OPERATION AND MAINTENANCE MANUAL
NEW HAVEN, MISSOURI, FLOOD PROTECTION PROJECT
MISSOURI RIVER

(Entire Volume Revised June 1979)

DEPARTMENT OF THE ARMY
Kansas City District, Corps of Engineers
Kansas City, Missouri

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PREFACE

This manual contains detailed information on the operation and maintenance of the New Haven, Missouri, Flood Protection Project. It is furnished for the guidance of the local interests as outlined in the "Flood Control Regulation-Maintenance and Operation of Flood Control Works" approved by the acting Secretary of the Army on 9 August 1944 and made a part of this manual as Exhibit A.

A comprehensive reading of this manual and close adherence to the procedures prescribed for inspection, maintenance, and operation will insure successful functioning of the protective works and will comply with the above-mentioned regulations. Improper or inadequate practices may easily lead to structural failure during flood conditions, nullifying the benefits otherwise attainable. Therefore, only the most capable personnel available should be used for the supervision and performance of these tasks. This responsibility is an exceedingly important undertaking, since any small neglect could easily result in damage to property, loss of life, and serious impairment of public confidence in the security provided by the protective works. Any one of these consequences would defeat the desired objectives of the levee unit.

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OPERATION AND MAINTENANCE MANUAL
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DEPARTMENT OF THE ARMY
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CHAPTER 1

INTRODUCTION

1-01. Purpose of Manual. The purpose of this manual is to present detailed information for the use and guidance of local interests in the operation and maintenance of the New Haven, Missouri Flood Protection Project. Rigid adherence to the inspection procedures and full utilization of the descriptive material in this manual will facilitate compliance with regulations and insure successful functioning of the protective works. Improper or inadequate practices for maintenance and operation may easily lead to structural failure during flood conditions.

1-02. Parts and Scope of Manual. The complete manual is divided into several sections. The main body of the manual contains detailed information on the operation and maintenance of the unit as well as detailed information on operation, maintenance, safety, and inspection procedures of the pumping plant. In addition, the following are included in the manual:

a. Inclosures. Inclosure 1 contains names and phone numbers of personnel to be contacted in response to flood fighting. Inclosure 2 consists of "as-built" record drawings.

b. Exhibits. The exhibits consist of Federal regulations, local sponsor's resolutions, maintenance checklist, logs of operations, and drawings of emergency treatments.

c. Appendixes. Appendix I contains "as-built" shop drawings. Appendix II is a copy of the "General Safety Requirements." The appendixes are bound separately.

d. Photographs. Appropriate photographs are included.

1-03. Authority. The local protection project for New Haven, Missouri was included under provisions of Section 205, of Public Law 858, Eightieth Congress, second session, as amended by Section 212 of the Flood Control Act approved 17 May 1950.

1-04. Local Cooperation. The city of New Haven, Missouri furnished the required assurances of local cooperation by a resolution dated 26 April 1954. A copy of the resolution is included as Exhibit B.

1-05. Location and Description. The New Haven, Missouri Flood Protection Project protects the city of New Haven, which is located in Franklin County, about midway between Jefferson City and St. Louis on the right bank of the Missouri River between river miles 81.4 and 81.7. The flood protection project consists of earthen levee embankment, drainage facilities, riprap slopes and toe protection on riverside slope, seeding of crown and landside slope, ramps, and a pumping plant.

1-06. Pertinent Data.

Levee	2,230 lin. ft.
Drainage Structures	6 each
Pumping Plant (Sanitary Lift Station)	1 each

1-07. Need for Project. New Haven is a marketing and distribution center for the surrounding agricultural area, and several manufacturing establishments are located in or near the city. There was a maximum flood of record in 1844. In an 80-year period from 1873 to 1953, serious overbank flooding has occurred 12 times and lesser floods have occurred 49 times. The greatest flood of recent record occurred in July 1951. Studies were made subsequent to the 1951 flood, and a local flood protection plan was proposed. The plan was authorized and construction began in September 1954.

The flood protection project protects an area of seven blocks of business and residential property between the river bank and the Missouri Pacific Railroad tracks along the base of a high bluff.

1-08. Construction History. The contract for the construction of the pumping plant, diversion box, levee, and appurtenances was awarded 11 August 1954 to the J.B. Vandiver Construction Company. Work started 2 September 1954 and was completed on 6 April 1955. A 10-inch sewer pipe located at station 15+50 was extended by hired labor in 1956.

CHAPTER 2

GENERAL INFORMATION

2-01. General Rules and Procedures. The general rules by which local interests will be governed in the maintenance and operation of New Haven, Missouri Flood Protection Project are contained in "Flood Control Regulations - Maintenance and Operation of Flood Control Works" as approved by the acting Secretary of the Army on 9 August 1944, and published in the Federal Register of 17 August 1944. A copy of this regulation is bound in this volume as Exhibit A. This regulation is of a general nature and does not give detailed instructions for this specific project. In the following text, reference is made to appropriate paragraphs of the regulation with additional information furnished as applicable to this project.

a. General responsibilities are covered in paragraphs (a) (1), and (a) (10).

b. Local agency is defined in paragraph (a) (2). The city of New Haven, Missouri, is the local agency responsible for the maintenance and operation of the flood protection facilities.

c. Encroachments into or upon dedicated right-of-way are limited as indicated in paragraphs (a) (4) and (a) (5).

d. Materials. Paragraph (a) (3). A reserve supply of the material required for emergency closure and reinforcement of structures shall be maintained. These shall include, but not be limited to 3,000 sandbags; 10 round point shovels; 15 long handle and 15 short "D" handle shovels; and 15 each battery powered lanterns and flashlights.

e. Improvements or Alterations. Paragraphs (a) (4) and (a) (5). Drawings or prints of proposed improvements or alterations to the protective works including adjacent landside and riverside areas shall be submitted to the District Engineer, Kansas City District, Corps of Engineers, sufficiently in advance of proposed construction period to permit adequate study and consideration of the proposed work. After completion of the work, Record Drawings showing improvements or alterations "as-built" shall be furnished to the District Engineer.

f. Semiannual report of inspection, operation and maintenance of the flood control works shall be as required in paragraph (a) (6). The report shall be prepared by the Superintendent and submitted by the city of New Haven, Missouri, to the District Engineer to arrive on or before 1 April and 1 October of each year. The report should include the following items:

(1) Logs of operation.

(2) Dated copies of inspection checklists.

(3) Permanent repairs, description and date completed.

(4) Public comment and instances of public cooperation, where applicable.

g. Government Access and Directed Repairs. Paragraphs (a) (7) and (a) (8).

h. Agreements are defined in paragraph (a) (9).

i. Periodic inspections are required in paragraphs (b) (1) "Levees," (d) (1) "Drainage Structures," (f) (1) "Pumping Plants," and (h) (1) "Miscellaneous Facilities," and shall be performed as follows:

(1) Prior to the major flood season.

(2) Immediately following each major high-water period.

(3) Intermittently, at periods not to exceed 90 days.

(4) At other times as indicated by potential threat of flood following damage to the protective facilities.

2-02. Checklists. Exhibits C thru E are sample checklists furnished for reproduction and use by the sponsor. They provide a guide to aid in determining the state of maintenance and potential sources of trouble for each feature requiring attention. Items requiring maintenance should be noted to indicate the nature and extent of the problem. Where no deficiencies are found, this should be indicated by a check mark in the appropriate space.

2-03. Logs of Operation. Sample copies of the logs of operation for the various project elements are included as Exhibits M thru O of this manual. These logs are to be executed and delivered to the District Engineer each time the features are operated under flood or threat of flood conditions.

2-04. Drawings. Detailed "as-built" record drawings of the protective works are included in Inclosure 2 of this manual.

2-05. Safety in Operation and Maintenance. A copy of the manual "General Safety Requirements" is included in Appendix II of this manual. Both the frequency and the severity of accidents can be reduced by following the recommended practices. The Superintendent and the workmen should be familiar with all of the procedures applicable to the project.

CHAPTER 3

LEVEES

3-01. Description. The compacted earthfill levee encircles the lowland on three sides and ties into the Missouri Pacific Railroad embankment immediately upstream and downstream from the project area. The levee was constructed with a crown width of 8 feet, a 1V on 3H riverside slope and 1V on 2.5H landside slope.

The crown, landside slope, and berms are protected by sod. Riprap protection was applied to the riverside slope between stations 0+30 and 18+75. The riverside slope between stations 18+75 and 22+59.42 is protected by sod. Earthen ramps with 10-foot crowns and 1V on 3H side slopes were constructed at stations 20+45 and 21+20. Berms have been added to the landside levee slopes at appropriate locations for stability. The details and limits of the berms are shown on the record drawings.

3-02. Maintenance and Inspection. The city of New Haven, Missouri, shall continuously provide the maintenance and inspection required to keep the levee functional in time of flood.

a. Maintenance Measures.

(1) Promote and maintain growth of sod.

(2) Exterminate burrowing animals and repair damages.

(3) Provide for routine mowing of grass and weeds.

(4) Remove wild growth and drift deposits in the floodway.

(5) Repair damage to riprap, grouted gutters, and slopes caused by erosion and other forces.

(6) Maintain access roads and ramps.

(7) Remove trash, refuse, and other objectionable material from the levee crown and slopes.

(8) Replace any surfacing material which has been displaced, washed out, or removed.

(9) Remove willows, weeds, and other vegetation from the riprap.

(10) To avoid damage to the levee system, the following items should be ovserved:

(a) The stability berms must not be disturbed in any way including cultivation.

(b) All excavation riverward and within 500 feet landward of the levee centerline, including those for building foundation basements, loading pits, ditches, pipe trenches, or similar excavations must be accomplished in such a manner so as to not create underseepage problems which might result in levee failure during floods. Slabs, tanks, buried lines, and walls must be constructed in such a manner as to not create underseepage problems which might result in levee failure during floods. Slabs and walls must be designed to withstand water pressure forces for a maximum flood in addition to the usual stresses. To insure that any proposed construction within the above limits will not create a hazard, proposed construction plans for construction in these areas shall be submitted for review and comment to the District Engineer. Adequate time, dependent on the complexity, should be scheduled between submission and start of construction.

(c) Soil shall not be removed from the berm areas, and ditching through or along berms will not be permitted.

(d) Sod cover must be insured on the levee slopes.

b. Inspections. Periodic inspections shall be made by the Superintendent at the times specified in paragraph 2-01, i, "Periodic Inspections," to insure that the maintenance measures are being effectively carried out, and further to be certain that:

(1) None of the acts listed in paragraph 3-02 a. (10) above have been performed.

(2) Maintenance measures listed in paragraph 3-02 a. (1) through (9) above have been performed.

(3) No unusual settlement, sloughing, or material loss of grade or levee crown section has taken place.

(4) There is no caving or sliding of material on either side of the levee which might affect stability.

(5) There is evidence of seepage, saturated areas, or sand boils, and runoff is not ponding along the levee toe.

(6) Drainage structures through the levee are in good condition.

(7) Riprap has not been displaced, washed out, or removed.

(8) Nothing is being done to inhibit or discourage the development of sod, such as burning off growth in inappropriate seasons.

(9) Access roads are properly maintained and closed to public where applicable.

(10) The levee crown is closed to unauthorized traffic.

c. Inspection of Deficiencies. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accomplished during the appropriate season.

3-03. Checklist. A form suggested as a checklist for reporting inspections of levees is given in Exhibit C.

3-04. Correction of dangerous conditions, exposed by inspection or through other means, should be accomplished immediately.

3-05. Use of Chemical Sprays. The use of chemical sprays for control of weeds and other vegetation should be checked with the appropriate state authorities before being used.

CHAPTER 4

DRAINAGE STRUCTURES

4-01. Description. Drainage Structures. There are six drainage structures which pass through the levee to provide drainage from the protected area. The locations of the drainage structures are given on the "as-built" drawings and on the checklist, Exhibit D.

4-02. Maintenance.

a. Gates shall be examined and trial operated at intervals not to exceed 90 days. Inspections shall be made at the times specified in paragraph 2-01, i, "Periodic Inspections," to ascertain that:

(1) Pipes, gates, riprap, headwalls, and operating mechanisms are in good condition.

(2) Fires are not being built in or near the structures.

(3) Inlet and outlet channels are open and clear of trash, debris, sediment deposits, and heavy growth.

(4) Safety or stability of the structures is not endangered through erosion.

(5) Gatewells are not plugged or damaged.

b. Damaged, broken, or missing parts shall be repaired or replaced immediately. Conditions or practices contributing to damage through erosion or other actions shall be corrected and the damaged areas repaired.

c. Lubricants for protection and for working parts of sluice gates and for floorstands should be a lithium base, NLCI No. 2, water resistant grease, containing anticorrosion and antioxidation additives, such as Philube APGO by Phillips Petroleum Co. or Multifak EP No. 2 By Texaco Oil Co. It is recommended that cartridge packaged greases loaded in suitable hand-operated grease guns be used. Cartridge packaged greases are convenient to store, load and identify, and are not readily contaminated by dust and sand.

d. Sluice gates shall be test operated, the wedges and guides inspected, and the stem and floorstand (hoist) lubricated each March. Lubrication points on the floorstand and sluice gate are indicated by grease fittings. The lifting stem and guides should be kept coated with grease to inhibit corrosion and to discourage vandalism.

This coating should be replaced as necessary each March and after each operation of the gate. The threaded portion of the stem shall be visually examined and hand lubricated in those years with either 5 or 0 as the final digit. The stem cover is removed by unbolting the flange at the floorstand. The inspection, lubrication and replacement of the stem cover should be completed as rapidly as possible to prevent contamination of the lubrication.

e. Flap gates shall be inspected, oiled, and trial-operated at least every 90 days for correct operation and proper seating. The screws fixing the flap gate to the hinge bar shall be checked and adjusted to permit the gate to close tightly. Silt and debris shall be removed to provide free gate movement. Approach ditches shall be cleared only to the design flow line.

f. Related shop drawings are filed in Appendix I.

4-03. Checklist for reporting drainage structure inspections are given in Exhibit D. One complete list should be used for each inspection and as many as necessary for all conditions.

4-04. Safety. Two men should always be present during maintenance, inspection or operation of all drainage structures. When entering a drainage structure, one man should remain on the surface while the man entering the structure should wear a safety harness or belt with a rope attached. The man on the surface should snub the rope around a solid object in case the man entering the structure slips and/or falls. All personnel should be aware of the possibility of the accumulation of sewer gas and take appropriate safety measures.

CHAPTER 5

PUMPING PLANT

5-01. Location and Description. A complete underground pumping plant for removal of sanitary sewage is located at levee station 15+45.3. Sewage will flow by gravity to the river during normal river stages, but during high river stages, the sewage is diverted to the pumping plant. The pumping station is of welded steel construction, consisting of a chamber for pumps and accessories and an access tube extending from the pump chamber to ground level.

5-02. Electrical Power. Electrical power for operation of the pumps and other electrical equipment is supplied at 220 volts, 3 phase, 60 cycle. A main disconnect switch for the pumping plant is located on a service pole outside the plant. The switch for control of the station lights and blower fan is also located on the service pole. Circuit breakers, motor starters, relays, and other control equipment are installed in a common cabinet in the pump chamber.

5-03. Pumps and Motors.

a. Two main pumps capable of delivering 200 gpm at a total dynamic head of 25 feet are installed in the pumping plant. Each pump is operated by a 3 hp, 1,150 rpm, 3 phase, 60 cycle, 220 volt motor. The pumps installed are 4-inch, Figure 5432-K, Fairbanks, Morse & Company units.

b. Sump Pump. The sump pump is a submersible unit rated at 1,000 gph at a total dynamic head of 20 feet. The pump is controlled automatically by a built-in float. It discharges back into the wet well through a 1-1/4-inch galvanized pipe. Two check valves and a gate valve are installed in the discharge line to regulate flow. The sump pump is a Piqua Machine and Manufacturing Company product.

5-04. Pump Controls. To control the operation of the pumps with variations of sewage level in the wet well, an air bubbler system is provided, complete with air compressor, air and fluid reservoir, needle valve, flow meter, bubble line to the wet well, and sensitive pressure switches for each pump. The unit is operated by forcing air from the air compressor through the vertical pipe dropped into the wet well. Variations in liquid level produce corresponding variations in the air pressure necessary to maintain bubbling. This air pressure operates the pressure switches in the pump control circuits, providing automatic starting and stopping of each pump.

a. Air Flow Meter. The air flow meter includes a heavy plastic pot through which the air will bubble just as it does in the wet well. This pot permits visual checking of bubbling rate at the control site.

A needle valve is installed in the air line to regulate the air flow. After initial installation, no adjustment of the air flow meter should be made. The needle valve should be left in its original position.

b. Pump Alternator. An automatic alternator with manual disconnect is provided to reverse the sequence of pump operation on the completion of each pumping cycle. Provision is also made for both pumps to operate in parallel should the level in the wet well continue to raise above the starting level of the low level pump.

c. Circuit Breakers. Thermal magnetic circuit breakers with dead fronts are provided, both as disconnecting switches and overload protection for each motor, for the motor pilot circuits, and each of four service units.

d. Motor Starters. Magnetic across the line starters with thermal overload protection and under voltage release are installed for each pump. A Hand-Off-Automatic switch is provided for automatic or manual operation of each main pump.

5-05. Dehumidifier and Ventilating Blower.

a. Dehumidifier. A Victor, Model DH-3A dehumidifier assembly is furnished to maintain the relative humidity of the air in the pump chamber low enough to keep the electrical equipment dry and to prevent condensation on the walls in the pump chamber. The dehumidifier is operated automatically by an adjustable humidistat with a low air temperature cut-out, which in turn operates a heavy duty relay for the dehumidifier motor. The condensate is drained to the sump.

b. Ventilating Blower. A 4-inch air intake line is coupled to a blower in the station so as to draw fresh air from the outside and discharge it directly into the inlet of the dehumidifier so that most moisture may be removed before the air is circulated within the station. Another blower is piped to pick up air from within 18 inches of the floor and discharge it through a 4-inch pipe to the outside air.

5-06. Wet Well. The wet well adjacent to the pumping plant is a reinforced concrete structure. The sanitary sewer during low river stages flows in piping through the wet well to the outlet structure. During high river stages the outfall sewer to the river is closed off by means of a gate valve in the wet well. Sewage flow is directed to the pumping plant by opening the by-pass line gate valve. Sewage will then flow through a trash screen into the wet well.

5-07. Miscellaneous Piping. The main pumps take suction in the wet well through 4-inch suction lines. A common 6-inch pump discharge line is connected to the outfall sewer.

5-08. Planned Maintenance. Proper operation of the pumping plant facilities must include a program that will serve to eliminate equipment failures and thus enable the unhampered functioning of the plant. Such a plan calls for detection and correction of incipient faults. This is brought about by frequent inspections, proper lubrication, and the prompt replacement or repair of worn parts. To prevent breakdown, all operating equipment must be periodically and systematically inspected, lubricated, and overhauled. In addition, a properly functioning maintenance program calls for a system of permanent records. A planned program should accomplish the following objectives:

a. Schedule inspections, lubrication, and necessary repair of regular and stand-by equipment on a definite periodic basis.

b. Arrange preventive maintenance work so that it is evenly distributed throughout the year, thereby eliminating excessively busy weeks for the maintenance crew with accompanying haphazard inspections.

c. Create a permanent record, easily and quickly accessible, of the maintenance work called for and performed upon each item of equipment.

d. Schedule maintenance work so that similar or related work is done consecutively, thereby utilizing available manpower to the best advantage.

e. Provide a record of the maintenance work to be performed upon each piece of equipment at given times during the year.

5-09. Pumping Station and Small Equipment. The pumping station and small equipment should be checked during each inspection to be certain that:

a. Exposed metal is adequately covered with paint.

b. Wet well is free from silt and other debris.

c. Vents are free.

d. Trash screen in wet well and access covers are in place and free from debris.

e. Gate valves and stems are in good mechanical condition and adequately lubricated.

f. Pumps, motors and other equipment having moving parts have been lubricated with the type and amount of lubricant specified by the manufacturer of the respective machinery units.

g. All lamp sockets are filled with light bulbs of proper illuminating capacity in serviceable condition.

h. Pump chamber has been cleaned and equipment wiped off and left in a clean and ready to operate condition.

i. An adequate supply of lubricants is on hand.

j. Operation and maintenance manual is available in the plant.

5-10. Interior Electrical System.

a. Conductors. All conductors in the interior of the pumping plant are rated at 600 volts. The general appearance of all conductors shall be checked as far as practicable. Particular attention should be given to taps and splices. Whenever one conductor is attached to another by means of a connector, the latter should be carefully inspected for tightness and sufficient clearance between metal parts to prevent short circuiting when the equipment is in operation. Insulation resistance measurements on all connectors mentioned in subparagraphs (1), (2), and (3) below, should be made by means of a 500 volt Megger or equivalent instrument at intervals not exceeding one year. Megger tests should also be made whenever it is suspected that interior wiring, especially that in the windings of the pump motors, has become damp. Complete records shall be made of all of these tests. The interior wiring is composed of a number of elements, several of which may be tested at once. However, if an adverse reading results, the tests should be repeated after eliminating, one at a time, each of the component parts until the offending one is located. Megger reading lower than the specified minimum indicates damp or faulty insulation, constituting a potential hazard to operation of the system. All wires with insufficient insulation resistance should be replaced with new conductors. A splice should never be pulled into a conduit. The main circuit breaker shall be in the open position during tests.

(1) 220-Volt Circuit. With all motor control circuit breakers closed, the handle of the Hand-Off-Automatic switch in the automatic position, and the thermal overload relay in the closed position (closed position may be assured by pressing on the reset button), a reading of the Megger is taken between any one of the load terminals of the main circuit breaker and ground. The Megger reading obtained from the above tests should not be less than one megohm.

(2) Motor Winding Circuit. To obtain reliable information on the condition of the stator winding of a motor requires careful test procedure and discerning interpretation of results. The following steps in procedure are given as a guide, but individual initiative must be exercised in drawing conclusions therefrom:

(a) With the motor cold and the circuit breakers in the open position, a Megger reading (insulation resistance) is obtained for each motor between any one of the three motor terminals and ground.

(b) If the minimum insulation resistance is below one megohm, disconnect the motor leads at the motor and repeat the Megger tests at the motor terminals. If the latter reading shows a marked decrease from previously observed values and falls below the recommended minimum, consideration should be given to drying out windings immediately.

(c) If the test values fall above the minimum value, the winding is satisfactory; if it falls below and is considerably lower than previous readings, the winding insulation is deteriorating or damp. The motor may give satisfactory service below the recommended minimum, but moisture in the winding should be removed at the earliest opportunity.

(3) 120-Volt Circuit. With the line and load terminals of the neutral bar in the lighting panel disconnected, and with all lamps in place and all circuit breakers and switches closed, a Megger reading is obtained between one of the disconnected leads and ground. The reading should not be less than one megohm. After the test is made, the leads terminating at the neutral bar should be securely replaced.

b. Air Circuit Breakers. The condition of the air circuit breaker contacts should be noted at the time of each inspection. The wiping action of arms should be checked for proper alinement and movement. Dirt and dust shall not be allowed to accumulate on the unit.

c. Motor Control Units. Motor control units should be kept dry and free from dust. The contacts of the units shall be examined for evidence of excessive roughness or burning. Poor contacts shall be dressed with sandpaper or a fine file. A coil may burn out on occasions, and in this case a continuity test will readily reveal when a coil is faulty. A new coil should be used to replace the damaged one, and repair of the faulty coil should not be attempted.

d. Motors.

(1) Oiling. The oil lubricated bearings of the motors will require inspection, and lubrication will be required as needed. The bearings should be kept filled to within 1/8-inch of the top of the oil filling cup with a high grade of automotive lubricating oil, having a viscosity of SAE #10 and being free from acid or alkali. The oil should be changed once a year. In changing oil, the motor should first be operated to warm the oil, and then ample time should be allowed for draining oil after the motor has been stopped. New oil should be poured in the overflow cup while the motor is at rest.

(2) Electrical Conditions. A motor will overheat due to abnormal electrical conditions, such as prolonged overload current resulting from pump load or due to low voltage on a normally loaded motor.

The voltage and current on the motor should be ascertained and compared with the rated values stamped on the name plate. Motor operation may be adversely affected by the presence of a ground in the motor windings, especially in the splices at the junction box on the yoke, where the power loads are connected to the stator windings. The existence of grounds may be detected by a Megger test.

(3) Moisture. During the interval between inspections, moisture may collect in the motor windings. Two methods of drying out motor windings are in general use. The recommended method is by application of heat under a canvas cover, well vented to allow escape of the moisture. The other method, in which extreme care must be exercised, is by circulating a current through the windings at low voltage. This method should be applied only by skilled technicians. An exceptionally low insulation resistance reading indicates probable contact between stator winding and frame. In this instance, drying out of the motor should be deferred until the ground is repaired.

e. Lighting and Convenience Outlets. All circuit breakers should be inspected visually and damaged units replaced with new ones of like size and type. All reflectors, lamps and globes should be cleaned at least once each year. Defective lamp bulbs should be replaced with new bulbs. Switches and convenience outlets used infrequently should be operated several times to prevent oxidation of contacts which may cause faulty operation. Switch and convenience outlet boxes shall be checked annually for evidence of accumulation of dust or dirt.

5-11. Pumps. Inspection of the pump impellers shall be made annually for evidence of damage, pitting, or looseness on shaft. Packing glands shall be checked annually to determine that they are not deteriorating or fitting loosely. Excessive vertical play in the pump impeller shaft should be eliminated by taking up the shaft. Pump bearings shall be greased with the type lubricant recommended by the manufacturer.

5-12. Sump Pump. At each periodic inspection, the condition of the sump pump should be noted. The freedom of operation of the float should be checked. Condition of the power cable should be noted. Any necessary repairs should be made as required.

5-13. Operation of Pumping Plant. Competent operators shall be on duty at the pumping plant 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 manufacturer's instructions and drawings and with the operating instructions for the plant. The equipment shall be operated in accordance with the aforementioned instructions. Care shall be exercised to assure that proper lubrication is being supplied all equipment, and that no overheating or undue vibration is occurring.

Immediately upon final recession of flood waters, the pumping station shall be cleaned and equipment thoroughly cleaned, oiled, and greased.

5-14. Stages to Commence Pumping Plant Operations. Pumping of storm run-off or sanitary sewage at the pumping plant will be required when the river attains such elevation as to restrict the gravity flow of the sewer into the river. Restriction of gravity flow will occur when the river reaches elevation 486.12 feet m.s.l. at the pumping station. Operating personnel should be dispatched to reach the plant prior to such time as predictions indicate that the river will attain stages at which pumping will be required, and the operators will hold the plant in operation or in constant readiness for operation until the river has receded to the elevation given above and predictions indicate that another increase in river stages is not anticipated from the current flood.

5-15. Log of Operation. The operator shall keep a log of operation for his entire duty period. This log of operation (Exhibit N) shall include the following:

a. Water elevations at 1-hour intervals.

b. A record of all operational and maintenance duties performed.

c. The exact time of manual starting or stopping of each pump.

5-16. Method of Operating Equipment.

a. Ventilation of Pumping Plant. The pump chamber shall be thoroughly ventilated by operating the ventilating blower. The blower is started by closing the main circuit breaker and the switch mounted on the service pole outside the pumping station. No person shall enter the pump chamber without one or more persons present above to provide assistance if such should become necessary. Prior to entering the pump chamber, an interval of time should be allowed to elapse for clearance of possible dangerous gases.

b. Setting of Circuit Breakers.

(1) Close the "incoming line" circuit breaker located on the service pole outside pumping station.

(2) Close the following breakers in the control cabinet located in the pump chamber:

(a) Breaker for control circuit.

(b) Breaker for transformer. This breaker shall be left closed at all times.

(c) Breaker for 110-volt supply circuit. This breaker shall be left closed at all times.

(d) Breaker for lights and blower. This breaker shall be left closed at all times.

(e) Breaker for sump pump and receptacles.

(f) Breakers for main pump motors.

c. Manually Testing Main Pumps.

(1) Lubricate motor bearings with type of lubricant recommended by the manufacturer.

(2) Operate main pumps.

(a) Turn Hand-Off-Automatic control switch to "Hand" position.

(b) Note running condition of pump and motor.

(c) Turn Hand-Off-Automatic switch to "Off" position.

(d) Record in operating log the time of checking pump and operating condition.

(e) Arrange to have necessary repairs made if required.

d. Setting of Sluice Gate and Control Valves.

(1) River elevations below 486.12 feet. At river stages below elevation 486.12 feet, (18.6 feet on New Haven Gage) the following is applicable:

(a) The 10-inch flood stop gate valve located in wet well shall be opened.

(b) The 10-inch by-pass gate valve located in the wet well shall be closed.

(c) The gate valves on the main pump suction and discharge lines shall be closed.

(2) River stages above elevation 486.12 feet (18.6 feet on New Haven Gage).

(a) The 10-inch gate valve controlling the gravity flow of the sewer shall be closed.

(b) The 10-inch by-pass valve on the sewer line shall be opened.

(c) The gate valves on the main pump suction and discharge lines shall be opened.

(d) The gate valves on the sump pump shall be opened.

e. Operate Main Pumps Automatically.

(1) Turn Hand-Off-Automatic switch to "Automatic" position.

(2) Pumps will operate automatically. In case of failure of automatic controls or other emergency, either pump may be started and operated manually by turning the Hand-Off-Automatic switch to "Hand" position.

5-17. Preparation of Plant for Standby Status. Immediately following the return of the river to normal stages, after a flood requiring operation of the pumping plant, the pumps and operating equipment should be placed in order for lay-up during off-flood periods.

a. Gate Valves.

(1) Close 10-inch by-pass gate valve located in wet well.

(2) Open 10-inch flood stop gate valve located in wet well.

b. Pumps and Motors.

(1) Operate main pumps manually to remove water from wet well.

(2) Close gate valves on suction and discharge lines after wet well is dewatered.

(3) Remove drain plate from pump, drain pump and piping, and replace plate.

(4) Inspect pumps and piping.

(5) Grease and oil pump equipment for standby.

(6) Make arrangements for necessary repair or replacement.

c. Electrical Controls.

(1) Control cabinet in pump chamber.

(a) Close breaker for transformer.

(b) Close breaker for 110-volt supply circuit.

(c) Close breaker for lights and blower.

(d) Close breaker for dehumidifier.

(e) Open breaker for sump pump and receptacles.

(f) Open breaker for control circuit.

(g) Open breakers for main pump motors.

NOTE: The four breakers above should be left in the closed position to permit operation of the ventilating blower from outside the station and to operate the dehumidifier automatically.

(2) Service pole outside pumping station.

(a) Open disconnect switch operating plant lights and blower.

(b) Close main circuit breaker to permit operation of dehumidifier during standby period.

d. Trash Racks and Miscellaneous.

(1) Clean off trash screen located in wet well.

(2) Inspect trash screen and arrange for necessary repairs if required.

(3) Clean out pump chamber and wipe off equipment and machinery.

(4) Replace all manhole covers.

(5) All metal surfaces from which paint has been removed shall be repainted with the same quality and color.

e. Lock plant for protection of pumping machinery.

f. Record in operating log condition of the plant and the necessary repairs (see Exhibit E).

CHAPTER 6

MAINTENANCE DURING FLOODS

6-01. General. This chapter consists of general statements on standard practices which have been used to advantage during flood patrols with particular reference to levees. If problems arise which are not covered by these suggestions and there is doubt as to the procedure to be used, the city of New Haven, Missouri, should consult the Corps of Engineers (see Inclosure 1) for advice and assistance as necessary. The methods of combating various problems which may occur in an earthen levee are described in the following paragraphs and have proved effective during many years of use by the Corps of Engineers.

6-02. Sand boils.

a. General. A sand boil is the result of a transfer (through a pervious stratum under the levee) of pressure head and seepage from the river to some point landward of the levee at, or near, the ground surface level. This seepage tends to push its way to the surface and actually floats the material grains or particles through which it flows. If the weight of the more impervious soil blanket overlying the pervious stratum (aquifer) in which the flow is occurring is sufficient to counterbalance this excess pressure, no harmful effect results. When the soil stratum overlying the pervious layer fails to counterbalance the upward pressure, or when no such stratum exists, boils break through the landside surface. The sand boils may discharge relatively clear water or the discharge may contain quantities of sand and silt, depending upon the magnitude of the excess pressure and the size of the boil. CLEAR WATER DISCHARGE IS ADVANTAGEOUS. WATER CONTAINING SOIL PARTICLES IS SERIOUS. Since any boil indicates a serious landside condition and may grow from small to large very quickly and may change from clear water to water-carrying soil, all boils should be watched closely. Any boil represents potential failure of the levee.

b. Effects of Sand Boils. Sand boils can produce three distinctly different adverse effects on the levee as illustrated in Exhibit F.

(1) Development of Pipe under Levee (Figure 1, Exhibit F). Steadily increasing underseepage discharge can create a very definite pipe or seepage path under the levee which breaks out at the landward toe in the form of one or more large sand boils. Unless checked, a solution channel resembling a small cavern is created under the levee, causing subsidence and subsequent overtopping.

(2) Sloughing of Landside Slope (Figure 2, Exhibit F). Pressurized seepage water flows from under the levee without following a well-defined path and results in one or more large sand boils outcropping at or near the landside toe. The flow from these boils tends to produce sloughing of the slope evidenced by cutting and raveling of the landside toe.

(3) Development of Shear Slide (Figure 3, Exhibit F). Numerous small boils, many of which are scarcely noticeable, may outcrop at or near the toe of the levee. While no boil may appear dangerous in itself, a group of boils may indicate flotation of soil and erosion of the toe, and cause ultimate failure of the slope through sliding.

c. Method of Treatment.

(1) The accepted method of treating sand boils containing soil particles is to construct a ring of sandbags around the boil, building up a head of water within the ring sufficient to counter-balance the upward pressure and prevent any movement of sand and silt (see Exhibit G).

(a) The entire base for the sack ring is cleared of debris in order to provide watertight contact between the natural ground and the sandbags.

(b) Sandbags are then laid in a ring and each bag tamped into place around the sand boil or group of boils; subsequent layers are built on the top of the previous layer with the joints staggered for stability (see Exhibit G).

(c) The ring is carried only to a height sufficient to assure discharge of clear water in the boil. The ring should not entirely stop the flow of water.

(d) A spillway may be built of sandbags as shown on Exhibit G to carry off the overflow water.

(2) Actual conditions at each sand boil will determine the exact dimensions of the ring. The necessary diameter and height of the ring will depend upon the size of the boil and the flow water. In general, the following considerations will govern:

(a) The base width (wall thickness) of the sandbag ring should not be less than 1-1/2 times the contemplated height. This height should be determined for the maximum predicated flood stage (see Exhibit G).

(b) "Weak" or "quick" ground near the boil should be included within the ring, thereby preventing a breakthrough later.

(3) Where several sand boils are found to exist in a localized area, a ring levee of sandbags should be constructed around the entire area.

(4) In areas where sand boils are developing, all basement walls and basement floors should be watched for heaving, breakups or boil activity. It may be necessary to support basement walls or weigh down basement floors to prevent uncontrolled piping or excess seepage.

6-03. Sloughs. Water seeping through a levee first appears as a saturated area on lower portion of the slope. As the seepage increases, the saturated areas spread until the whole slope is wet and the seep water slowly flows down in a sheet. Prolonged seepage will cause the slope to become more and more saturated and soggy until it is likely to slide or even flow out, resulting in a levee failure or requiring extreme measures to prevent a failure. A slide may occur on steep slopes even though the soil does not appear to be extremely wet since the increased moisture content causes a decrease in the natural cohesive qualities of the soil and is an indication of increased differential water force. In a slide, the slope breaks away in a clearly defined crack or cleavage plan and moves downward and outward, taking the toe with it. In any case where it appears that slope failure is likely, the following measures should be instituted immediately.

a. Brush Mattress. When saturated areas appear on the landside levee slopes which might develop into sloughs, a layer of willow brush, small trees, or limbs should be laid up and down the levee slope and extend out from the slope several feet. On top of the brush, a buttress of sandbags should be built in the shape of a small berm at the toe of the levee. The sandbags should be extended up the levee slope as required to hold the brush in place, but not more than two-thirds of the distance from the toe of the slope to the top of the saturated area (see Exhibit H).

b. Board Matrress. When brush is not available or is impracticable to obtain, a board mattress may be constructed. Any width of lumber may be used, but 6- or 8-inch will probably be more available than other sizes. Lay the boards, at right angles to the levee, up and down the levee slope and as far across the berm as is considered necessary to hold the slope in place.

Spaces approximately 1 inch wide should be left between the boards. Place the top layer of boards across the bottom layer parallel to the levee with spaces approximately 2 inches wide left between the boards and weigh down with sandbags. Begin at the toe of the levee and work up and out. On levee slopes 1 on 3 and steeper, 2- by 4-inch lumber should be placed about every 3 feet in the top layer to prevent sandbags from slipping down (see Exhibit H).

6-04. Wave Wash. The patrol leaders should study the levee beforehand to determine the probable locations of wave wash. All potential trouble areas should be located well in advance; and for use in emergency, a reserve supply of partially filled sandbags and lumber should be maintained. If the slope is well sodded, a storm of an hour's duration should cause very little damage. During periods of flood stages and high wind and when waves attack a levee, ample labor should stand by with experienced personnel present to detect the beginnings of scour or beaching. Sandbags should be placed in the beached area in an effective manner as soon as possible. The sandbags should be laid in sections of sufficient length to give protection well above the anticipated rise. Rock may also be used for wave wash protection.

6-05. Scours. Careful observations should be made of the riverside of the levee for its entire length during high water periods. Trouble may be expected at road crossing ramps and at locations where pipes, sewers, and other structures penetrate the levee. If any scour is observed, soundings should be taken to observe the amount and progress of the scour. At low stages, the usual method of construction to check scour will be to construct deflection dikes, using lumber backed with sandbags, rock, or earth. At high stages, construct a protective berm over the scour area with sandbags; but dumping rock, slag, or other available durable material may be more expedient, since all work must be done from the top of the levee (see Exhibit I).

6-06. Topping. If the existing levees or floodwalls are forecasted to overtop, immediate consideration should be given to raising the levees and floodwalls. The topping may be done by (1) sandbag topping, (2) lumber and sandbag topping, and (3) earth hauling equipment.

a. Sandbag Topping. A sandbag topping may be used to raise the crown of the levee about 3 feet (see Exhibit J). The sandbags should be laid lengthwise along the levee for the first three layers, crosswise for the fourth layer, and so on.

Sandbags should be lapped at least one-third either way and mauled into place. When properly laid and tamped, one sandbag will give about 3 or 4 inches of topping. If gravel is available, it should be used for the front facing in order to prevent the finer material from being lost through leaching.

b. Lumber and Sandbag Topping. Stakes (2- by 4-inch or 2- by 6-inch) are driven in the riverside of the crown 6 feet apart and 1- by 12-inch boards nailed to the landside of the stakes. This wall, backed with a single tier of filled sandbags, will hold out at least 1 foot of water. If a second foot is necessary, the layer of sandbags will have to be increased in number and reinforced. The stakes should be driven at least 18 inches into the ground and should project out at least 3 feet. If necessary, in extreme cases, the wall could then be braced behind with sufficient sandbags and earth to provide a 3-foot topping (see Exhibit K).

c. Earth Hauling Equipment. This method should receive first consideration in raising low stretches of levee, provided the work is done well in advance of high water stages. Heavy equipment should not be allowed on the levee when the water is near the top as the vibration might cause a failure, especially to sandy levees. Under no circumstances should equipment be allowed to travel up or down the levee slopes. All equipment should use the ramp entrances.

6-07. Unauthorized Excavation. Excavation should not be permitted riverward and 500 feet landward of the levee centerline without prior approval of the Corps of Engineers and then only under closely controlled conditions (see Exhibit A). Excavation landward of the levee produces weak areas, which may permit sand boils or piping. Excavation riverward of the levee permits shortened seepage paths (see Exhibit L).

6-08. Gated Drainage Structures. The drainage structures with flap gates should be inspected frequently during flood periods to ascertain whether the flap gates are operating properly. If it is observed that a flap gate is not operating properly, and water is flowing back through the structure, the sluice gate should be closed. If the sluice gate fails to close, every effort should be made to plug the outlet structure with sandbags or any other available material. If the efforts to plug the outlet structure fail, immediate action should be taken to plug the gatewell or to build a sandbag or earth ring round the inlet structure.

CHAPTER 7

FLOOD EMERGENCY OPERATION PLAN

7-01. Introduction. This chapter contains information essential to the operation of the project during an actual flood. It gives a summary of responsibilities for forecasts, actions to be taken, personnel responsibilities and assistance by the Corps of Engineers. It also contains background information from the design studies for effective administration of the project. Maintenance, routine and under flood conditions, has been covered in preceding chapters.

7-02. River Forecasts. The River Forecast Center of the National Weather Service, National Oceanic and Atmospheric Administration, prepares crest forecasts during times of high water for the forecast gage at the Hermann, Missouri, Gage which are distributed to the public via news media. The city of New Haven may consult with the River Forecast Center or the Kansas City District, Corps of Engineers concerning flood crest forecasts. Names and telephone numbers of personnel familiar with these forecasts are given in Inclosure 1. The Kansas City District Office can provide consultation on the significance of forecasts and effects of forecast stages on the Missouri River. An excellent data collection system for the elaborate network of rainfall and stage reporting stations in the Missouri River basin supports these forecasts. There is close coordination between the Kansas City District, the Reservoir Control Center of the Missouri River Division Corps of Engineers, and the River Forecast Center of the National Weather Service, on regulation of flood storage in the complex system of multipurpose lakes in the Kansas River basin and the six large main-stem reservoirs on the Upper Missouri River.

7-03. Hydrologic Reporting Stations.

a. Rainfall. Rainfall amounts are measured and recorded at Hermann, Missouri.

b. Forecasting Gage. The Weather Bureau has a river forecasting gage at Hermann, Missouri. The gage is a Canfield Wire Weight gage and is located on the downstream side of the Highway 19 bridge, river mile 97.9. Zero of the gage is 481.6 feet, m.s.l. River stage measurements are available since 1873.

c. River Gage. The Corps of Engineers has a slope and staff gage at the foot of Pickney Street, New Haven, Missouri. The range of the gage is from 0.3 feet to 31.7 feet. Zero of the gage is 467.03 feet, m.s.l.

7-04. Operational data for an organized schedule of collection of information and of action to be taken is presented herein. The proper exercise of these methods aids in successfully passing flood flows and obtaining the full design benefit. The appropriate precedence of patrolling the structures, closing gates, stoplog gaps, and reading and reporting gage levels has been determined and tabulated.

7-05. Local Organization. The regulations quoted in paragraph 2-01, b, establish the responsibility of the Superintendent. To meet these responsibilities under flood conditions, he should organize a flood fight team from city employees. Patrol teams, of at least two men, should be assigned to particular stretches of the unit. Training sessions and drills to promote confidence and familiarity with areas and structures assigned to each team are recommended. This also has the advantage of determining potential points of weakness in the organization. Inclosure 1 contains the names and telephone numbers of the members of the local organization.

7-06. Duties of the Superintendent and Field Personnel. When notified of a forecast river rise above flood stage, the field personnel shall be alerted to report for flood duty. Preliminary actions should be taken as follows:

a. Action by the Superintendent.

(1) Arrange for condition inventory of flood fighting equipment.

(2) List available heavy equipment, motorboats and trucks.

(3) Arrange for continuous recording of gage readings.

b. Action by the Field Personnel.

(1) Determine condition of gates, structures, and freeboard gages. Make necessary repairs.

(2) Check recently repaired areas and correct deficiencies.

(3) Examine drainage ditches and remove obstructions, but do not remove turf, riprap, or other materials forming the ditch.

(4) Fill holes, gutters, and washes in the levee crown side slopes and landside berms.

Materials should be obtained from off the right-a-way unless otherwise approved by the Corps of Engineers' unit engineering advisor. Such excavation should be permitted only under direct supervision of the Superintendent. See paragraph 6-07., "Unauthorized Excavation."

(5) Check availability of necessary tools and materials (sandbags, shovels, lantern, etc.).

7-07. General Operating Procedures.

a. Levees shall be patrolled continuously for the duration of the flood threat, starting when a reading of 16 feet on the Hermann gage is recorded. Patrols shall search for imminent or potential sand boils, slides or scours and take the corrective action indicated in Chapter 3. Basements near the levee should be included in the patrol area.

b. Gage readings shall be recorded at regular intervals of 1 hour or less during the period the levee is patrolled. The record should list the date, the time, the gage level, and identification of the gage. A suggested form for this record is contained as Exhibit O. These records should be reported to the Corps of Engineers as soon as possible. A representative of the Corps of Engineers will usually be in the area during potential flood conditions and reports may be given to him. Reports can otherwise be made by telephone to the station listed on Inclosure 1.

c. Drainage structures shall, except where specifically indicated otherwise on Table I be generally operated as follows:

(1) Determine by observation that flap gates are clear of obstruction and will close automatically.

(2) Sluice gates behind flap gates will not be closed unless the flap gate does not operate properly or unless otherwise directed. Sluice gates so closed should be reopened when drainage from the protected area will flow out by gravity.

(3) Structures, while under flood conditions, shall be inspected frequently for seepage at juncture with landside slope of the levee. Proper corrective measures for this condition are described in Chapter 6.

(4) Maintain a log of operations for each structure. A recommended sample form is contained as Exhibit M. Each operation of each structure shall be logged.

7-08. Declaration of "All Clear" shall be made by responsible officials when forecasts show the critical period has passed and no subsequent threat is imminent. Immediate action should be initiated to repair damages or deficiencies in the unit.

7-09. Assistance from the Corps of Engineers is available to aid in combating floods. The Kansas City District, representing the Department of the Army locally, is assigned the following responsibilities:

a. Protect the installations and properties of the Government.

b. Recommend precautions or evacuation to affected local agencies or officials when flooding conditions are forecasted by the River Forecast Center National Weather Service.

c. Furnish advice, supervision and materials, as appropriate, to obtain the maximum benefit from flood protection works.

d. Assist the Red Cross and Coast Guard in evacuation when demand exceeds their facilities or their mobilization abilities.

e. Assess flood damage. The District Engineer will survey affected areas and structures when water has receded.

f. Assist local agencies to repair and restore flood-damaged flood control units, as directed by the applicable laws.

7-10. Coordination of Flood Data. Coordination with the National Weather Service, U.S. Geological Survey, and individual observers is maintained by the Water Control Section Corps of Engineers, for collection of river stages, rainfall data, current and forecasted reservoir operations, and river flows. Gage readings as defined in paragraph 7-07, b, with additional pertinent information such as closure of sandbag gaps, operation of drainage structures, and local flooding information should be forwarded as soon as possible for use in forecasts, operational decisions, and required reports. Information that is generated and/or coordinated by the Water Control Section, Corps of Engineers, is available as follows:

a. Collection of hydrologic data and issuance of information bulletins on a 24-hour basis.

b. Forecasts as required in connection with operation of flood fighting operations.

c. Preparation of reservoir regulation directives for all Federal flood control pools.

d. Obtain National Weather Service evaluations of rainfall potential and interpolations of data during critical periods.

e. Information on streamflow measuring program and field reconnaissance of the U.S. Geological Survey and special measuring teams of the Corps of Engineers when applicable.

f. Recommend assignment of mobile radio units designated for emergency collection of hydrologic data to critical areas.

g. Maintain complete record of all hydrologic data for future design or repair engineering studies.

h. Coordinate river forecasts with the National Weather Service for issuance.

7-11. Engineering Design Information.

a. Levee Design. The design discharge for the New Haven project was developed in the Definite Report, Missouri River Agricultural Levees, April 1946, by the following method:

(1) Gage records at Hermann, Missouri, from the period 1873 through 1944 were used to develop a discharge frequency curve representing conditions current at that time. The 100-year recurrence interval flood from this curve was 655,000 cfs.

(2) This discharge was reduced to 434,000 cfs to take into account what is essentially the existing system of reservoirs above Kansas City, Missouri. However, this study also included Pattonsburg and Hickory Lakes in the Grand River basin and Arlington, Richland, and Rich Fountain Lakes in the Gasconade River basin which were never built.

(3) This discharge was then increased to 529,000 cfs to allow for an increase in discharge due to confinement of flood flows by all of the authorized Missouri River Agricultural levees.

Thus the levee was designed to provide 100-year flood protection by adding 3 feet of freeboard onto the water surface profile computed for 529,000 cfs.

b. Present Level of Protection. Using current computed water surface profiles for existing conditions, it appears that the levee will pass approx. 510,000 cfs with 3 feet of freeboard. Discharge frequency relationships for the Missouri River have been recomputed since the design study was published. The current discharge frequency relationship at Hermann is represented by Condition VI of the Missouri River Agricultural Levee Restudy Program - Hydrology Report, March 1962. This condition essentially represents the existing system of reservoirs and a levee system which includes all authorized Missouri River Agricultural levees. The 510,000 cfs capacity of the levee corresponds to approx. a 35-year flood under these conditions.

TABLE I
NEW HAVEN MISSOURI

CLOSURE OF DRAINAGE STRUCTURES

Location	No.of Gates	Size of Opening	Type of Gates	Invert Elevation	Operation During Flood	Initiate Action at Gage* Reading
6+51	1	14" CIP	Automatic Flap Gate & Sluice Gate	485.16	Preliminary inspection for drift and mechanical operation. Periodic inspection for leakage. Close sluice gate in case of emergency.	17.6
11+54.3	1	16" CIP	Automatic Flap Gate & Sluice Gate	489.50	Preliminary inspection for drift and mechanical operation. Periodic inspection for leakage. Close sluice gate in case of emergency.	22.0
13+71	1	14" CIP	Automatic Flap Gate & Sluice Gate	483.92	Preliminary inspection for drift and mechanical operation. Periodic inspection for leakage. Close sluice gate in case of emergency.	16.3

* New Haven, Missouri Gage, Elevation Zero = 467.03 feet, m.s.l.

TABLE I
NEW HAVEN, MISSOURI
CLOSURE OF DRAINAGE STRUCTURES

Location	No.of Gates	Size of Opening	Type of Gates	Invert Elevation	Operation During Flood	Initiate Action at Gage* Reading
15+45.3	1	10" CIP	Automatic Flap Gate	485.65	Preliminary inspection for drift and mechanical operation. Periodic inspection for leakage.	18.0
15+50.6	1	14" CIP	Automatic Flap Gate & Sluice Gate	490.01	Preliminary inspection for drift and mechanical operation. Periodic inspection for leakage. Close sluice gate in case of emergency.	22.5
15+54.9	1	42" Conc. Pipe	Automatic Flap Gate & Sluice Gate	487.08	Preliminary inspection for drift and mechanical operation. Periodic inspection for leakage. Close sluice gate in case of emergency.	19.6

* New Haven, Missouri Gage, Elevation Zero = 467.03 feet, m.s.l.