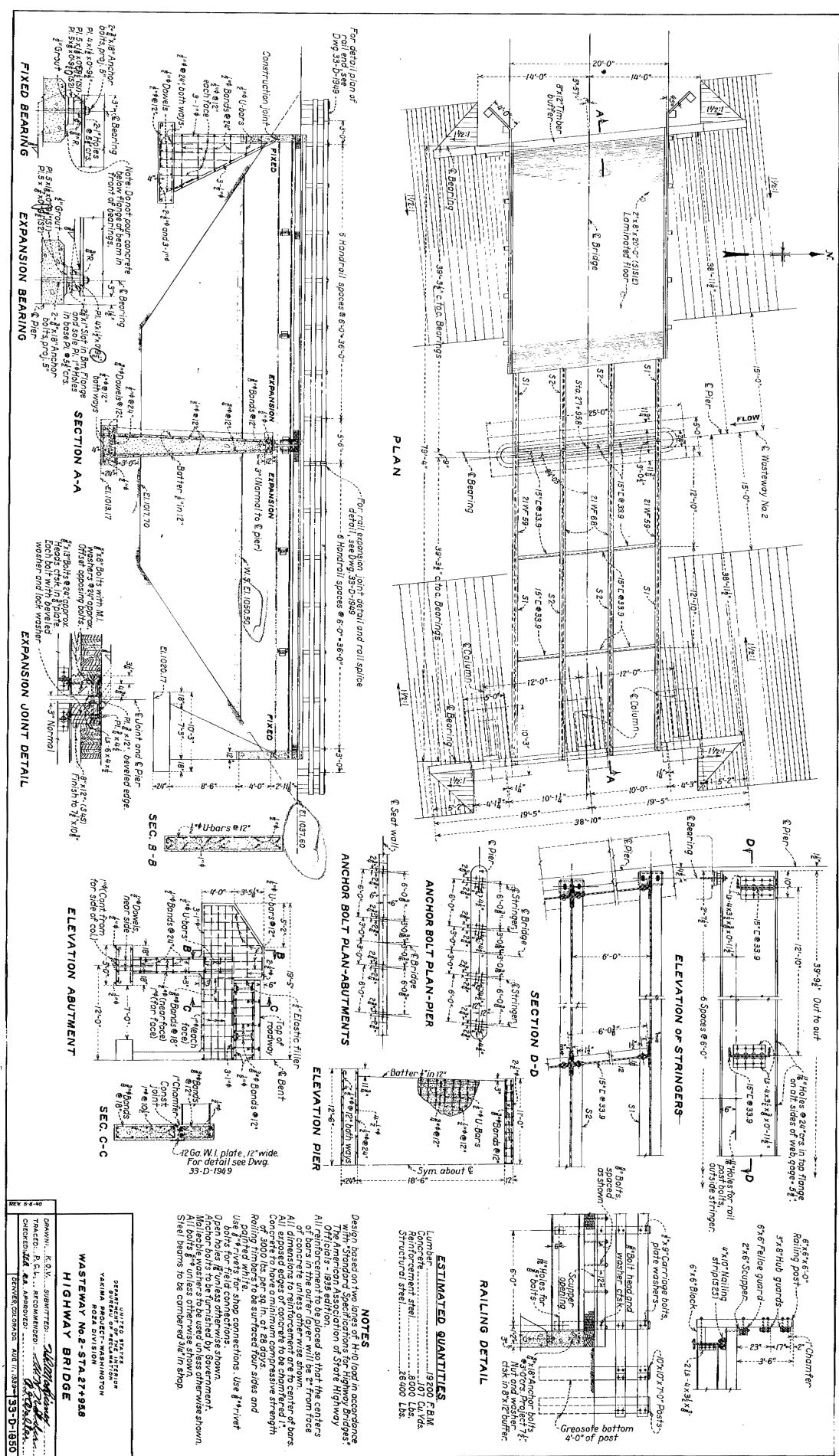


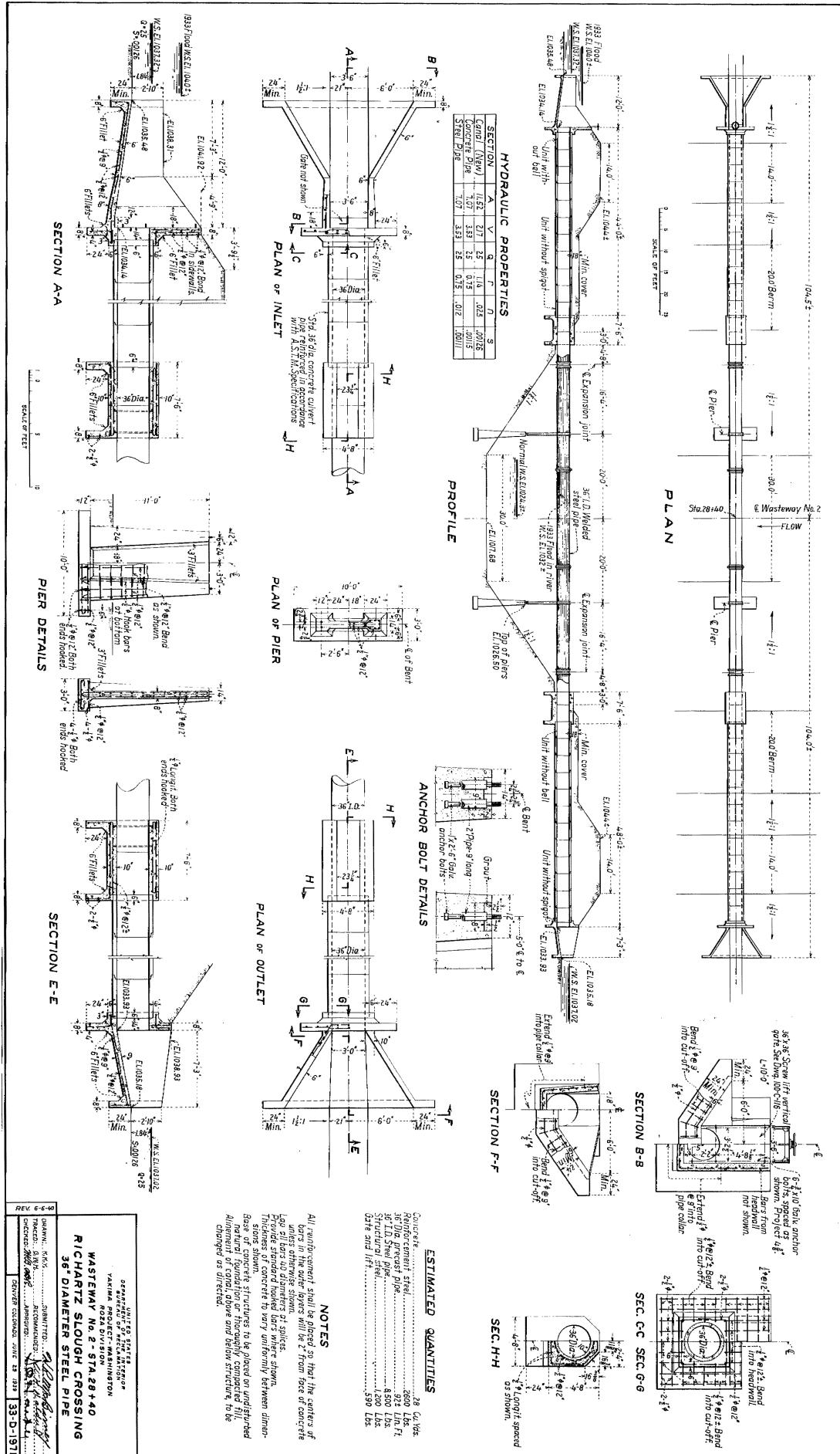












APPENDIX VI



Photo No. 1. - Stop plank guides in Hubbard Canal at U. S. Highway No. 410 crossing.



Photo. No. 2.

Stop plank structure in Pacific Power and Light Company Canal between the N.P. Ry. (Naches Branch) and U. S. Highway No. 410. Note the stop log storage structure on the right side of the photograph.



Photo No. 3. - Stop plank guides in the Northern Pacific Railway (Main Line) underpass. Note the stop log storage structure on the right side of the photograph.



Photo No. 4. - Union Canal upstream of U.S. Highway No. 410. Location for erection of sandbag closure

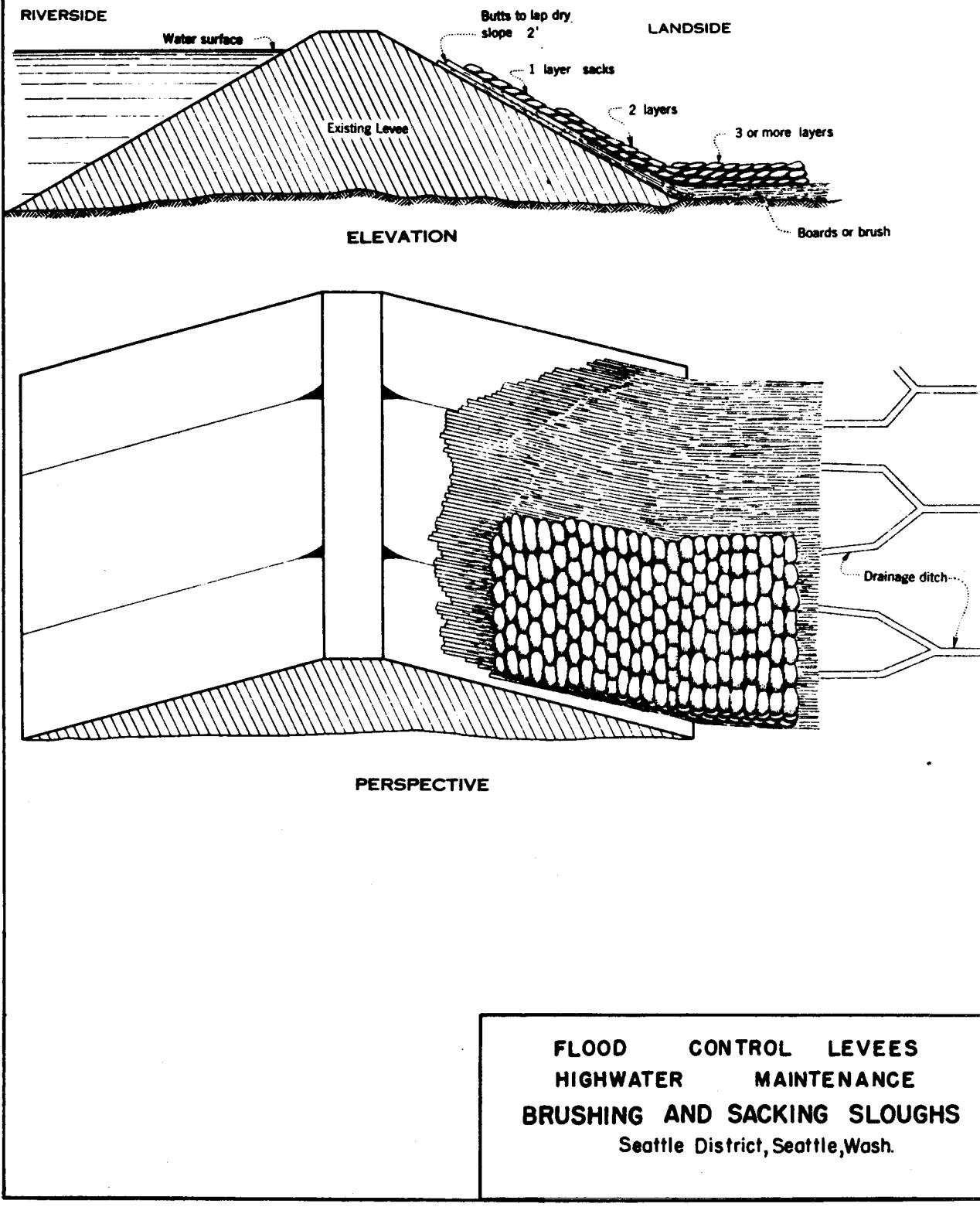
APPENDIX VII

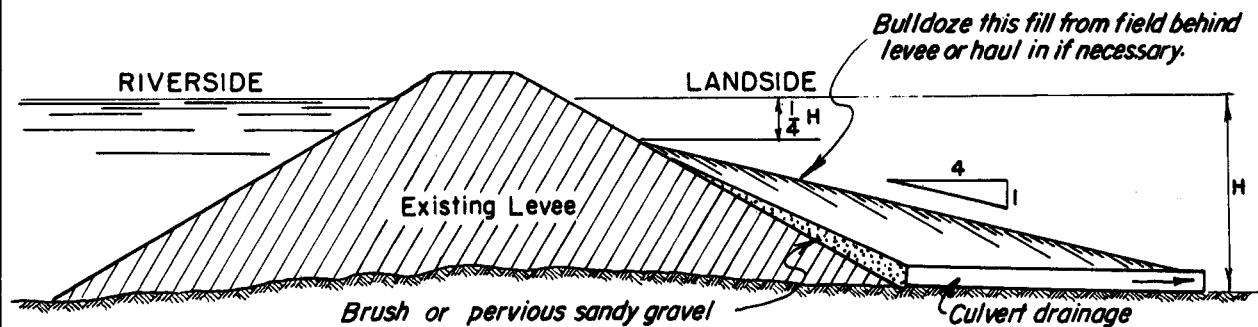
Sketches From

the

Flood Emergency Manual

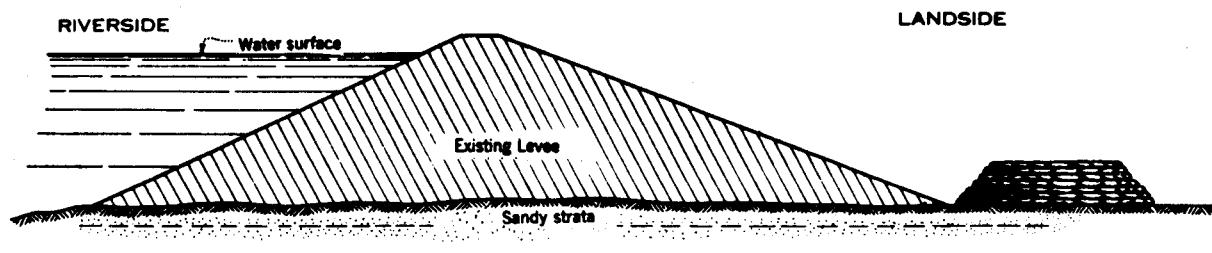
APPENDIX VII



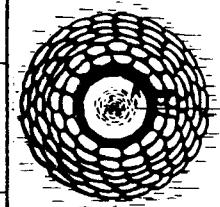
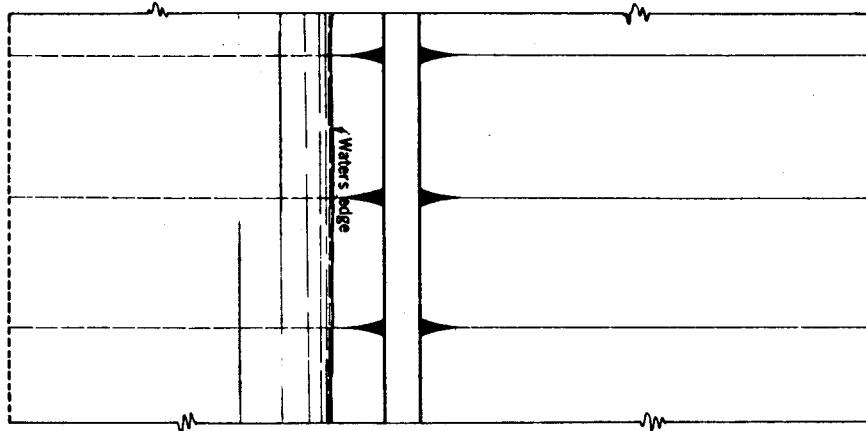


SECTION

FLOOD CONTROL LEVEES
HIGHWATER MAINTENANCE
STABILIZING FILL FOR SLOUGHS
Seattle District, Seattle, Wash.



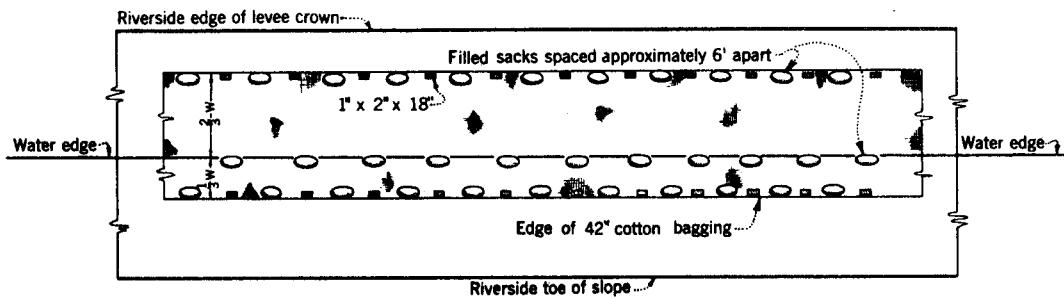
Note:
Bottom to be no less than $1\frac{1}{2}$ times height.
Be sure to clear sand discharge.
Tie into levee if boil is near toe.



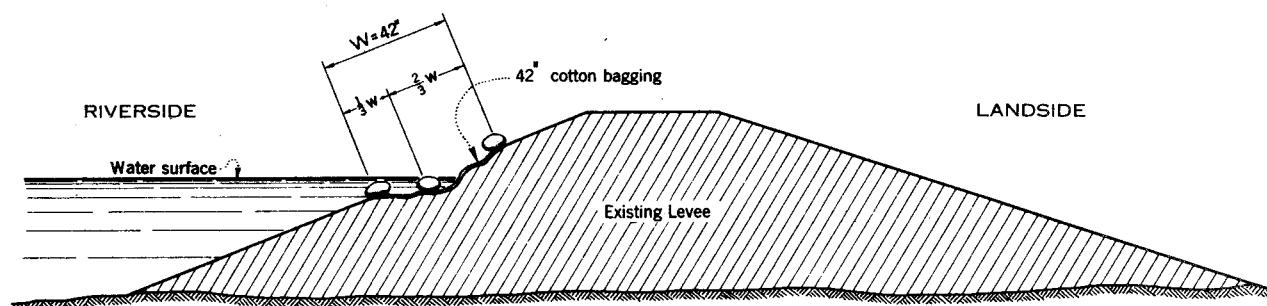
PLAN

Note:
Do not sack boil which does not put out material.
Height of sack loop or ring should be only sufficient
to create enough head to slow down flow through
boil so that no more material is displaced and boil
runs clear. Never attempt to completely stop flow
through boil.

FLOOD CONTROL LEVEES
HIGHWATER MAINTENANCE
SAND BOIL
Seattle District, Seattle, Wash.



PLAN



SECTION

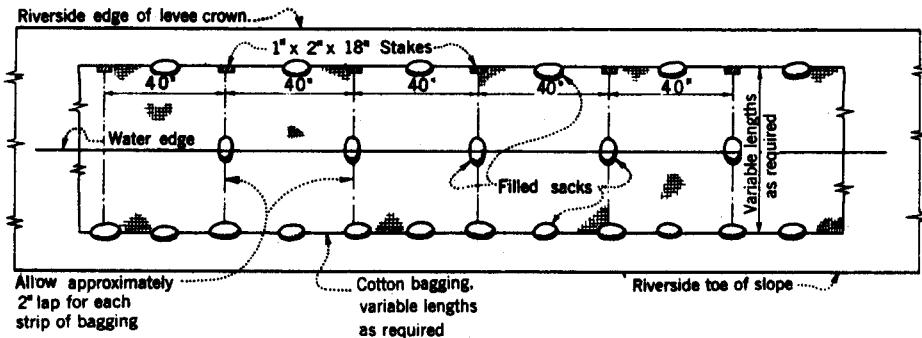
BILL OF MATERIAL PER 180 LINEAR FEET

One roll regular (jute) cotton bagging 42" x 180'
 90 - Filled sacks
 60 - Stakes 1" x 2" x 18" (sharpened)

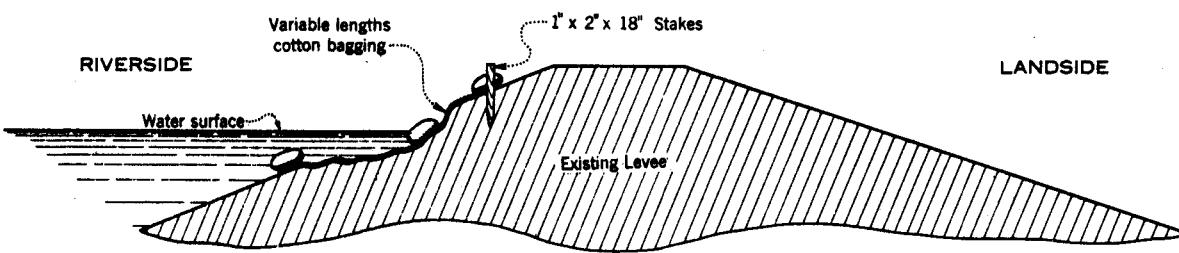
Note:

Lay 42" wide cotton or burlap bagging longitudinally along riverside slope of levee with approximately $\frac{1}{3}$ width of bagging laying above water surface. Weight edges and top of bagging along water surface with filled sacks spaced approximately six feet apart. Drive stakes alternately between filled sacks located along each edge of bagging. If regular 42" width cotton bagging is not sufficient in width to provide desired protection, two or more widths of bagging may be laced together and layed as desired.

FLOOD CONTROL LEVEES
 HIGHWATER MAINTENANCE
 WAVE WASH PROTECTION
 Seattle District, Seattle, Wash.



PLAN



SECTION

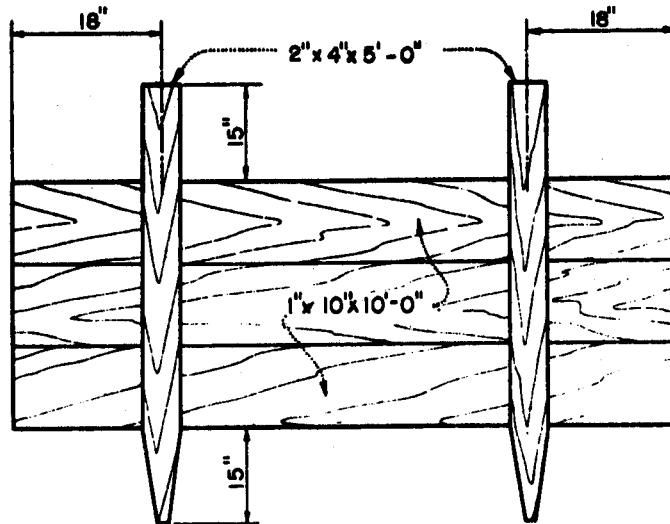
Note:

Lay lengths as required of cotton or burlap bagging approximately parallel with levee slope and across damaged section. Weight top and edges of bagging with filled sacks as shown above. The filled sacks should be wired or tied to each strip before laying in place. Stake the corners of each strip above water surface.

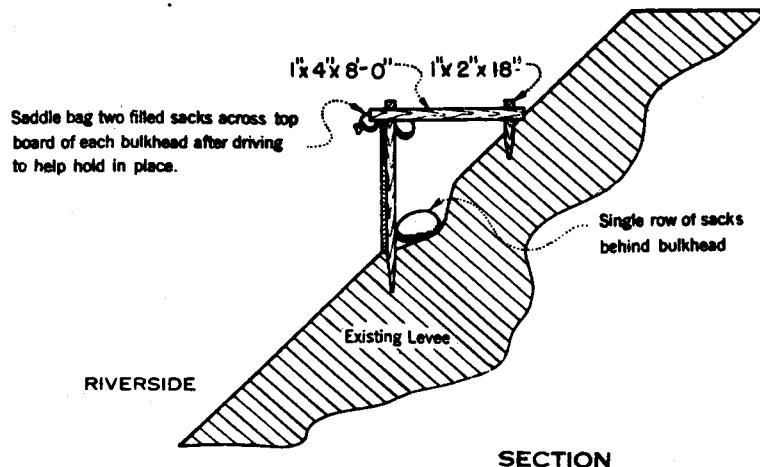
BILL OF MATERIAL PER 100 LINEAR FEET

Cotton bagging (jute) as required
120-Filled sacks
30-Stakes 1" x 2" x 18" (sharpened)

FLOOD CONTROL LEVEES
HIGHWATER MAINTENANCE
WAVE WASH PROTECTION
Seattle District, Seattle, Wash



PORTABLE BULKHEAD



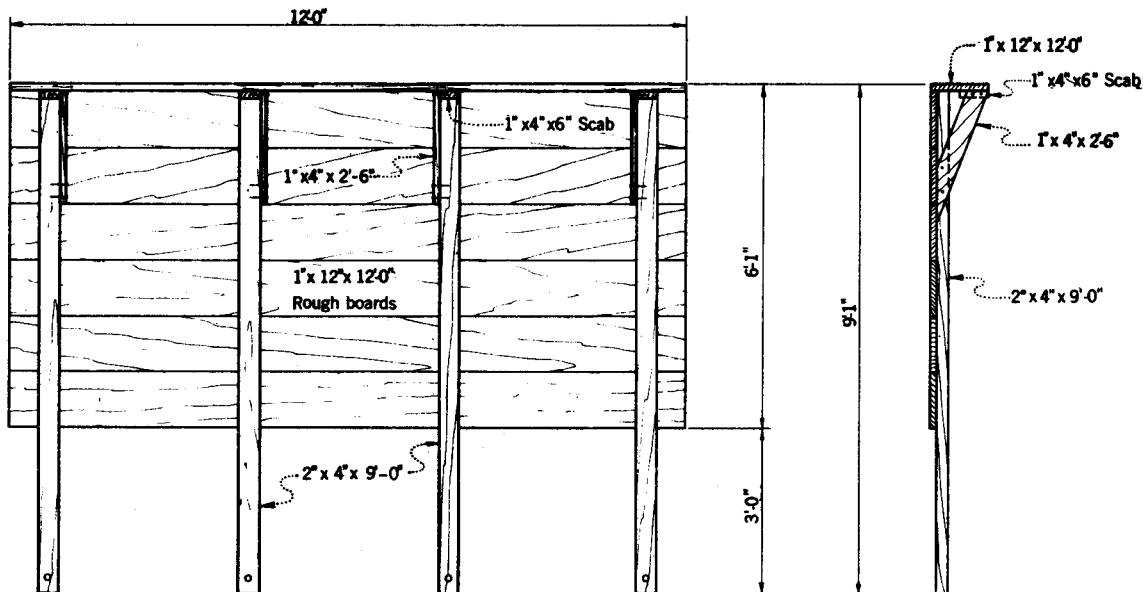
SECTION

BILL OF MATERIAL PER 100 LINEAR FEET

Lumber and Nails

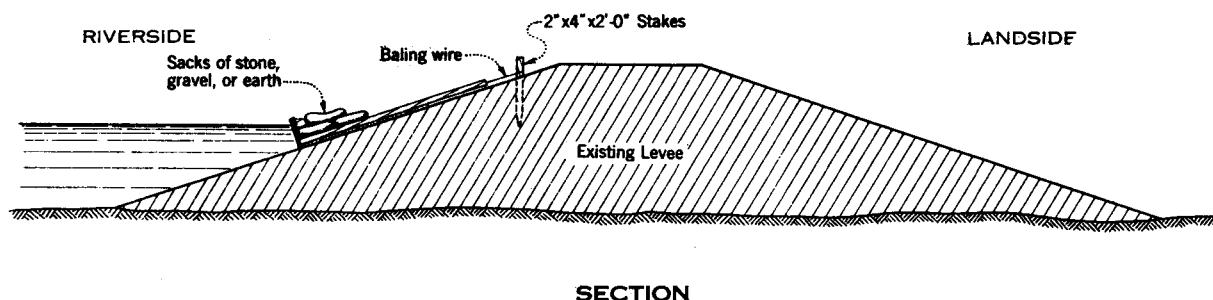
- 36 pieces 1'x 10"x 10'-0"
- 24 pieces 2"x 4"x 5'-0" (sharpened)
- 24 pieces 1"x 4"x 8'-0"
- 24 pieces 1"x 2"x 18" (sharpened)
- 2½ lbs. 8d nails
- 150-filled sacks

FLOOD CONTROL LEVEES
HIGHWATER MAINTENANCE
WAVE WASH PROTECTION
Seattle District, Seattle, Wash.



TOP VIEW

SIDE VIEW



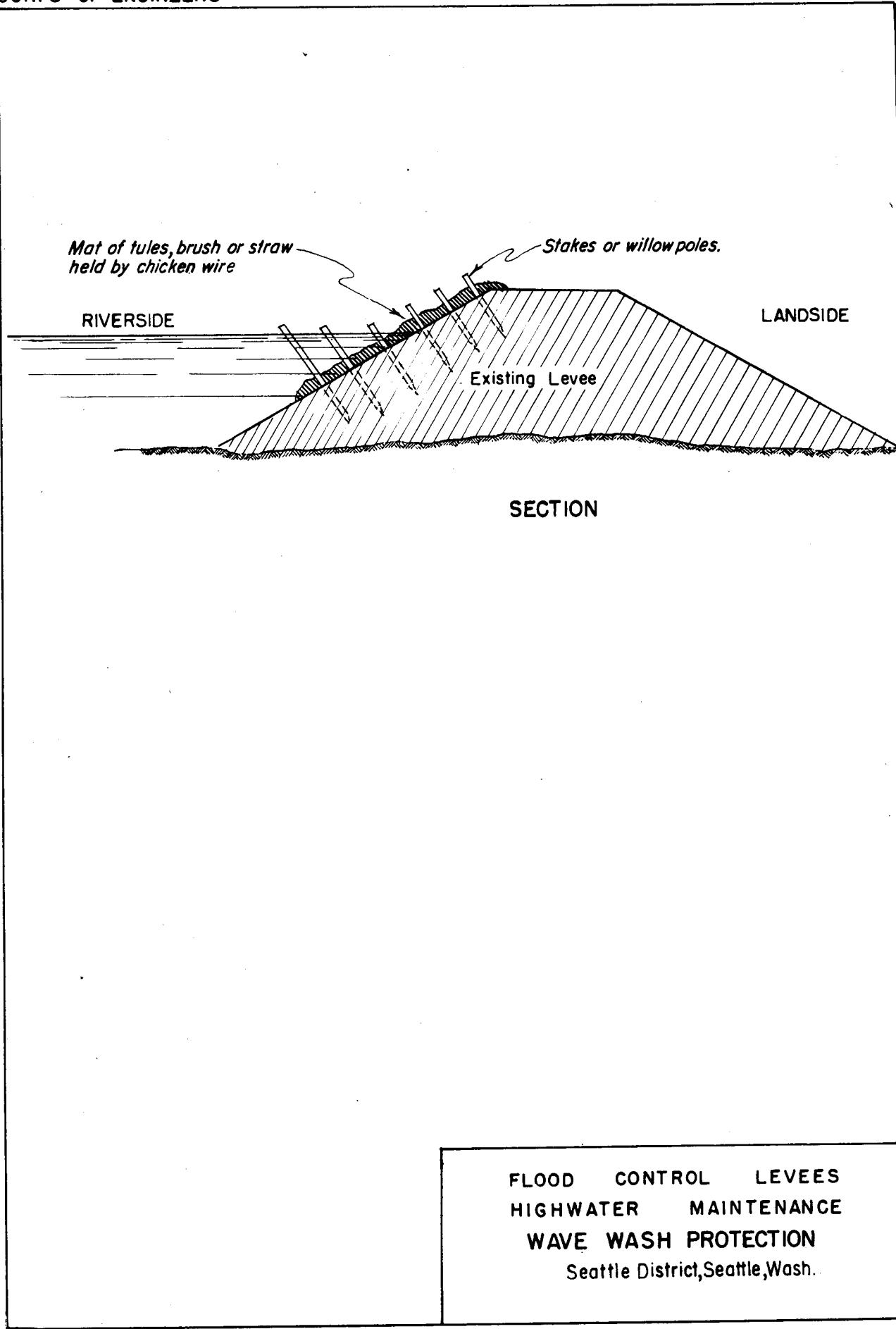
SECTION

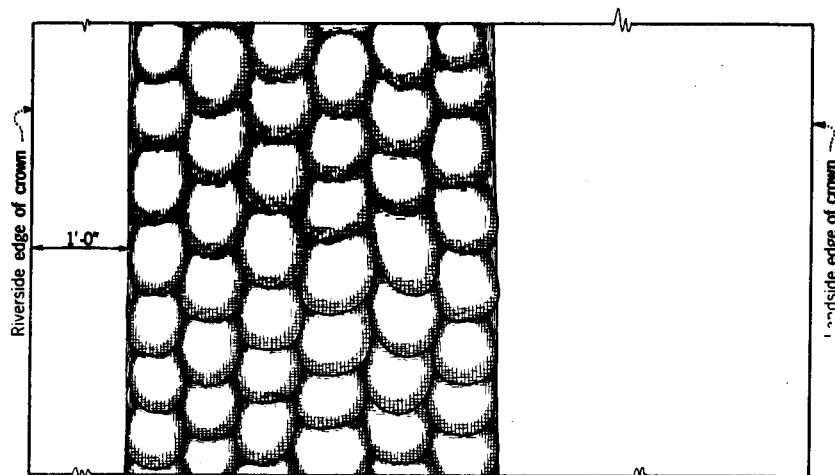
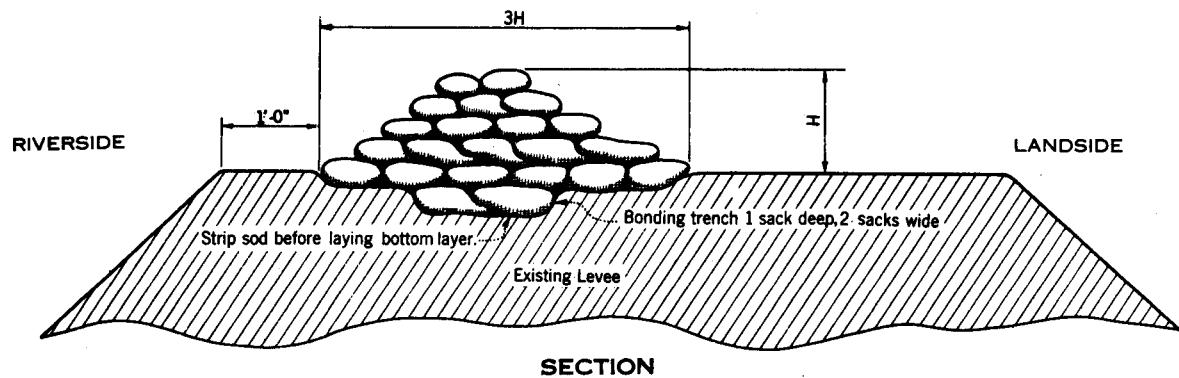
BILL OF MATERIAL PER 100 LINEAR FEET

- 56 pieces 1' x 12' x 12'-0"
- 32 pieces 2' x 4" x 9'-0"
- 32 pieces 1' x 4" x 2'-6"
- 32 pieces 2' x 4" x 2'-0" (sharpened)
- 200 lf. Baling wire
- 4½ lbs. 8d nails
- Bags as required

FLOOD CONTROL LEVEES
HIGHWATER MAINTENANCE
MOVABLE WAVE WASH PROTECTION
 Seattle District, Seattle, Wash.

SKETCH NO. 7





PLAN OF BOTTOM LAYER

Note:

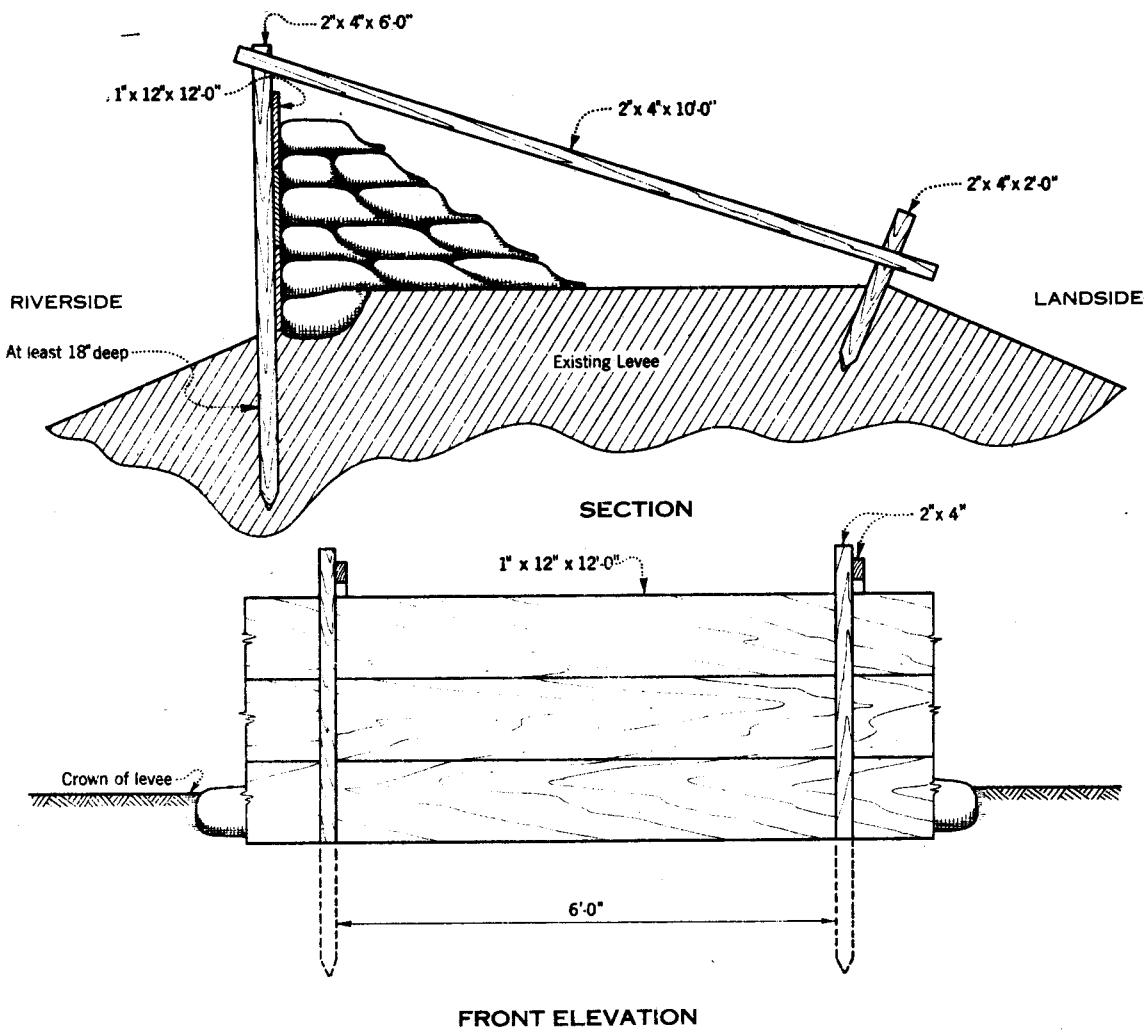
Alternate direction of sacks with bottom layer lengthwise of levee, next layer crosswise, etc.
 Lap unfilled portion under next sack.
 Tieing or sewing sacks not necessary.
 Tamp thoroughly in place.
 Bags should be approximately $\frac{1}{3}$ full of clay, silt, or sand.



METHOD OF LAPPING SACKS.

BAGS REQUIRED PER 100 LINEAR FEET OF LEVEE	
Height above levee	Bags required
1 foot	800
2 feet	2000
3 feet	3400

FLOOD CONTROL LEVEES
 HIGHWATER MAINTENANCE
 SACK TOPPING
 Seattle District, Seattle, Wash

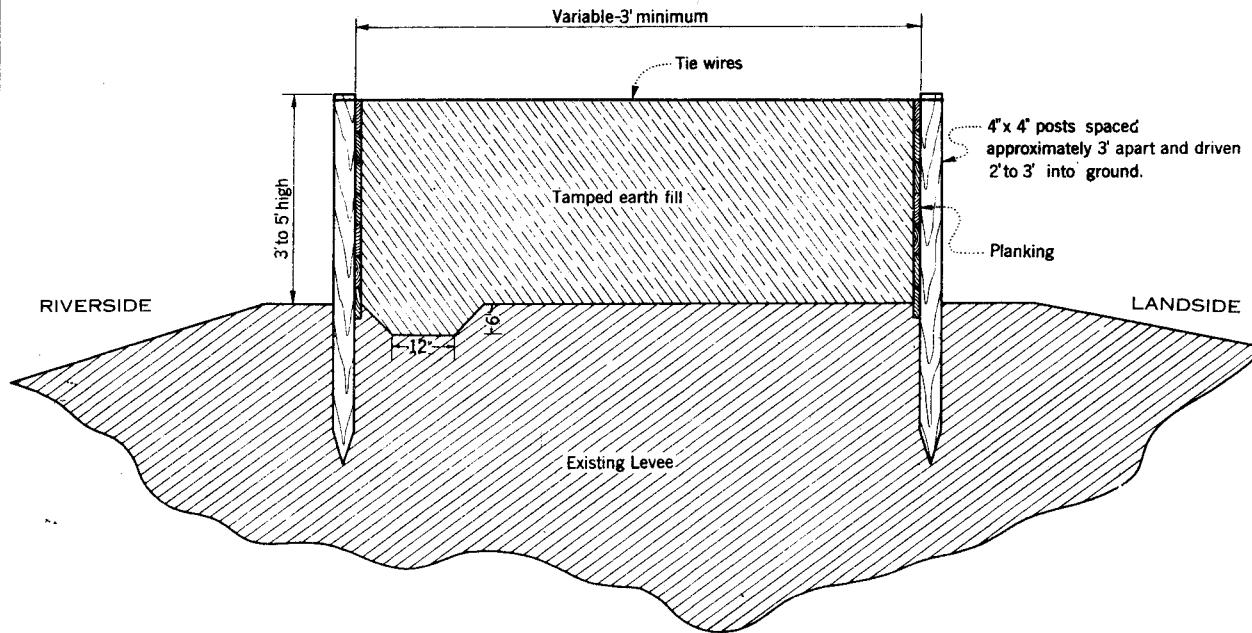


BILL OF MATERIAL TO CONSTRUCT 100' TOPPING

- 25 pieces 1' x 12' x 12'-0"
- 17 pieces 2'x 4"x 10'-0"
- 17 pieces 2"x 4"x 6'-0" (sharpened)
- 17 pieces 2"x 4"x 2'-0" (sharpened)
- 1 lb.-8d nails
- 2 lbs.-16d nails
- 1100 bags

FLOOD CONTROL LEVEES
HIGHWATER MAINTENANCE
LUMBER AND SACK TOPPING

Seattle District, Seattle, Wash.



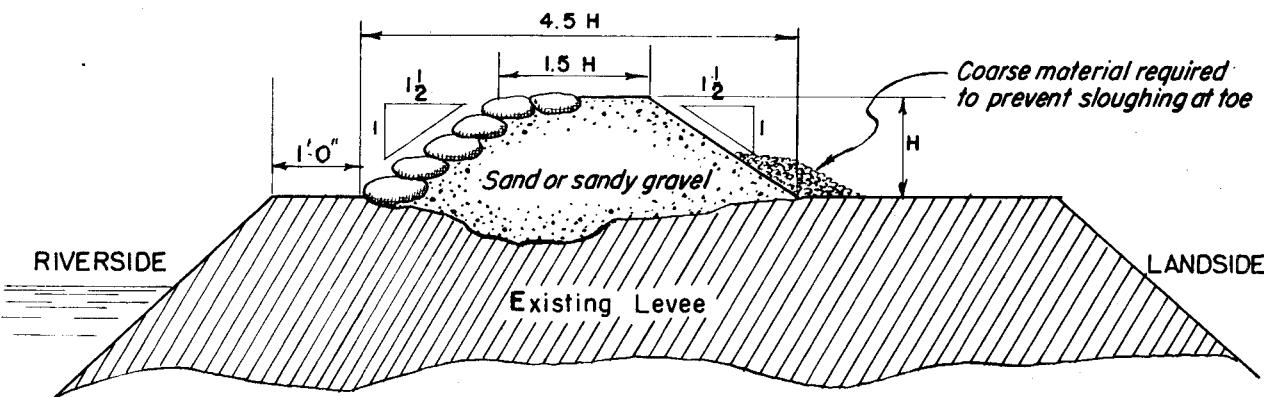
Note:

Surface vegetation to be stripped or
bonding trench excavated to insure seal.

SECTION

BILL OF MATERIAL PER 100 LINEAR FEET		
3 Feet high	4 Feet high	5 Feet high
*62 pieces 4"x4"x6'-0" 100 pieces 1"x8"x10'-0" 7½ lbs.-8d nails 400 l.f.-No. 9 wire *Sharpened	*62 pieces 4"x4"x7'-0" 140 pieces 1"x8"x10'-0" 9½ lbs.-8d nails 400 l.f.-No. 9 wire	*62 pieces 4"x4"x8'-0" 180 pieces 1"x8"x10'-0" 11½ lbs.-8d nails 400 l.f.-No. 9 wire

FLOOD CONTROL LEVEES
HIGHWATER MAINTENANCE
EXTENSION OF HEIGHT
Seattle District, Seattle, Wash.



SECTION

FLOOD CONTROL LEVEES
HIGHWATER MAINTENANCE
EARTH AND SACK TOPPING
Seattle District, Seattle, Wash.

SKETCH NO.

✓ Floodgates From Yakima

#1 Spring creek

#2 ~~Not Hill~~ Home Wrecking - County Pit

#3 Road behind Central Pit -

#4 North of Flakely Tokes (by log
on Dike)

#5 Straight out from White Pass
Chinook Pass sign of off ramp

#6 Around Little Pond to

#7 ~~twid~~ Bridges

#8 "

#9 Just west of RR Bridge across
~~Yakima~~ River - 1500' East of
Concrete Gauge Bldg.

#10 Next to Telephone Cable
Crossing & Light Pole ~~#1~~
~~800~~

#11 Next to MP 201 ~~+~~ 200'
East of (Acc Hardware) White Line

#12 MP 201.20 Across
from Acc Hardware loading
clocks (marked by yellow
post)

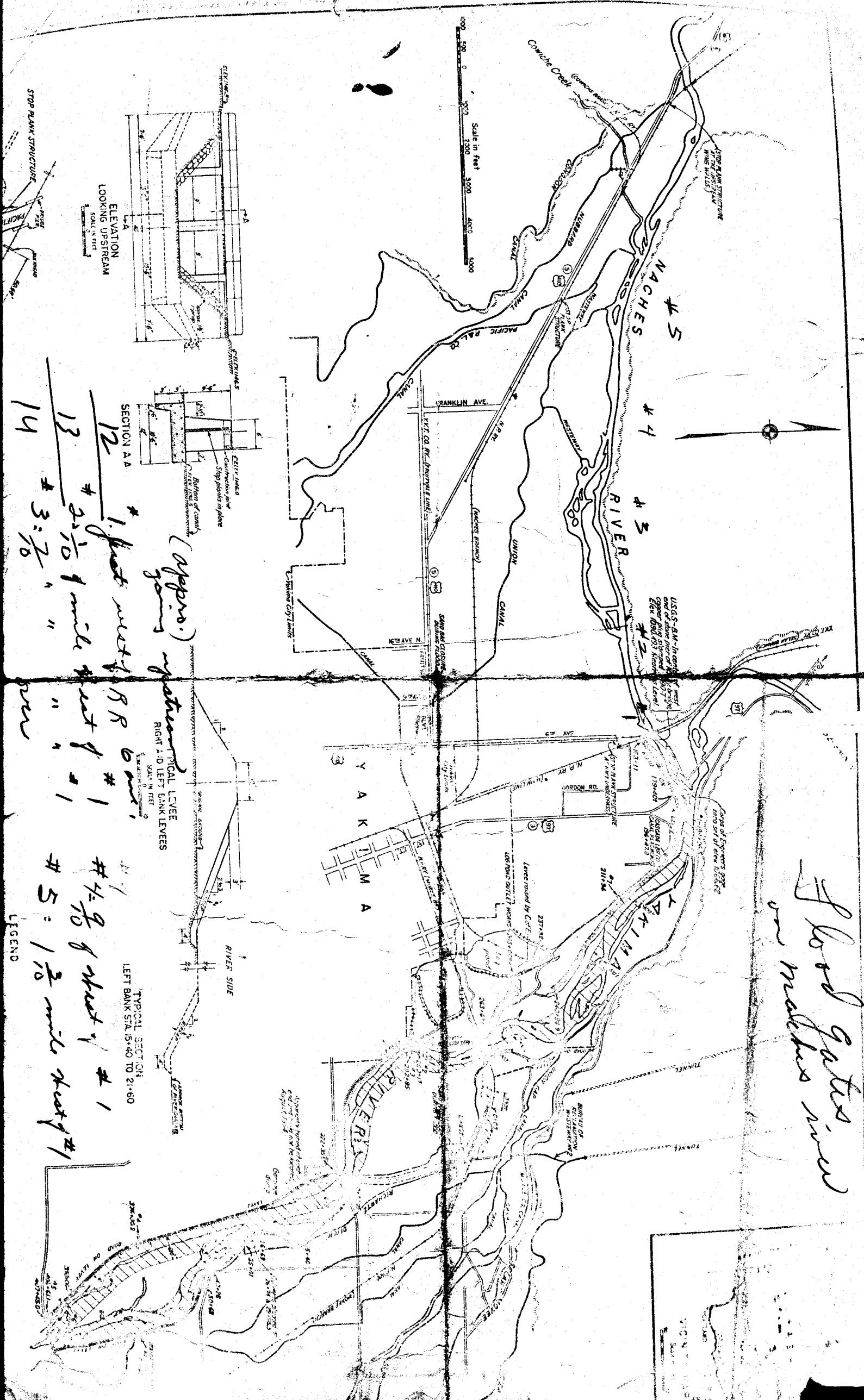
13 40th Ave Ext
Bld#9* Freeway entrance
from 40th wooden Bldg
contains wooden gates
Boards #15 Painted Rocks Bldg holds
Boards - (small bldg)
#76 Gate Remained - metal
metal only as cover
End of 4 lane at Nachos
Fruit Stand Pole H
East of Nachos Sewage
Treatment Plant

Bl. t. or yellow
charge to Dikes
RIP

~~Possibly 1 6th 6th~~
Ave. 5th or RR

On East Side - Between Hartford & Marsh
Dd Hartford just ~~west~~ of Canal
Dd dike North app 1000 from Hartford

of flood gates river
on Naches river



II 26 1.38 Mi. N. of
w. Birch Field. on The Dike

#27 1.08 Mi.

28 .98 MI.

29 .83 Mi.

30 .43 Mi.