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HYDRAULIC DESIGN OF A CANAL SYSTEM FOR GRAVITY IRRIGATION

By:

Timothy Gates, William O. Ree, Mohamed Helal
Azza Nasr and David J. Molden

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Colorado State University
Engineering Research Center
Ft. Collins, Colorado 80521
USA

Consortium for International
Development
5151 E. Broadway, Ste., 1500
Tucson, Arizona 85711 USA

Abstract

Irrigation by gravity from a water delivery system where the difference in elevation between the canal's source and the fields is small requires careful use of the limited head available. Drop structures normally used to control flow are not used in order to conserve head. Instead a desired distribution of the flow is achieved by sizing canal and channel turnouts. Turnout size depends on the required discharge rate and on the differential head. This head in turn is determined by flow rates in the connected channels and their cross-sections, hydraulic roughnesses and slopes. Since the flow rate and head are interdependent, an iterative procedure is required to solve the turnout size problem. Furthermore, a change in water level at a single point may be reflected throughout the entire system. A computer model solves the hydraulics of the integrated system. Application of the model is demonstrated in the design of the distribution system for the Abyuha region in Middle Egypt.

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مستخلص

ان الرى بالراحة من نظام رى يكون فيه الفرق فى الارتفاع بين الترعة كمصدر للمياه والحقول صغيرا يتطلب استخدام محكم لمستوى المياه . أما المساقط المائيه التى تستخدم عادة فى التحكم فى تدفق المياه فهى لاتستعمل للمحافظة على مستوى المياه . وبدلا من هذا يتحقق التوزيع المطلوب لمياه الرى عن طريق التحكم فى حجم الترعة وفتحات الرى . ويعتمد حجم فتحة الرى على سرعة التصرف المطلوبة وايضا على فرق ارتفاع مستوى المياه . وهذا المستوى بدوره يتحدد بواسطة سرعة تدفق المياه فى القنوات المتصلة وقطاعاتها والاحتكاك الهيدروليكى بها وميولها . وبما ان سرعة التدفق وارتفاع مستوى المياه يعتمد كل منهما على الآخر ، فانه لابد من استخدام طريقه التجربه والخطا لحل مشكلة حجم فتحات الرى . بالاضافة الى ذلك ، فان حدوث تغير فى مستوى المياه عند نقطة واحدة يؤثر على النظام كله ويستخدم نموذج الحاسب الالكترونى فى حل هيدروليكية النظام المتكامل . ويتضح تطبيق هذا النموذج فى تصميم نظام الرى بمنطقة ابيوها بالمنيا .

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INTRODUCTION

The rehabilitation of the irrigation system for the Abyuha area in Egypt involved a change from a partial to a complete gravity flow delivery system. A computer model was developed to aid in the design of the new system.

At the outset the designers realized the difficulties they faced in designing a gravity flow delivery system with a small head difference between the water surface elevation in the canal's source and the agricultural land elevation. They could not readily follow the specifications for water control set forth in Jensen (1980) where it is stated, "Adequate structures must be provided in the delivery systems to permit control and regulation of the water flow" or those of Robinson and Humphreys (1976) who said, "An efficient irrigation system requires that the operator have complete control of the water. Open channel water control on the farm is achieved by using structures to control the water as it is conveyed from the main canal or lateral headgate .... to its destination on the field". Water control by structures is best accomplished when structures have unchanging head-discharge relationships which means freedom from tail water effects. To eliminate such effects would require head-consuming drops which could not be used in a small head system. Thus, the designers opted not to use drop structures for water control in the system except for checks in the *mesqas* (farm channels) as needed. Instead, they would rely on a careful accounting of all head losses to estimate the tail water elevation at a structure location. The tail water would be taken into account in the design of the structure. They realized that the system operation would be affected by the friction factors for the distributary canal and *mesqas*. As the friction factors varied so would flow distribution characteristics of the system vary. This variation could be kept within limits by canal and channel maintenance, i.e., clearing and removing vegetative growth. So the designers stayed with the plan to base their design on carefully selected turnout sizes and on friction control. The alternatives were to abandon the design attempt or to design a system requiring pumps. The latter alternative was not very attractive in view of the high cost of energy.

A design procedure (Appendices A, B and C) was developed that will be useful for application to relatively level areas with limited elevation differences between land surface and water supply surface. The model may seem complex because of the great amount of detail involved. Actually, the theory is relatively simple and ordinary hydraulic computation procedures were used.

A limitation of the model is that no provision has been made for including drop structures for regulating flow division. It is suited for level areas like the one which led to the development of the design procedure, the Abyuha region of Middle Egypt.

SITE DESCRIPTION

The Abyuha region of the Egypt Water Use and Management Project (EWUP) is in Middle Egypt about 17 km south of the city of El-Minya. It is an intensively cultivated, irrigated area of about 1213 *feddans* (509 hectares) where the principal crops are berseem (a forage legume), cotton, sugarcane, broad beans, corn and wheat. The average farm size is about 0.83 *feddans* (0.35 hectares). The site is served by the 4000 meter long Abyuha canal which in turn receives its water from the Ibrahimiya canal. Twenty-seven *mesqas* receive water from the Abyuha canal and distribute it to the fields. In addition, nine turnouts are used to directly irrigate a total of 25.4 *feddans* (11 hectares) at various locations adjacent to the canal. Figure 1 is a map of the area.

The site is quite flat, its surface varying but one meter in elevation. About 700 *feddans* (294 hectares or about 60 percent of the area) was irrigated by gravity flow, though with low head. at the time of design formulation. Hand operated *tambours* (Archimedes screw) or diesel engine driven centrifugal pumps lifted water to the remaining area.

Irrigation water is supplied by the Ibrahimiya canal which receives its water directly from the River Nile. The possible flow rate into the Abyuha canal depends directly upon the Ibrahimiya canal water level which varies seasonally, reaching a peak in July or August and a low in December. This level is a primary constraint on gravity irrigation feasibility and therefore hydrographs of the canal water level for several years were given close scrutiny. For the design of the Abyuha system the 1980 water level shown in Figure 2 was selected for future water level prediction. There is little or no rain in this area; thus, for design purposes precipitation was assumed to be zero.

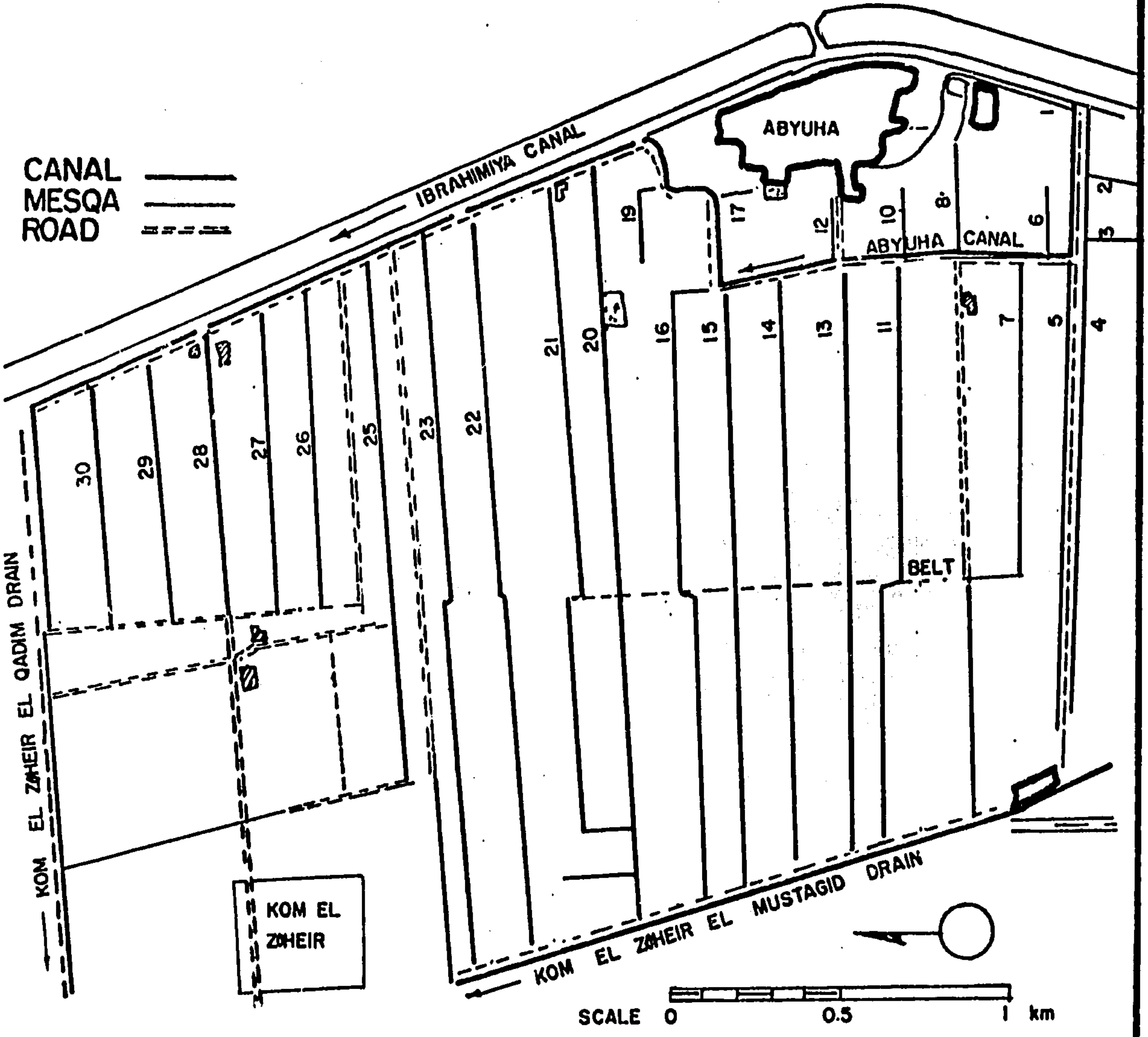

FIG. I ABYUHA EWUP FIELD SITE NEAR EL MINYA EGYPT

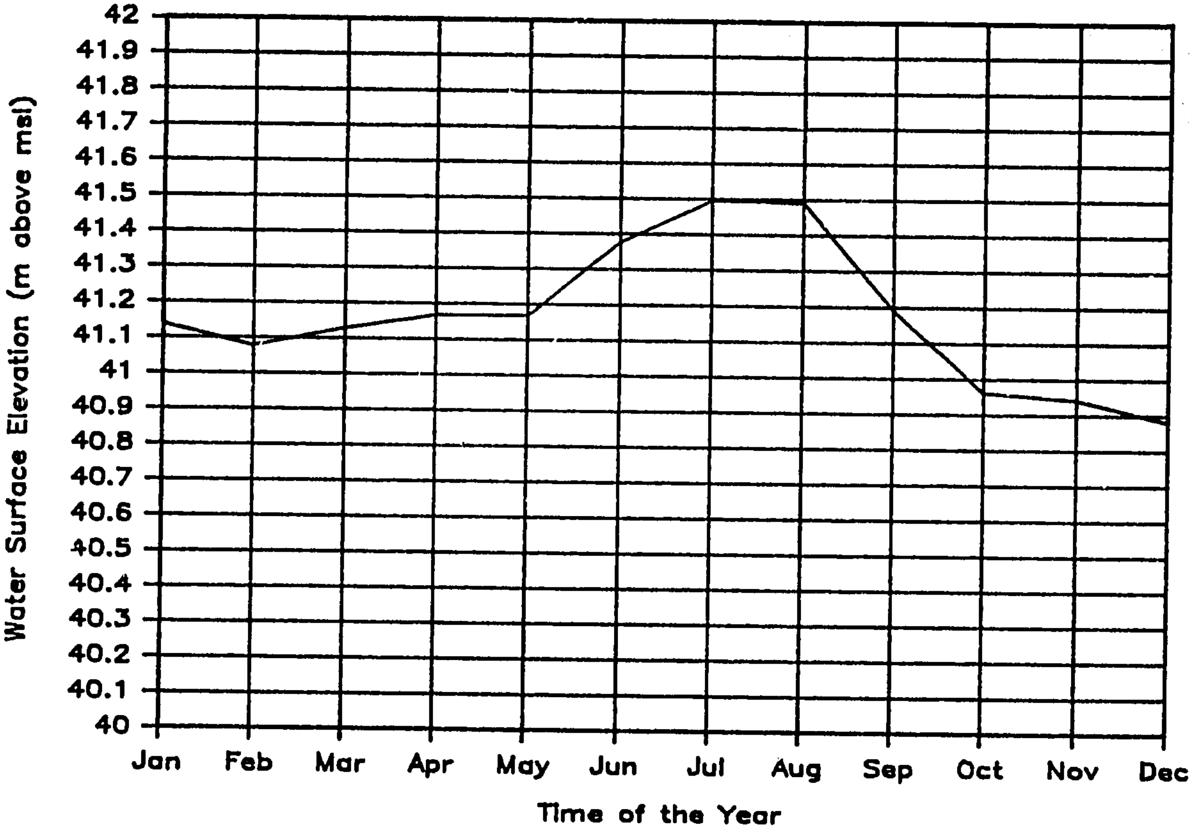

Figure 2. Water level available in Ibrahimiya canal at the inlet to Abyuha canal (1980 data).

PRELIMINARY INVESTIGATION

Studies of the existing system showed that small stream sizes were a major problem. Head at the farm fields was often inadequate because of excessive head losses upstream. Also, lack of control of the flow into and out of the *mesqas* caused excessive loss of water to the drains. Any plan for a gravity flow delivery system would need to address these problems. Also, the many small fields under separate ownerships dictated that the existing layout of the water delivery system essentially would have to be retained. Some minor changes could be made if found desirable, such as eliminating an existing *mesqa* and supplying the affected fields from an adjacent *mesqa*. The eliminated *mesqas* would be replaced with roads to facilitate farm access and thereby promote mechanization of farming practices.

Comparison of the water surface elevation in the Ibrahimiya canal with the land elevation revealed that it was possible to bring the entire area under gravity irrigation. The water level would need to be raised in the distributary canal and the head thus gained be conserved by a more efficient channel system and adequate turnouts.

Several systems were investigated before the final selection was made. The single canal of the present system was compared with a two canal system, the second canal located at the Belt shown on Figure 1.

Continuous versus rotation flows were studied for both systems. The finding was that a system with a single distributary canal carrying flow every day (continuous flow) would require the smallest canal and would not require a flow dividing structure. The flow would be rotated among groups of adjacent *mesqas*. This is an accepted practice. Cerdon (1972) defined it as, "The principle of rotational irrigation .... based upon continuous water deliveries to relatively large areas which are subdivided and receive water by rotation".

PERFORMANCE REQUIREMENTS AND SPECIFICATIONS

At the outset goals were identified and these are summarized in the following performance requirements:

1. Deliver water to any point in the area by gravity flow and within time to meet crop need (or approach these requirements as nearly as possible).

2. Have the capacity to supply water requirements with flow during daylight hours only (since farmers in the area were accustomed to irrigating during the day only).

3. Have the capability to deliver water with flow rates and head large enough to facilitate high application efficiency.

4. Prevent waste of water through drain outflow.

5. Have a system acceptable to farmers.

6. Have a system simple to operate.

7. Make the changeover with the least disturbance to present operation and take no additional land out of cultivation.

The preliminary investigation and discussion with staff and project people led to the establishment of specifications for the system. Some specifications were based on current standards for irrigation work, others were based on the opinions of people who were acquainted with the area and knew what was practical and acceptable. For example, the initial decision not to line the canals and *mesqas* was made without first making detailed hydraulic and economic studies. Rather, it was judged that for the given conditions the costs of lining would far outweigh any benefits derived.

The specifications for the Abyuha system were:

1. Retain the present location of the distributary canal except for minor straightening or shifting to stay within the designated legal boundaries for the canal.

2. Retain the present *mesqa* locations. Some *mesqas* may be eliminated and replaced with roads.

3. Equip each turnout to a *mesqa* with an adjustable gate.

4. Do not line the canal.

5. Provide a flow measuring flume in the distributary canal.

6. Install outlet check structures at the end of the distributary canal and each *mesqa* to create head needed at turnouts and to prevent flow to drains (except for emergency overflow).

WATER REQUIREMENTS AND DELIVERY SCHEDULE

The volume of water required by a crop during a specified time depends upon the crop, its stage of growth and climatic factors. Potential evapotranspiration formulas like the Penman, the Blaney-Criddle or the Jensen-Haise which provide a relationship among these variables are generally used to estimate the water requirement. For a detailed presentation of these methods see Jensen (1980). In Egypt the Ministry of Irrigation (1981) has developed information on depth of water required for major crops in Lower, Middle and Upper Egypt for each month of the crop growing season. These data were used to estimate water demand. The areas of each crop at Abyuha were measured during the period of 1980 through 1982 (Helal, et al., 1984) and these areas multiplied by the depth of water requirement to determine the volume of water needed for crop consumptive use for each month. The maximum volumes of consumptive use determined for each month were used for the design. Added to these volumes were estimated volumes of water required for land preparation (planting irrigations). Dividing the sum by the overall efficiency of the system (estimated as 0.63, the product of a conveyance efficiency of 0.90 and application efficiency of 0.70) provided the estimate of the water volume to be diverted into the Abyuha canal each month. These volumes are given in Table 1 and illustrated in Figure 3. They range from a low of 257,000 cubic meters in October to a high of 1,690,000 cubic meters in July.

TABLE 1. WATER REQUIRED FOR CROP CONSUMPTIVE USE AND LAND PREPARATION AND TOTAL WATER REQUIREMENT (INCLUDING LOSSES) FOR THE ABYUHA REGION.

Month	Crop Consumptive Use (m^3)	Land Preparation (m^3)	Total Water Requirement (m^3)
JAN	300,000		476,000
FEB	388,000		616,000
MAR	557,000		884,000
APR	571,000		906,000
MAY	408,000	114,000	829,000
JUN	800,000		1,270,000
JUL	1,065,000		1,690,000
AUG	782,000		1,241,000
SEP	514,000		816,000
OCT	136,000	26,000	257,000
NOV	258,000	10,000	425,000
DEC	311,000		494,000

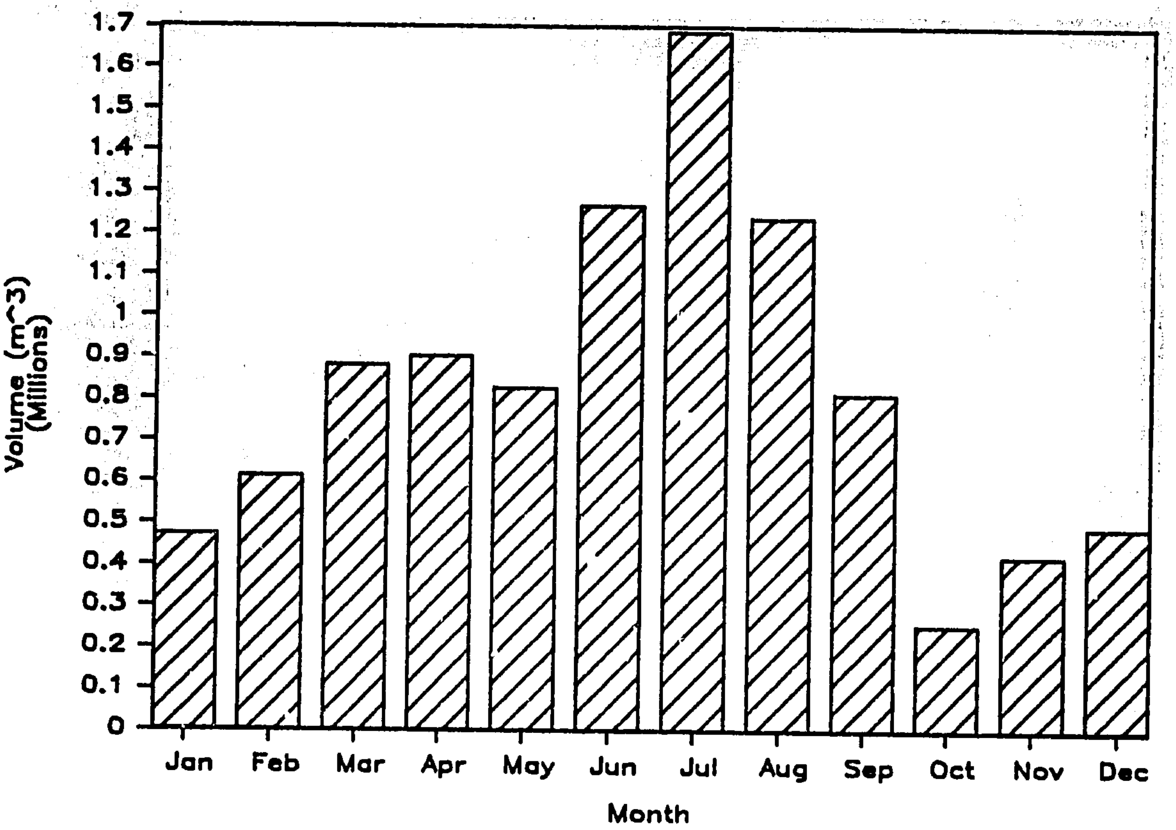

Figure 3. Total monthly volumes of water required for diversion to the Abyuha canal.

A canal delivery schedule specifies the frequency, rate, and duration of flow delivered to the canal to meet the water requirements of the region served (Jensen, 1980). In Abyuha the water requirements had to be met under a condition of seasonally variable and limited available head. A rigid rotation of variable frequency, rate, and duration was selected as the most appropriate type of schedule to deliver water to the *mesqas* and turnouts. Continuous flow of a variable rate would be maintained in the Abyuha canal to serve the *mesqa* and turnout rotations.

The net daily rate of flow required for each month was calculated by dividing the volume of water requirement by the total operation time during the month. The total operation time generally was computed as the total number of days in the month multiplied by a daily time of irrigation of 12 hours. Flow to the canal would be shut off at night. In the case of January, the month of closure for canal maintenance, the number of operating days was assumed to be only five. Since the water level in the Ibrahimiya canal is very low during January adequate head is not available to supply the extremely high flow rate required for the short pre-closure irrigation. Thus, it was necessary to increase the daily time of irrigation to 15 hours and to make the safe assumption that half of the water requirement for January could be supplied from soil root zone storage and water table contribution during the closure period. Gross daily flow rates were computed by increasing the net daily flow rates by 10% to compensate for time losses expected from changing irrigation rotations (opening and closing gates) along the canal and *mesqas*. Thus, the gross daily flow rate for the canal, Q_d, was determined as:

$$Q_d = \frac{(1.1)V}{(N)(n)\ (3600\ \text{sec/hr})}$$

Where

V = volume of water required for a given month, m^3

N = number of operating days during month

n = daily hours of irrigation

Values of Q_d computed for each month are given in Table 2.

TABLE 2. GROSS DAILY FLOW RATE FOR THE ABYUHA CANAL FOR EACH MONTH.

Month	Gross Daily Flow Rate (m^3/s)
JAN	0.970
FEB	0.560
MAR	0.726
APR	0.769
MAY	0.681
JUN	1.078
JUL	1.388
AUG	1.019
SEP	0.693
OCT	0.211
NOV	0.361
DEC	0.406

The gross daily flow rate for a given month was apportioned among the *mesqas* and turnouts in proportion to the respective areas served. The total area served by a *mesqa* was dependent on which *mesqas* were to be replaced by roads in the future and how their respective areas would be reapportioned for service by the remaining *mesqas*. A future alternative for area distribution which considered *mesqa* replacement by roads is given in Table 3 along with the existing area distribution. The gross daily flow rate for each *mesqa* or turnout, q_d, was computed on a monthly basis for each alternative area distribution and is given in Tables D1 through D12 of Appendix D.

The gross daily flow rates would provide the monthly water requirement if all *mesqas* and turnouts were operated for the entire period each day. However, some *mesqas* and turnouts would be flowing at a rate too small for efficient application of water. The solution was to reduce the number of *mesqas* and turnouts operating at one time while increasing the flow rate and reducing the operating time. For example, for July if *mesqas* serving half the area received the entire Abyuha canal flow for half time the flow rates would need to be doubled bringing some to an acceptable flow rate. Even so, some of the *mesqas* and turnouts would be assigned flows too small. In these cases a minimum *mesqa* and turnout flow rate of 0.020 m^3/s was

Table 3. AREA DISTRIBUTION ALTERNATIVES 1 (EXISTING) AND 2(FUTURE) FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL

Mesqa No.	Turnout No.	Area Served (*feddans*)	
		Alternative 1	Alternative 2
1		10.0	10.0
2		3.0	3.0
3		5.0	5.0
4		90.0	90.0
5		50.0	50.0
6		6.0	6.0
7		90.7	90.7
8		15.0	15.0
--		--	--
10		8.0	8.0
11		83.0	109.0
12		12.0	12.0
13		58.0	--
14		62.7	130.0
--	1	2.5	2.5
15		64.1	--
16		68.2	138.2
	2	2.3	2.3
	3	3.5	3.5
	4	5.0	5.0
	5	2.8	2.8
	6	2.5	2.5
17		7.0	7.0
--		--	--
	7	2.3	2.3
19		10.0	13.8
	8	2.0	2.0
	9	2.5	2.5
20		84.5	--
21		65.1	104.6
22		118.0	118.0
23		65.0	65.0
--		--	--
25		49.4	49.4
26		39.7	39.7
27		30.3	44.6
28		28.2	--
29		28.6	54.9
30		36.5	--
31		--	24.1
Total		1213.4	1213.4

assigned. Months having smaller flows typically required more than two divisions, or rotations, to appropriately increase the flow rates. In selecting the number of rotations for a given month consideration had to be given to the time required to accomplish an irrigation and make the change from one rotation to another. The monthly rotation schedules and respective *mesqa*, turnout, and canal design flow rates are given in Tables D13 to D24 of Appendix D for the existing area distribution and for the proposed future area distribution.

The frequency with which a given rotation occurs in a month and its duration are primarily dependent on the evapotranspiration rate, crop characteristics, the water storage capacity of the soil, and the time required to change rotations. These factors were considered in developing the proposed annual delivery schedule for the Abyuha canal given in Early, et al. (1984). This schedule summarizes the frequency, rate, and duration of each monthly flow rotation for the existing area distribution.

HYDRAULIC DESIGN

Determining the hydraulic system parameters, system variables, and required head of water to deliver the design flow rates was a complex problem of spatially varied flow in open channels. To facilitate the solution and allow for the analysis of several alternative designs, a mathematical system model was developed for programming on a micro computer. Care was taken to develop the model as a general one which could be used for designing similar systems in other parts of Egypt. The model was used to determine system variables, including water surface profiles in the *mesqas* and in the Abyuha Canal, and the water level required in the Ibrahimiya Canal for alternative sets of hydraulic system parameters. A feasible alternative which appeared most desirable was then selected as the design. The system model and the design procedures used are discussed below. Copies of the computer programs, written in Basic language for the IBM Personal Computer, are given in Appendix F.

System Model

The model that was developed simulates flow in a network consisting of a distributary canal serving several farm channels from which fields are directly irrigated. For a specified set of hydraulic system parameters and boundary conditions the model is used to determine values of system variables required to deliver the design flow rates at elevations required on the field. The primary system variables determined for the delivery network are turnout sizes, flow depths, flow velocities, and water surface profiles. Adjusted flow rates are also computed for conditions where control of turnouts is not of adequate precision to deliver the exact design flow rate for a given head loss. Structures existing within the network for water conveyance, control, or measurement are accounted for in the analysis.

The hydraulic condition represented by the model is one of spatially varied flow in a network of non-prismatic open channels with local occurrences of rapidly varied flow. The flow is classified as spatially varied since the discharge entering at the head of any channel in the system is gradually diminished as it exits the turnouts along the channel's length. Examples of rapidly varied flow that commonly occur in canal systems are flow through measuring flumes, over check structures, through channel enlargements or contractions, around bends, and through turnouts. Rather than determining detailed water surface profiles for these local conditions of rapidly varied flow, the model computes the total head loss or momentum change created and incorporates it into the spatially varied flow profile.

Beginning with the elevation of the water surface on the irrigated field farthest downstream, trial and error solutions of the flow equations are used to compute head losses and momentum changes that determine the water surface profile upstream in the farm channel. Iterative solutions are required to select the proper turnout vent sizes to discharge the required flow rates with the computed head available. After solutions are obtained for each of the farm channels, the same procedure is used for analysis of the flow in the distributary canal. Again an iterative solution is required to balance the flow condition in each of the farm channels with that in the distributary canal. If the constraints imposed on the system are violated the values of hydraulic parameters or hydraulic variables must be adjusted to obtain a feasible solution. Since many different combinations of parameter and variable values may yield feasible solutions, the designer must judge the best solution based on the criteria that he has selected.

Several basic assumptions that were made in the development of the model are stated:

1) The flow is unidirectional within any channel except at the location of turnouts.

2) The velocity and momentum distributions across the channel section are uniform; that is, the velocity and momentum coefficients are assumed to be unity.

3) The streamlines are parallel within any channel; thus, the pressure distribution is hydrostatic.

4) The slope of any channel is less than critical slope and is relatively small. Thus, the effects of slope on pressure head and on the force on channel sections are negligible.

5) The Manning equation may be used to determine the friction loss in the channels.

6) The hydraulic control of pipes and siphon tubes used for turnouts in the system is governed by the condition of a submerged outlet.

The model determines the hydraulic variables at each successive station in a channel, moving in an upstream direction. Stations in a channel are defined by type as follows:

Type 1 At the head of the channel. This is the location of the first station for every channel.

Type 2 At the end of the channel. This is the location of the last station for every channel.

Type 3 At the location of each open turnout (all turnouts from the distributary canal to the farm channels are assumed to be of Type 3A):

Type 3A	Pipe with adjustable gate
Type 3B	Siphon tube
Type 3C	Bank cut

Type 4 At the location of each structure for measurement or control:

Type 4A	Cutthroat flume
Type 4B	Trapezoidal flume
Type 4C	Check structure

Type 5 At the location of each bend.

Type 6 At the location of each change in the section parameters of the channel:

Type 6A Section enlargement or contraction
Type 6B Hydraulic roughness or bottom slope change

Type 7 "Dummy" station located between two stations separated by a large distance in order to increase computational precision.

Computations are made for each of the farm channels and then for the distributary canal. The model is described in a step-by-step outline in Appendices A, B and C. For a more detailed discussion of the hydraulic concepts the reader is referred to a standard text of open channel flow such as Chow (1959).

Design Procedures

Outlined below are the procedures that were followed in employing the above described model to design the Abyuha system.

A. The following baseline survey data were collected initially to allow selection of boundary conditions, hydraulic system parameters, and constraints for use in design:

1. Hydraulic properties of farm fields to be surface irrigated.
    a. Field length and width
    b. Surface roughness
    c. Type of irrigation - basin, furrow, etc.

2. Topographic surveys of farm land adjacent to *mesqas*.

3. Cross-sections of the Abyuha Canal and each of the *mesqas*.

4. Locations of *mesqas* and locations and types of other stations on the Abyuha Canal.

5. Locations and types of farm turnouts and other stations on the *mesqas*.

6. Hydraulic parameters associated with each type of station to be considered for installation on the Abyuha Canal or the *mesqas*.

7. Water surface elevation in the Ibrahimiya Canal at the head of the Abyuha Canal throughout the year.

8. Cost estimates for construction and construction materials.

B. Boundary conditions on the system were identified. The lower boundary conditions on the system were the water surface elevation to be supplied at the farm turnouts and the nature of control at the end of the *mesqas* and the canal. Under the severe conditions of a densely planted and hydraulically rough field of berseem (a fodder crop similar to alfalfa), a depth of flow at the head of the field was calculated using the procedures outlined in USDA (1974) for level border irrigation as practiced in Abyuha. The depth calculated was about 0.12 m. This depth was added to the field surface elevations along each *mesqa* to determine the water surface elevations to be supplied at the farm turnouts. The water surface in the *mesqas* and the Abyuha Canal were to be controlled by outlet check structures.

   The upper boundary condition on the system was the water level elevation in the Ibrahimiya Canal. This elevation determined the total energy available to force the required flow rate through the system and distribute it to the farms at the elevations required at the turnouts. For a hydraulically feasible design, the head required to operate the system could not exceed this available energy.

C. Alternative sets of hydraulic parameters were selected for determination of an initial system design.

   To allow the renovation of the Abyuha Canal to begin on schedule, the initial baseline survey data were studied to proceed with an initial system design. Knowing the design field water surface elevations to be served by each *mesqa*, the design flow rates for each rotation, and the expected water level in the Ibrahimiya Canal during each rotation, alternative values of hydraulic system parameters were selected. In this initial design run, only earth channels were considered and the *mesqas* were assumed to have pipe turnouts. A later refined design (discussed below) considered other alternatives for *mesqa* design. Analysis was made for area distribution alternatives one and two to design a system of adequate capacity to serve either case.

D. The following additional survey data were collected to allow a refined system design.

   1. Additional and refined topographical surveys of farm land adjacent to *mesqas*.

2. Additional cross-sections along each *mesqa*.

3. Refined cost estimates for construction and construction materials.

4. Refined estimates of turnout location on *mesqas*.

E. Additional alternative sets of hydraulic parameters were selected for the mesqas to allow a refined system design to be determined. The additional survey data were used to develop additional alternatives of cross-section parameters, types of farm turnouts, and lining for *mesqa* design. Alternatives were constrained to require no additional system operating head than that computed in the initial design. That is, the water surface elevation at the head of the *mesqa*, WSu(i,1), had to be less than or equal to that computed in the initial design for the alternative to be considered feasible. Required operating head, overall *mesqa* width, construction and maintenance costs, and farmer acceptibility were the main criteria used to evaluate alternatives and select the refined design.

Constraints on the selection of the values of hydraulic system parameters for the intital design included: (1) the need to keep canal construction costs low; (2) the need to prevent additional farm land from being consumed by channel cross-section; (3) the future possibility of replacing some *mesqas* with roads and thereby increasing the area served by other *mesqas* (4) the available head given the water levels in the Ibrahimiya Canal; (5) the expected level of maintenance of the *mesqas* and canal; (6) requirements for efficient water management and irrigation scheduling; and (7) availability of equipment and expertise for construction. Working under these constraints, alternative values of hydraulic system parameters were selected, the model was employed, and the resulting hydraulic system variables were studied. The peak demand rotation for July established the size of pipes required at the *mesqa* inlets. Gate settings were determined for the other rotations. Though subject to additional refinements, an initial system design was selected that would allow construction of the canal and the headgates for the *mesqas* to begin.

F. The final refined system design was analyzed to determine the effects of various levels of maintenance on system operating head.

With the exception of one lined *mesqa*, the final design was for a system composed entirely of earth channels with Manning's hydraulic roughness, n, equal to 0.04. Since vegetative growth in earth channels is a perennial problem in the area, the model was used to analyze system operation under conditions of limited maintenance, that is for n = 0.06 and n = 0.08. A condition of good maintenance (n = 0.03) was also considered.

G. The final refined system design was analyzed to determine the effect of a water measuring flume on system operating head.

Obtaining accurate flow measurement with a flume requires a condition of free flow or low submergence. Consequently, a significant amount of head loss must occur through the flume. The model was used to determine the additional system operating head that would be required if a flume were installed.

RESULTS

Example computer printouts of the hydraulic analysis of the system are given as Tables E1 to E42 of Appendix E for July/rotation 2/alternative 1. Tables E1 to E21 contain the hydraulic parameter values and boundary conditions that were specified as inputs to the model. Tables E22 to E42 contain the computed hydraulic variable values. Similar analyses were performed for the various alternatives described in the preceding section to determine final designs for the canal and *mesqas*.

Summaries of the principal channel hydraulic parameters and variables determined for the Abyuha canal and *mesqas* are given in Tables 4 and 5 respectively. A definition sketch of a channel cross-section is given in Figure 4. The channel side slope was 1.0 for the canal and all of the *mesqas*.

Table 4. CHANNEL HYDRAULIC PARAMETERS FOR THE ABYUHA CANAL (REFER TO FIGURE 4).

Section of Channel (km)	Bottom Slope (m/m)	Bottom Width BW (m)	Depth D (m)	Channel Top Width CTW (m)	Left Bank Top Width LBTW (m)	Right Bank Top Width RBTW (m)
0.000-0.400	0.0001	3.0	1.62	6.24	4.0	2.0
0.400-2.260	0.0001	3.0	1.62	6.24	1.0	2.0
2.260-3.200	0.0001	2.0	1.62	5.24	1.0	-
3.200-4.080	0.0001	1.5	1.62	4.74	1.0	-

Table 5. CHANNEL HYDRAULIC PARAMETERS FOR *MESQAS* ON ABYUHA CANAL (REFER TO FIGURE 4)

Mesqa No.	Channel Type	Length (m)	Bottom Slope (m/m)	Bottom Width BW (m)	Depth D (m)	Channel Top Width CTW (m)	Left Bank Top Width LBTW (m)	Right Bank Top Width RBTW (m)
1	Earth	550	0.0004	0.35	0.82	1.99	0.60	0.60
3	Earth	180	0.0002	0.35	0.80	1.95	0.60	0.60
4	Earth	1400	0.0002	0.35	1.09	2.53	0.60	0.60
5	Earth	1400	0.0002	0.35	1.01	2.37	0.60	0.60
6	Earth	200	0.0002	0.35	0.88	2.10	0.60	0.60
7	Earth	875	0.0003	0.35	1.02	2.39	0.60	0.60
8	Earth	255	0.0003	0.35	0.82	2.00	0.60	0.60
10	Earth	182	0.0002	0.35	0.57	1.48	0.60	0.60
11	Earth	1550	0.0003	0.35	1.12	2.58	0.60	0.60
12	Earth	275	0.0002	0.35	0.57	1.49	0.60	0.60
13	Lined	1640	0.0003	0.30	--	--	0.30	0.30
14	Earth	1650	0.0003	0.35	1.15	2.65	0.60	0.60
15	Earth	1650	0.0003	0.35	0.90	2.16	0.60	0.60
16	Earth	1850	0.0003	0.35	1.08	2.51	0.60	0.60
17	Earth	100	0.0002	0.35	0.51	1.38	0.60	0.60
19	Earth	260	0.0003	0.35	0.59	1.54	0.60	0.60
20	Earth	2110	0.0003	0.35	1.18	2.71	0.60	0.60
21	Earth	1895	0.0003	0.35	1.05	2.46	0.60	0.60
22	Earth	2085	0.0003	0.35	1.26	2.87	0.60	0.60
23	Earth	2080	0.0003	0.35	1.16	2.68	0.60	0.60
25	Earth	985	0.0003	0.35	1.03	2.41	0.60	0.60
26	Earth	850	0.0002	0.35	0.80	1.96	0.60	0.60
27	Earth	802	0.0003	0.35	1.02	2.38	0.60	0.60
28	Earth	780	0.0003	0.35	0.96	2.27	0.60	0.60
29	Earth	670	0.0003	0.35	0.93	2.21	0.60	0.60
30	Earth	600	0.0002	0.35	0.94	2.23	0.60	0.60

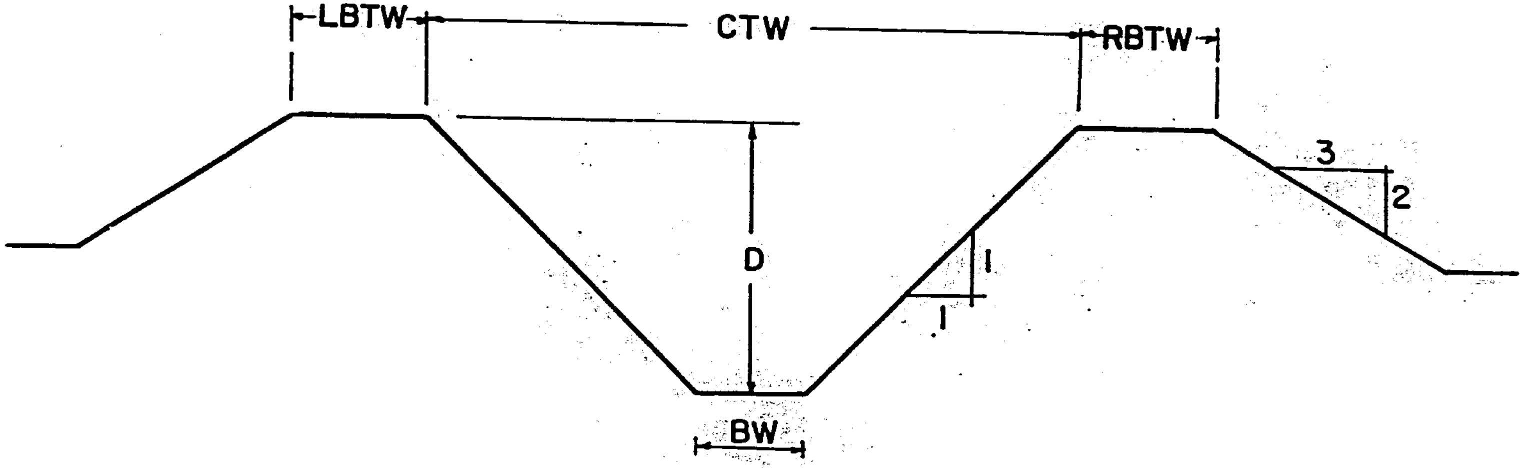

Figure 4. Definition sketch for channel cross-section parameters.

Table 6 summarizes the pipe sizes designed for the inlets to the *mesqas*. The sizes ranged from 20 cm diameter to 75 cm diameter. The head operating on the pipe was a determining factor. For example, *mesqa* 4 needed a 45 cm pipe to serve 90 *feddans* while *mesqa* 20 needed a 65 cm pipe to serve 84.5 *feddans*, the difference in pipe size being attributed to the different computed heads on the two pipes.

Pitching of side slopes, bends and bridges were included in the design for selected locations in the canal. Detailed structural specifications for the various components of the system are given in Gwinn, et al (1984).

The flow velocities computed for the Abyuha canal and *mesqas* were low. Maximum velocity computed for the canal was 0.47 m/s. Maximum velocities for the *mesqas* ranged from 0.06 m/s to 0.23 m/s. At these velocities erosion would not be a problem.

Examples of water surface profiles in the Abyuha canal are shown in Figures 5 and 6 for July/rotation 2/alternative 1 and October/rotation 5/alternative 1 respectively. The symbols along the bottom profile indicate the station type. The large head loss that would be created in the canal by a trapezoidal E-2 flume is clearly illustrated.

Figure 7 shows the available water level (1980 data) in the Ibrahimiya Canal compared to the water level required for operating the new gravity system under conditions of good, fair, and poor maintenance if a measuring flume were not installed in the canal. With good maintenance (n =.03 in the canal and *mesqas*) the available water level should always exceed the required water level making operation of a good gravity system feasible throughout the year except during December when the water level in the Ibrahimiya is very low. With fair maintenance (n =.04 in the canal and *mesqas*) there should be adequate head available throughout most of the year with the exception of the winter months when some pumping from *mesqas* may be required. Under conditions of poor maintenance (n =.06 in the canal and n =.08 in the *mesqas*), the operation of a good gravity system will be practically impossible.

Figure 8 shows that if a trapezoidal E-2 measuring flume is installed in the canal, significantly more operating head would be required. Even under conditions of good maintenance (n = 0.03), adequate head would be available for operating the system only during the summer months. Thus, it was concluded that a measuring flume should not be installed. Instead, the canal headgate should be calibrated and equipped with continuous water level recorders for flow measurement.

Table 6. PIPE SIZES FOR INLETS TO *MESQAS* AND TURNOUTS ON ABYUHA CANAL

Mesqa No.	Turnout No.	Area Served (*feddan*)	Pipe Size (ID, cm)
1		10.0	20
2		3.0	20
3		5.0	20
4		90.0	45
5		50.0	45
6		6.0	20
7		90.7	50
8		15.0	20
--		--	--
10		8.0	20
11		83.0	70
12		12.0	20
13		58.0	50
14		62.7	65
	1	2.5	20
15		64.1	50
16		68.2	65
	2	2.3	20
	3	3.5	20
	4	5.0	20
	5	2.8	20
	6	2.5	20
17		7.0	20
	7	2.3	20
--		--	--
19		10.0	20
	8	2.0	20
	9	2.5	20
20		84.5	70
21		65.1	40
22		118.0	65
23		65.0	70
--		--	--
25		49.4	30
26		39.7	35
27		30.3	35
28		28.2	30
29		28.6	40
30		36.5	30

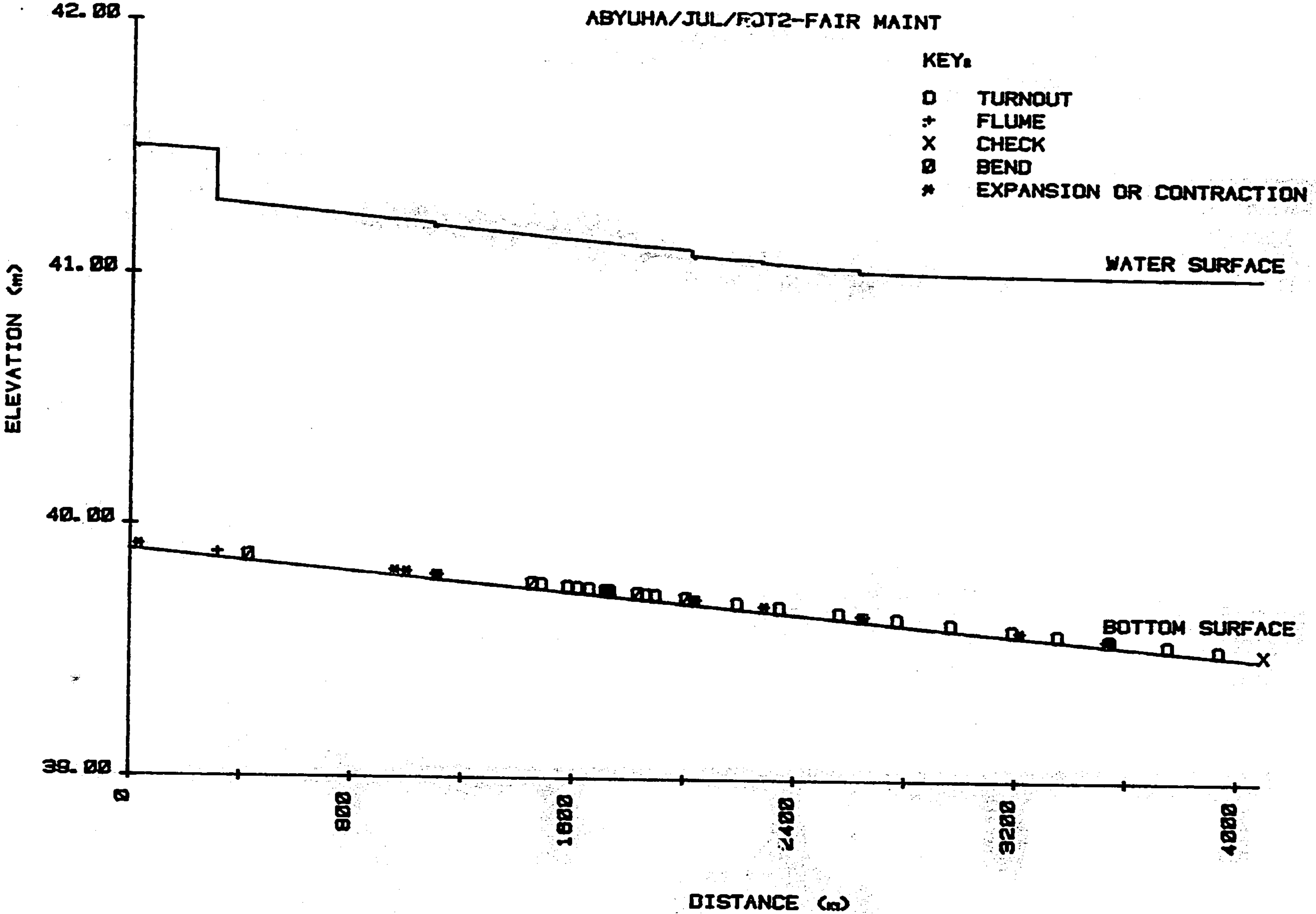

Figure 5. Water surface profile in Abyuha canal for July/rotation 2/alternative 1 with fair maintenance and a flume in the canal.

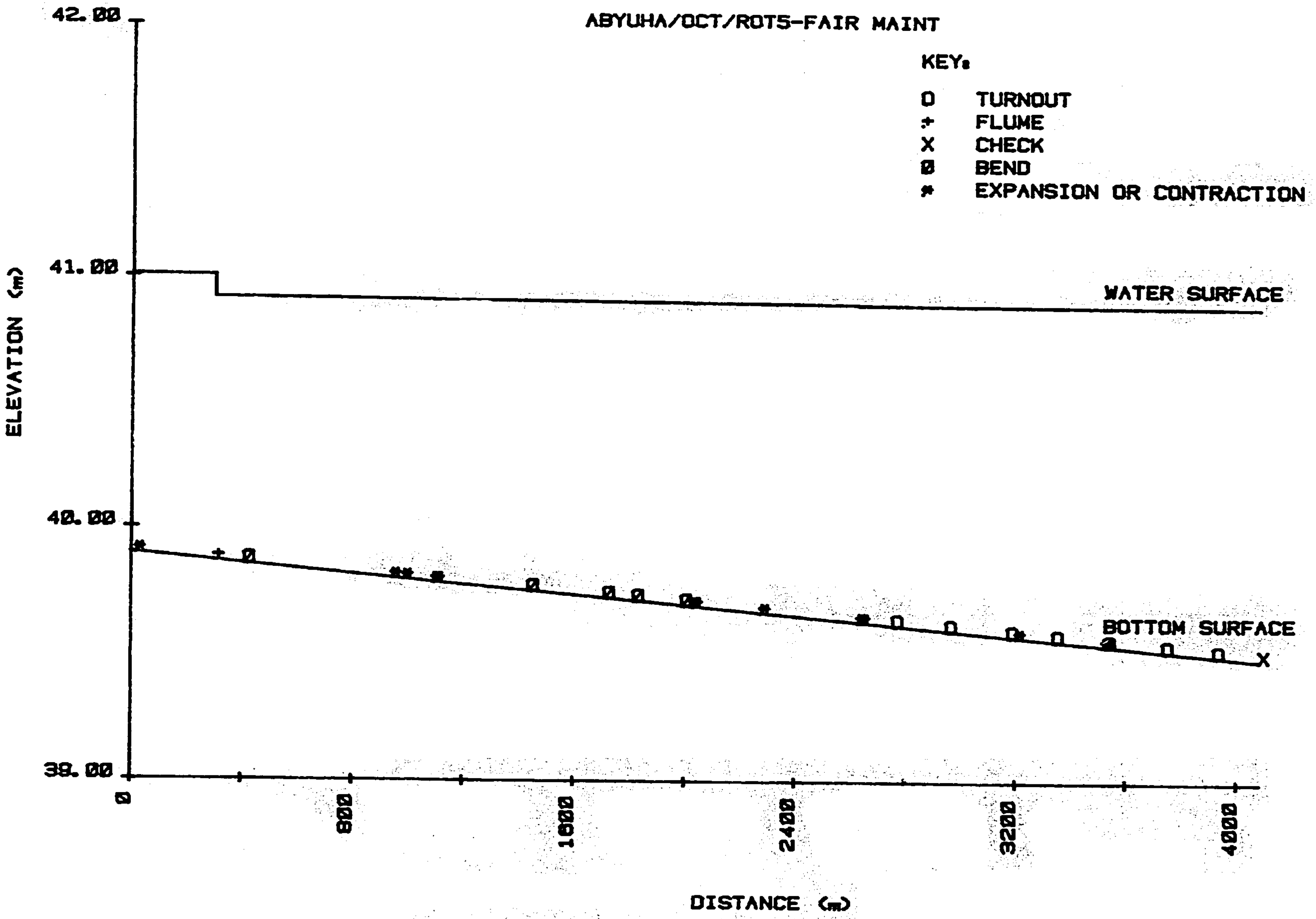

Figure 6. Water surface profile in Abyuha canal for October/rotation 5/alternative 1 with fair maintenance and a flume in the canal.

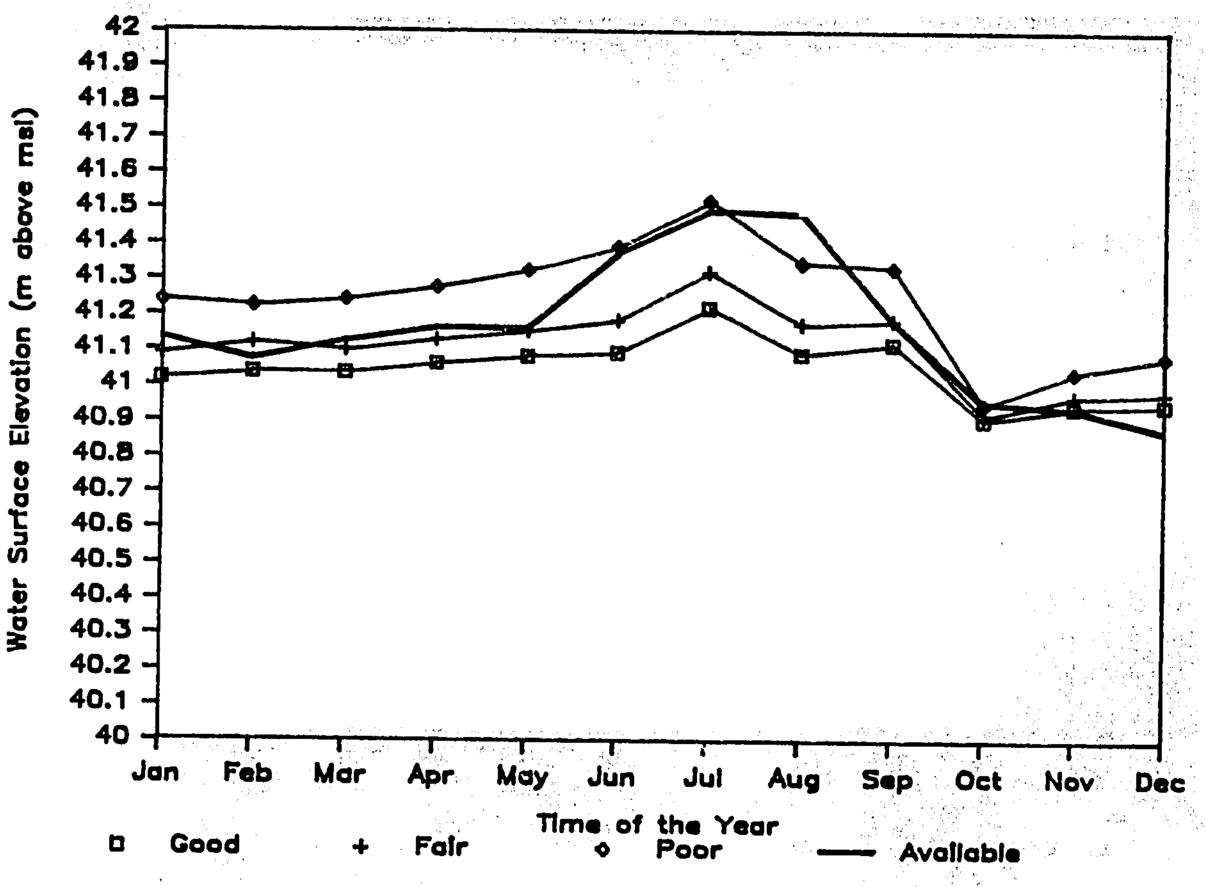

Figure 7. Required and available operating water level at head of Abyuha canal for various levels of channel maintenance (good, fair, and poor) without a flume in the canal.

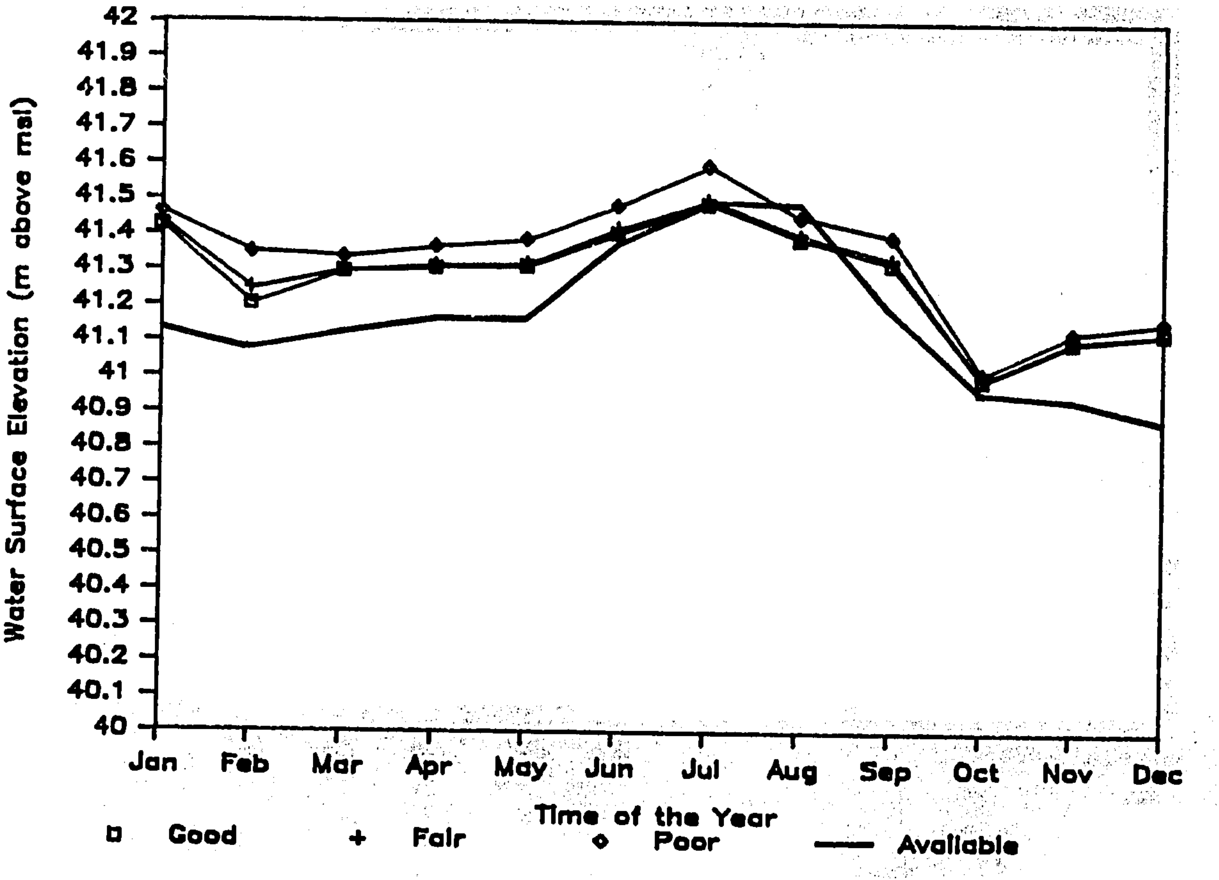

Figure 8. Required and available operating water level at head of Abyuha canal for various levels of channel maintenance (good, fair, and poor) with a flume in the canal.

SUMMARY

The rehabilitation of the irrigation system for the Abyuha region in Middle Egypt involved a change from a partial to a complete gravity flow delivery system. Preliminary studies of the existing system and investigations of alternatives for system renovation were briefly described. The performance requirements and specifications indentified for the new system were presented along with a description of how water delivery schedules were determined for supplying the time varying water requirements.

To aid in the hydraulic design of the new system a mathematical system model was developed for programming on a micro computer. The model was constructed as a general one appropriate for use in similar gravity irrigation system design problems where the difference in elevation between the land surface and water supply surface is limited. The model was described in detail and its application was demonstrated in the design of the Abyuha system. The design procedures used in employing the model were presented.

The principal hydraulic parameters and variables designed for the Abyuha canal and *mesqas* were summarized. Results showed that operation of a gravity irrigation system in Abyuha would be highly dependent on the degree of channel maintenance in the system. A measuring flume could not be installed in the system due to the excessive operating head required.

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APPENDICES

APPENDIX A: DESCRIPTION OF THE HYDRAULIC SYSTEM MODEL

A list of the notation used in Appendices A, B and C is given in Appendix G.

A. Enter Hydraulic System Parameters and Boundary Conditions

The following hydraulic system parameters and boundary conditions must be specified as inputs to the model (all units are of the SI system of kg/m/s):

1) The <u>total number</u> of stations along the distributary canal, M, and the <u>type</u> of each station i (STA(i))

2) The distance of each STA(i) from the head of the distributary canal, L(i) in meters.

3) The seepage rate per unit length of the distributary canal, s in $(m^3/s)/m$. (Seepage outflow is considered to be a positive value while seepage inflow must be entered as a negative value)

4) The parameters and boundary conditions associated with each type of station on the distributary canal:

Type 1 Head of the canal (STA(1)):

Hydraulic roughness of the canal at the head, n(1)
Side slope of the canal at the head, Z(1)
Bottom slope of the canal at the head, $S_o(1)$
Bottom width of the canal at the head, W(1)

Type 2 End of the canal (STA(M)):

Elevation of the bottom of the canal at the end, E(M) in meters

Type 3 Turnouts to farm channels (Pipes with adjustable gates):

Friction factor (Darcy - Weisbach) of pipe for each STA(i) with a turnout, f(i)
Length of pipe at each STA (i) with a turnout, $L_p(i)$ in meters.
Diameter (inside) of the pipe at the <u>last</u> STA (i) with a turnout, $d_p(i)$ in meters
Height of the bottom of the gate above the pipe

invert at the last STA(i) with a turnout, $d_g(i)$ in meters

Optional: Diameter (inside) of the pipe at each STA(i) with a turnout, $d_p(i)$ in meters

Height of the bottom of the gate above the pipe invert at each STA(i) with turnout, $d_g(i)$ in meters

Type 4 Structures for measurement or control:

Type 4A, 4B Cutthroat and Trapezoidal Flumes: (Figures A1 and A2)

Length of the flume located at STA(i), $L_f(i)$ in meters

Throat width of flume located at STA(i), $W_f(i)$ in meters

Submergence ratio of flume located at STA(i), SR(i)

Floor elevation of flume located at STA(i), $E_f(i)$.

Type 4C Check structure (Figure A3):

Crest length of check located at STA(i), $L_c(i)$ in meters

Crest elevation of check located at STA(i), $E_c(i)$ in meters

Type 5 Bends

Coefficient for head loss due to bend, at STA(i), $K_b(i)$

Type 6 Changes in section parameters of the canal:

Type 6A Section enlargement or contraction:

Side slope beginning at STA(i) of the canal, Z(i) and/or

Bottom slope beginning at STA(i) of the canal, $S_o(i)$ in meters and/or

Bottom width beginning at STA(i) of the canal, W(i) in meters

Coeffcient for head loss due to enlargement at STA(i), $K_e(i)$, or for head loss due to contraction at STA(i), $K_c(i)$

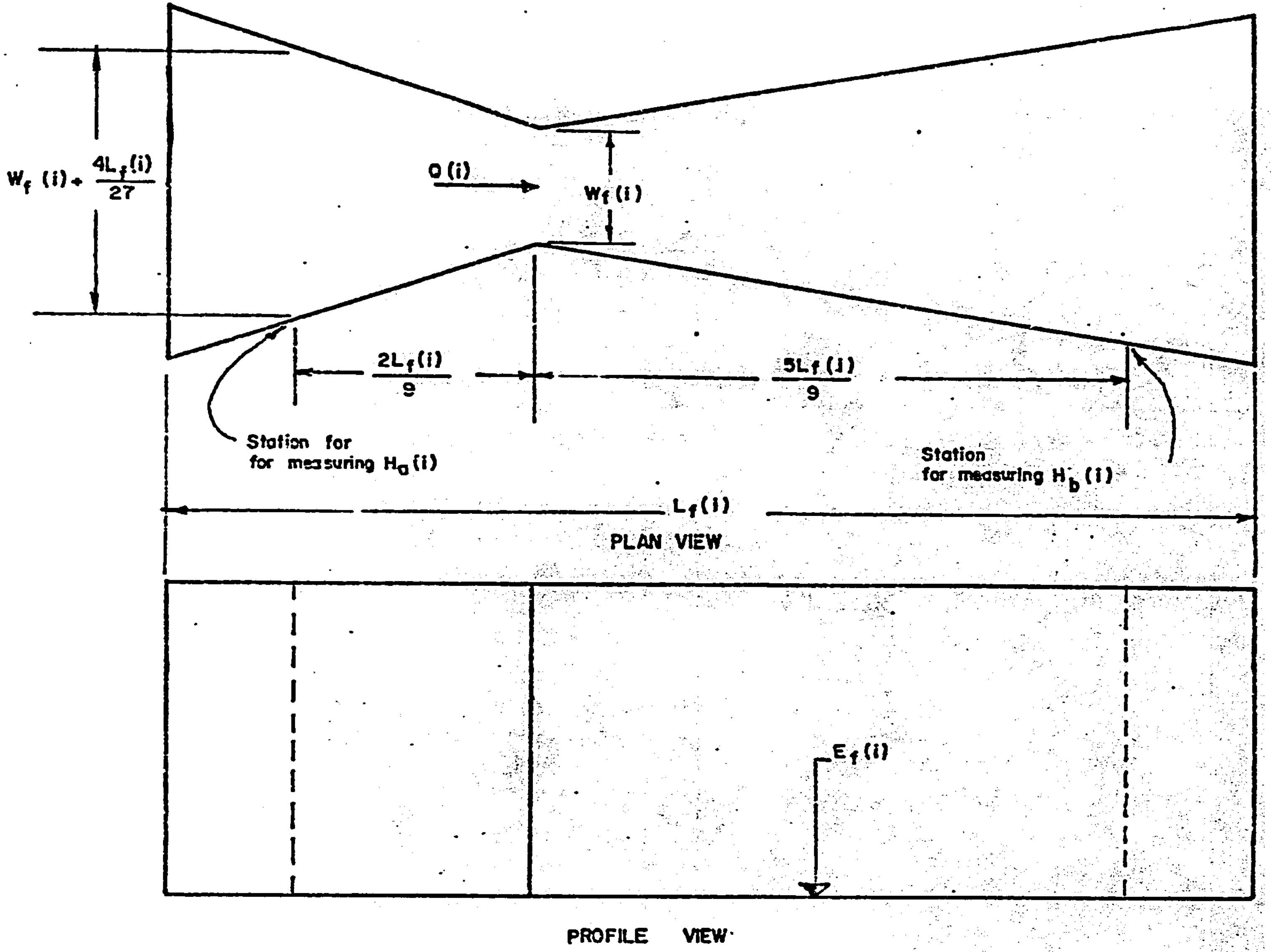

Figure A1. Definition sketch of cutthroat flume at a STA(i) in a canal. (The sketch is also applicable to a STA(i,j) in a farm channel with the notation (i) replaced by (i,j)).

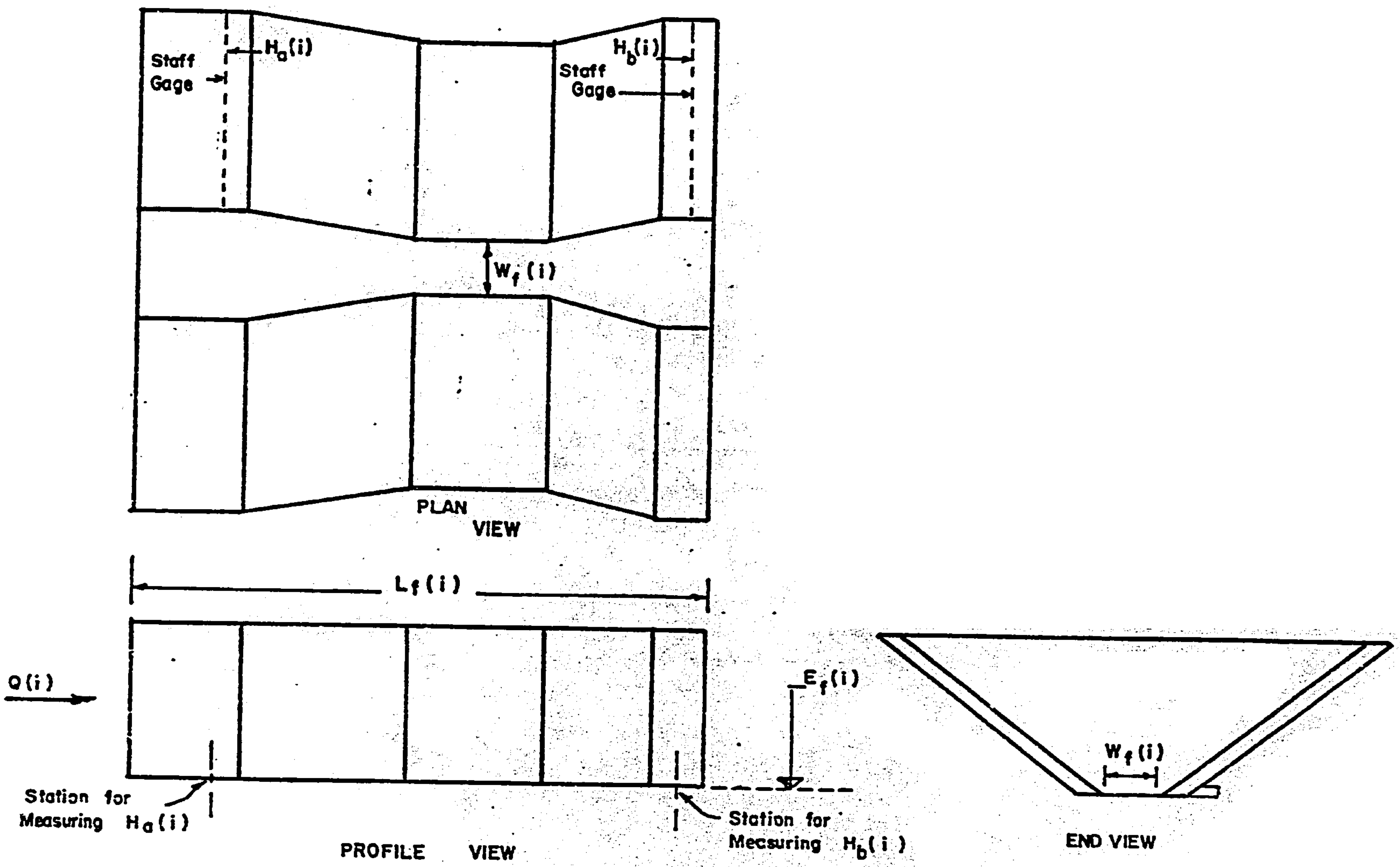

Figure A2. Definition sketch of trapezoidal flume at a STA(i) in a canal. (The sketch is also applicable to a STA(i,j) in a farm channel with the notation (i) replaced by (i,j)).

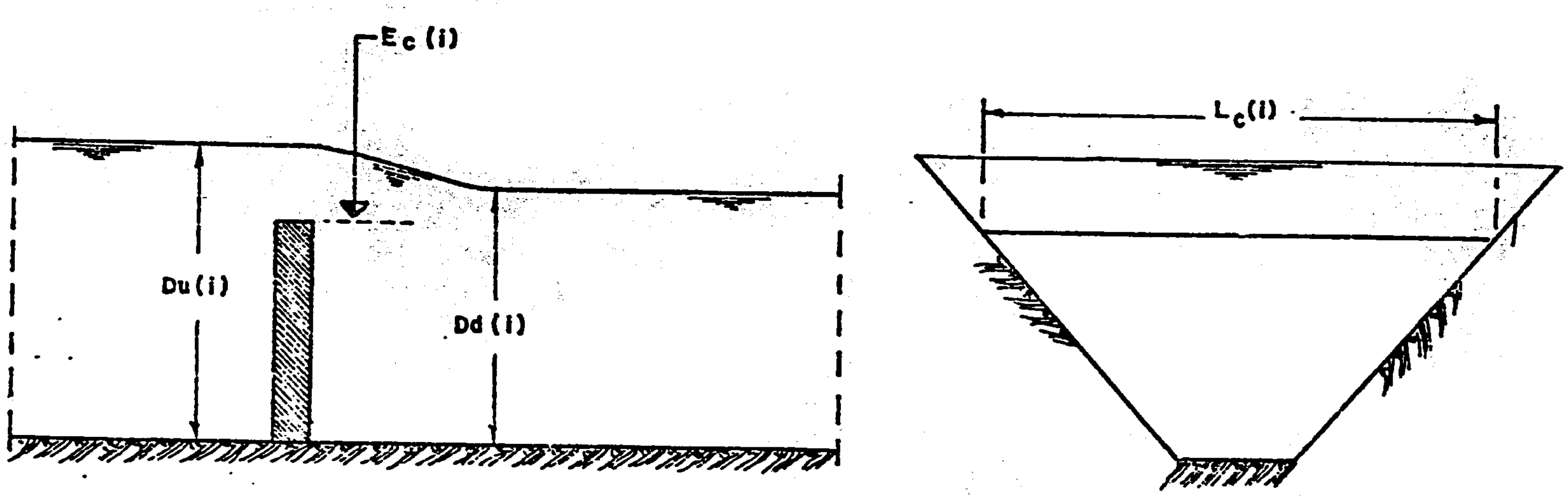

Figure A3. Definition sketch of flow over a check structure at a STA(i) in a canal. (The sketch is also applicable to a STA(i,j) in a farm channel with the notation (i) replaced by (i,j)).

Type 6B Hydraulic roughness or bottom slope change:
Hydraulic roughness beginning at STA(i) of the canal, n(i) and/or
Bottom slope beginning at STA(i) of the canal, $S_o(i)$

Type 7 "Dummy" computational station:
No parameter values required as input

5) The total number of stations along each of the farm channels (farm channels are located at each STA (i) of type 3 on the distributary canal), N(i), and the type of each station i, j(STA(i,j)).

6) The distance of each STA(i,j) from the head of each farm channel, L(i,j).

7) The seepage rate per unit length of each farm channel, s(i) in $(m^3/s)/m$

8) The parameters and boundary conditions associated with each type of STA(i,j) on each farm channel:

Type 1 Head of each farm channel (STA(i,1)):

Hydraulic roughness of each farm channel at the head, n(i,1)
Side slope of each farm channel at the head, Z(i,1)
Bottom slope of each farm channel at the head, $S_o(i,1)$ in meters
Bottom width of each farm channel at the head, W(i,1) in meters

Type 2 End of each farm channel (STA(i,N(i)):

Elevation of the bottom of each farm channel at the end, E (i,N(i)) in meters

Type 3 Turnouts on each farm channel:

Design flow rate for any type of turnout at STA(i,j), $q_d(i,j)$ in m^3/s
Elevation of water surface on field at the outlet of any type of turnout at STA (i,j), $WS_t(i,j)$ in meters

Type 3A Pipes with adjustable gates (Figure A4):

- Friction factor (Darcy-Weisbach) of pipe for each STA(i,j) with a pipe turnout, f(i,j)
- Length of pipe at each STA(i,j) with a pipe turnout, $L_p(i,j)$ in meters
- Diameter (inside) of pipe at the <u>last</u> STA(i,j) with a pipe turnout, $d_p(i,j)$ in meters
- Height of the bottom of the gate above the pipe invert at the <u>last</u> STA(i,j) with a turnout, $d_g(i,j)$ in meters
- Optional:
  - Diameter (inside) of pipe at <u>each</u> STA(i,j) with a pipe turnout, $d_p(i,j)$ in meters
  - Height of the bottom of the gate above the pipe invert at <u>each</u> STA(i,j) with a turnout, $d_g(i,j)$ in meters

Type 3B Siphon tubes (Figure A5):

- Length of siphon tube at each STA(i,j) with a siphon tube turnout, $L_s(i,j)$ in meters
- Siphon tube entrance head loss coefficient, $K_s(i,j)$
- Siphon tube roughness coefficient, $n_s(i,j)$
- Diameter (inside) of siphon tube at the <u>last</u> STA(i,j) with a siphon tube turnout, $d_s(i,j)$ in meters
- Optional:
  - Diameter (inside) of siphon tube at <u>each</u> STA(i,j) with a siphon tube turnout, $d_s(i,j)$ in meters

Type 3C Bankcuts (Figure A6):

- Length of bankcut at each STA(i,j) with a bankcut turnout, $L_b(i,j)$ in meters
- Elevation of the floor of the bankcut at each STA(i,j) with a bankcut turnout, $E_b(i,j)$ in meters
- Hydraulic roughness of the bankcut at each STA(i,j) with a bankcut turnout, $n_b(i,j)$
- Width of the bankcut at the <u>last</u> STA(i,j) with a bankcut turnout, $W_b(i,j)$ in meters

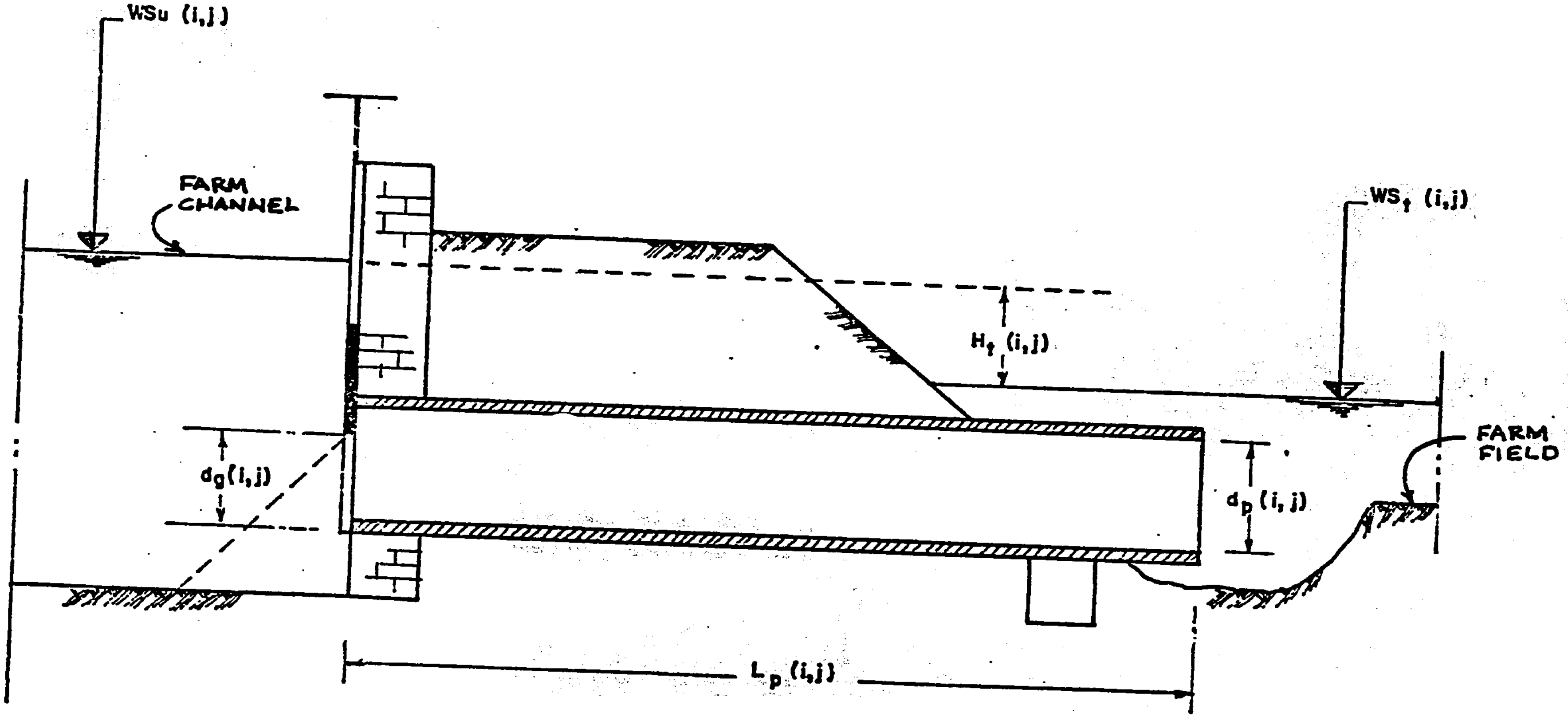

Figure A4. Definition sketch of flow through a pipe turnout with adjustable gate at a STA(i,j) in a farm channel

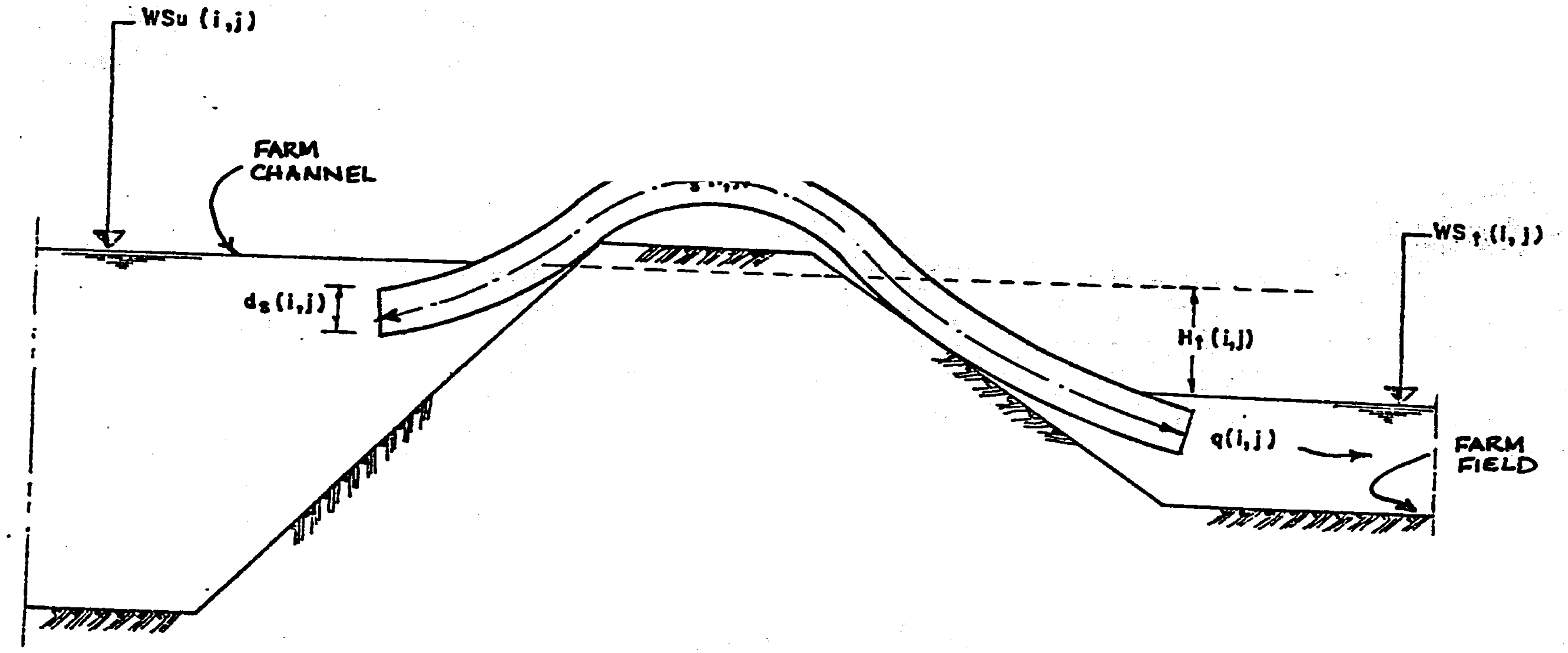

Figure A5. Definition sketch of flow through a siphon tube turnout at a STA(i,j) in a farm channel.

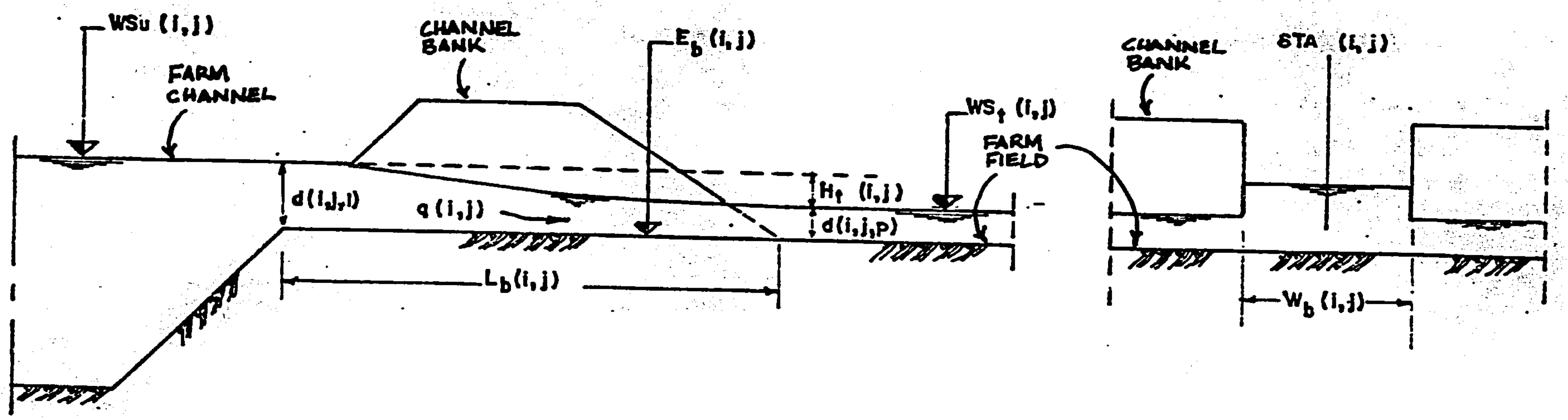

Figure A6. Definition sketch of flow through a bankcut turnout at a STA(i,j) in a farm channel.

Optional: Width of the bank cut at each STA(i,j) with a bank cut turnout, $W_b(i,j)$ in meters

Type 4 Structure for measurement or control on each farm channel:

Type 4A, Cutthroat and trapezoidal flumes:
4B Length of the flume located at STA (i,j), $L_f(i,j)$ in meters
Throat width of the flume located at STA(i,j), $W_f(i,j)$ in meters
Submergence ratio of the flume located at STA (i,j), SR(i,j) or
Floor elevation of flume located at STA(i,j), $E_f(i)$

Type 4C Check structures
Crest length of check located at STA(i,j), $L_c(i,j)$ in meters
Crest elevation of check located at STA(i,j), $E_c(i,j)$ in meters

Type 5 Bends
Coefficient for head loss due to bend, at STA(i,j), $K_b(i,j)$

Type 6 Changes in section parameters of each farm channel:

Type 6A Section enlargement or contraction:
Side slope beginning at STA(i,j) of the farm ditch, Z(i,j)
Bottom slope beginning at STA(i,j) of the farm ditch, $S_o(i,j)$
Bottom width beginning at STA(i,j) of the farm ditch, W(i,j) in meters
Coefficient for head loss due to enlargement at STA(i,j), $K_e(i,j)$, or for head loss due to contraction at STA(i,j), $K_c(i,j)$

Type 6B Hydraulic roughness or bottom slope change:
Hydraulic roughness beginning at STA(i,j) of the farm ditch, n(i,j) and/or
Bottom slope beginning at STA(i,j) of the farm ditch, $S_o(i)$

Type 7 "Dummy" computational station:
No input parameters required

The section parameters of all stations not of types 1, or 6 are assumed to be the same as the closest upstream station of type 1 or 6 unless otherwise specified.

B. Compute Hydraulic Variables in Farm Channels

Hydraulic variables are computed in each farm channel receiving water from the distributary canal. Beginning with the station corresponding to the last open turnout in the farm channel (station type 3A, 3B, or 3C) computations are made at each successive station moving in an upstream direction and ending with the station at the head. Trial and error procedures are used to achieve balanced solutions of the energy and momentum equations at each station and between stations.

A general decription of the computational steps for each STA(i,j) on a farm channel is given below. The subscript i in the notation refers to the number of the station corresponding to the location of the farm channel on the distributary canal. The subscript j refers to the number of the station on the farm channel. The values of i and j reveal nothing of the type of station under consideration (except in the case of the first and last stations) but indicate the relative location of the station along the flow channel and thus the place of that station in the computational sequence. However, since the hydraulics at any station are dependent upon its type, the type of each station determines the method of computation used.

It is assumed that the last open turnout on the farm channel is located at STA (i,x) where $1 < x < N(i)$.

1) Initialize Hydraulic Computations at STA (i,x).

   a) Compute the total discharge in the farm channel, Q(i,x) in m^3/s between STA(i,x) and STA(i,x-1).

$$Q(i,j) = Q(i,j+1) + q_d(i,j) + s(i)[L(i,j+1)-L(i,j)] \quad (A1)$$

Now $Q(i,x+1) = s(i)\ [L(i,N(i)) - L(i,x+1)]$ since there is only seepage flow in the farm channel downstream of STA(i,x). Thus,

$$Q(i,x) = s(i)[L(i,N(i)) - L(i,x+1)] + q_d(i,x) + s(i)[L(i,x+1) - L(i,x)]$$

$$= q_d(i,x) + s(i)[L(i,N(i)) - L(i,x)] \qquad (A2)$$

b) Compute the head loss, $H_t(i,x)$ in meters, to pass an actual flow rate, $q(i,x)$, equal to the design flow rate, $q_d(i,x)$, through the turnout at STA(i,x).

i) For turnout of Type 3A, substitute x for j and $q_d(i,x)$ for $q(i,j)$ in the following equations.

$$H_t(i,j) = \frac{q(i,j)^2[f(i,j)\ (L_p(i,j)/d_p(i,j)) + 1 + K_o(i,j)]}{2g\ \ A_p(i,j)^2} \qquad (A3)$$

Where $A_p(i,j)$ = the nominal cross-sectional area of the pipe with gate at STA(i,j)

$$= \frac{\pi d_p(i,j)^2}{4} \qquad (A3a)$$

$K_o(i,j)$ = the entrance loss coefficient for the pipe with gate at STA(i,j)

$$= 0.481\ \ \frac{d_g(i,j)}{d_p(i,j)}^{-3.168} \qquad (A3b)$$

g = acceleration due to gravity
= 9.81 m/s^2

Equation (A3b) for $K_o(i,j)$ was developed from data presented in USBR (1967) and Bos (1978).

ii) For a turnout of Type 3B substitute x for j and $q_d(i,x)$ for $q(i,j)$ in the following equations.

$$H_t(i,j) = \frac{8\ q(i,j)^2}{C_g(i,j)^2\ \pi^2\ d_g(i,j)^4\ g} \qquad (A4)$$

Where $C_s(i,j)$
= siphon tube discharge coefficient

$$= K_s(i,j)\left[\frac{1000d_s(i,j)^{4/3}}{(1.25X10^6)\ n_s^2\ K_s(i,j)^2\ L_s(i,j)+1000\ ds(i,j)^{4/3}}\right]^{1/2} \quad \text{(A5)}$$

$n_s(i,j)$ = siphon tube roughness coefficient, 0.008 for aluminum tubes up to 7.6 cm in diameter and 0.012 for aluminum tubes over 10 cm in diameter (Jensen,1980).

iii) For a turnout of Type 3C, an analysis of gradually varied flow through a small channel cut through a farm channel bank is used to calculate the head loss for a given flow. The details of this analysis are given in Appendix B.

c) Compute the water surface elevation just upstream of STA(i,x), WSu(i,x) in meters.

The water surface elevation just upstream of the point where water enters the farm channel turnout is equal to the head loss through the turnout added to the elevation of the water surface standing on the field at the outlet of the turnout. Figures A4, A5, and A6 illustrate this for any STA(i,j).

Expressed mathematically for STA(i,x),

$$WSu(i,x) = H_t(i,x) + WS_t(i,x) \quad \text{(A6)}$$

d) Compute the bottom elevation of the farm channel at STA(i,x), E(i,x) in meters.

The bottom elevation at STA(i,x) is equal to the bottom elevation at the end of the farm channel at STA(i,N(i)) plus the total rise in the bottom elevation between STA(i,N(i)) and STA(i,x). This total rise is computed as the sum of the products of the length of each intervening reach between stations and the bottom slope of that reach. The bottom slopes of each reach are known since the location of and bottom slope beginning at each station of type 1 or 6 is specified.

That is,

$$E(i,x) = E(i,N(i)) + \sum_{j=x}^{N(i)-1} [L(i,j+1)-L(i,j)]\ S_o(i,j) \qquad (A7)$$

e) Compute the flow depth just upstream of STA(i,x), Du(i,x) in meters.

The flow depth at any point along the farm channel is equal to the difference between the water surface elevation and the bottom elevation of the channel at that point.

Thus,

$$Du(i,x) = WSu(i,x) - E(i,x) \qquad (A8)$$

f) Compute the cross-sectional area of flow just upstream of STA(i,x), Au(i,x) in m^2.

For a trapezoidal section,

$$Au(i,x) = Du(i,x)\ W(i,x-1) + Du(i,x)^2\ Z(i,x-1) \qquad (A9)$$

g) Compute the average velocity of flow just upstream of STA(i,x), Vu(i,x) in m/s.

$$Vu(i,x) = Q(i,x)/\ Au(i,x) \qquad (A10)$$

h) Compute the kinetic energy of flow just upstream of STA(i,x), KEu(i,x) in meters.

$$KEu(i,x) = Vu(i,x)^2/2g \qquad (A11)$$

i) Compute the energy line elevation just upstream of STA(i,x), ELu(i,x) in meters.

$$ELu(i,x) = WSu(i,x) + KEu(i,x) \qquad (A12)$$

j) Compute the wetted perimeter just upstream of STA(i,x), Pu(i,x) in meters.

For a trapezoidal section,

$$Pu(i,x) = W(i,x-1) + 2Du(i,x)[1+ Z(i,x-1)^2]^{1/2} \qquad (A13)$$

k) Compute the hydraulic radius just upstream of STA(i,x), Ru(i,x) in meters.

$$Ru(i,x) = Au(i,x)/Pu(i,x) \qquad (A14)$$

l) Compute the friction slope just upstream of STA(i,x), SFu(i,x)

From Manning's equation,

$$SFu(i,x) = Vu(i,x)^2\ n(i,x-1\ )^2/Ru(i,x)^{4/3} \qquad (A15)$$

2) After completing initial hydraulic computations at STA(i,x), calculations are made at successive upstream stations, that is for each STA(i,j) where j = (x-1) to 1. Iterative solutions by trial and error are required.

a) Compute an initial trial value of water surface elevation just downstream of STA(i,j), WSd(i,j) in meters. This may be done by assuming uniform flow between STA(i,j) and the last computed station, STA(i,j+1).

$$WSd(i,j) = WSu(i,j+1) + [L(i,j+1) - L(i,j)]\ S_o(i,j) \qquad (A16)$$

b) Compute the bottom elevation at STA(i,j), E(i,j).

$$E(i,j) = E(i,j+1) + [L(i,j+1) - L(i,j)]\ S_o(i,j) \qquad (A17)$$

c) Compute the flow depth just downstream of STA (i,j), Dd (i,j) in meters.

$$Dd(i,j) = WSd(i,j) - E(i,j) \qquad (A18)$$

d) Compute the cross-sectional area of flow just downstream of STA (i,j), Ad(i,j) in m^2.

For a trapezoidal section,

$$Ad(i,j) = Dd(i,j)\ W(i,j+1) + Dd(i,j)^2\ Z(i,j) \qquad (A19)$$

e) Compute the average velocity of flow just downstream of STA(i,j), Vd(i,j) in m/s.

$$Vd(i,j) = Q(i,j+1)/Ad(i,j) \qquad (A20)$$

f) Compute the kinetic energy of flow just downstream of STA(i,j), KEd(i,j) in meters.

$$KEd(i,j) = Vd(i,j)^2/2g \tag{A21}$$

g) Compute the energy line elevation just downstream of STA(i,j), ELd(i,j) in meters.

$$ELd(i,j) = WSd(i,j) + KEd(i,j) \tag{A22}$$

h) Compute the wetted perimeter just downstream of STA (i,j), Pd(i,j) in meters.

For a trapezoidal section,

$$Pd(i,j) = W(i,j) + 2\ Dd(i,j)\ [1 + Z(i,j)^2]^{1/2} \tag{A23}$$

i) Compute the hydraulic radius just downstream of STA(i,j), Rd(i,j) in meters.

$$Rd(i,j) = Ad(i,j)/Pd(i,j) \tag{A24}$$

j) Compute the friction slope just downstream of STA(i,j), SFd(i,j).

From Manning's equation,

$$SFd(i,j) = Vd(i,j)^2\ n(i,j)^2/Rd(i,j)^{4/3} \tag{A25}$$

k) Compute the average friction slope for the section of the farm channel between STA(i,j) and STA(i,j+1), $SF_a(i,j+1)$.

$$SF_a(i,j+1) = (SFd(i,j) + SFu(i,j+1))/2 \tag{A26}$$

l) Compute the headloss due to friction between STA(i,j) and STA(i,j+1), HL (i,j+1) in meters.

$$HL(i,j+1) = SF_a(i,j+1)\ \ [L(i,j+1) - L(i,j)] \tag{A27}$$

m) Compute a new energy line elevation just downstream of STA(i,j), ELd(i,j)'in meters.

$$ELd(i,j)' = ELu(i,j+1) + HL(i,j+1) \quad \text{(A28)}$$

n) Compare ELd(i,j) and ELd(i,j)'to determine if trial value of WSd(i,j) is sufficiently accurate or if new trial value needs to be selected.

  i) If $| ELd(i,j) - ELd(i,j) | \leq 0.001$, WSd(i,j) is sufficiently accurate. Go to section (B2o).

  ii) If $| ELd(i,j) - ELd(i,j) | > 0.001$ select a new trial value of WSd(i,j) and return to section (B2b).

o) Compute the flow rate just upstream of STA(i,j), Q(i,j) in m^3/s.

  i) For stations of type 3, initially substitute the design discharge, $q_d(i,j)$, for the actual discharge, q(i,j), in the following equation.

$$Q(i,j) = Q(i,j+1) + q(i,j) + s(i)[L(i,j+1) - L(i,j)] \quad \text{(A29)}$$

  ii) For stations not of type 3,

$$Q(i,j) = Q(i,j+1) + s(i) \; [L(i,j+1) - L(i,j)] \quad \text{(A30)}$$

p) Compute the water surface elevation and flow depth just upstream of STA(i,j), WSu(i,j) and Du(i,j) respectively in meters.

  i) For stations of type 3, consider the momentum change due to abruptly diminishing flow at the turnout to determine Du(i,j). Reference is made to Figure A7 in the discussion that follows. Assumptions and procedures used to derive equations (A31) and (A32) are given in Appendix C.

  From Newton's 2nd law,

$$Fd(i,j) - Fu(i,j) =$$
$$\rho Q(i,j) \; Vu(i,j) - \rho Q(i,j+1) \; Vd(i,j) \quad \text{(A31)}$$

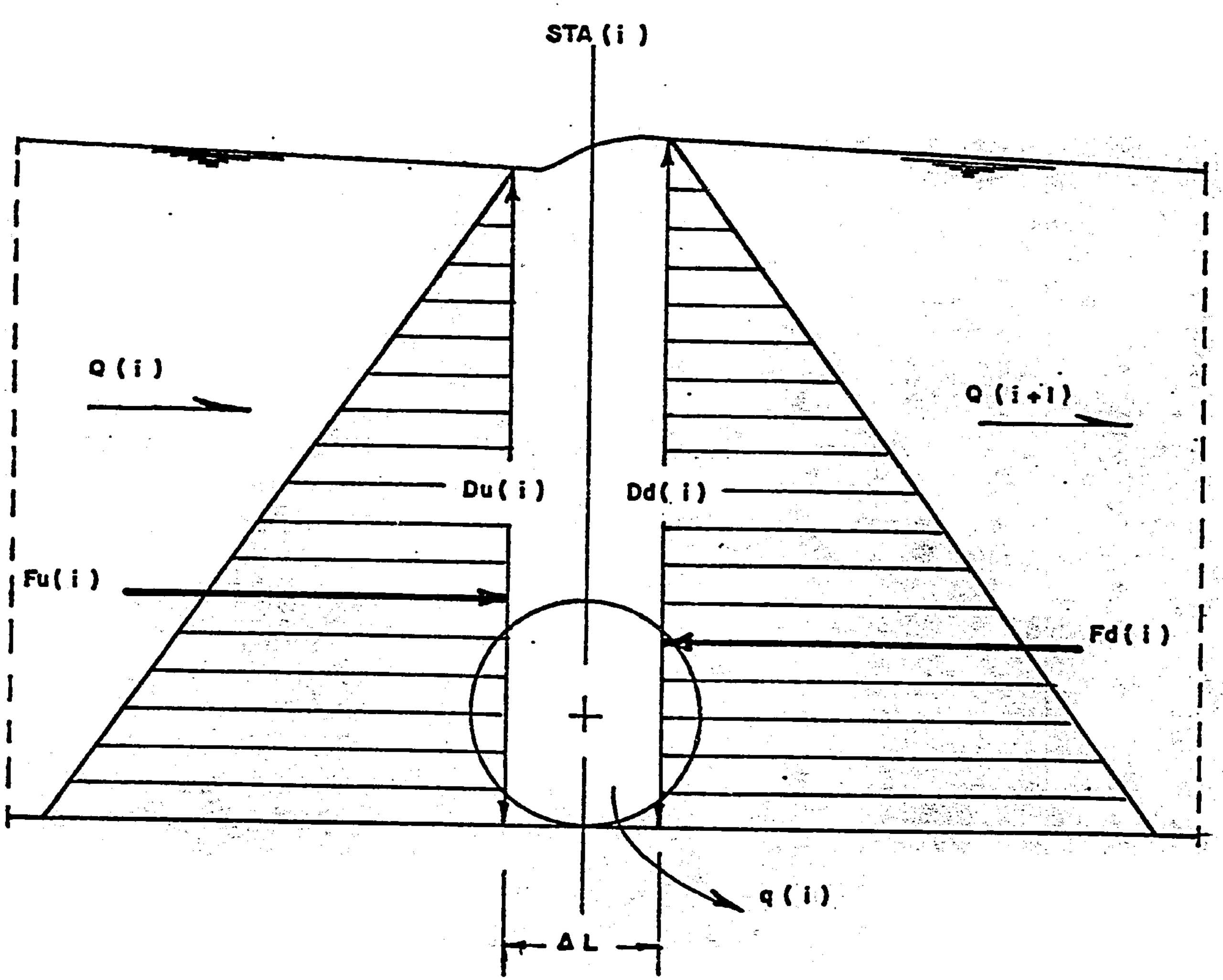

Figure A7. Definition sketch for application of the momentum principle to flow at a STA(i) with an open turnout in a canal. (The sketch is also applicable to a STA(i,j) in a farm channel with the notation (i) replaced by (i,j)).

Where Fd(i,j) and Fu(i,j) = the force due to water pressure on the section just downstream and just upstream of STA(i,j) respectively.

ρ = the mass density of water

Expanding equation (A31) gives

$$Ad(i,j)\left[\frac{3W(i,j)\ Dd(i,j)+2Dd(i,j)^2\ Z(i,j)}{6(W(i,j)+Dd(i,j)\ Z(i,j))}\right] g\ -$$

$$[W(i,j-1)Du(i,j)+Du(i,j)^2Z(i,j-1)]\ x$$

$$\left[\frac{3W(i,j-1)Du(i,j)+2Du(i,j)^2Z(i,j-1)}{6(W(i,j-1)+Du(i,j)Z(i,j-1))}\right] g$$

$$= \left[\frac{Q(i,j)^2}{W(i,j-1)\ Du(i,j-1)+Du(i,j)^2Z(i,j-1)}\right] - \left[\frac{Q(i,j+1)^2}{Ad(i,j)}\right] \qquad (A32)$$

Equation (A32) is solved by trial and error to determine Du(i,j).

Determine WSu (i,j) as

$$WSu(i,j) = E(i,j) + Du(i,j) \qquad (A33)$$

ii) For stations of type 4,

Type 4A, cutthroat flume:

If the flume floor elevation, $E_f(i,j)$, is specified, Du(i,j), WSu(i,j), and the submergence ratio SR (i,j) are computed as follows (refer to Figure A8).

Determine the downstream flow depth on the flume, $H_b(i,j)$ in meters

$$H_b(i,j) = WSd(i,j) - E_f(i,j) \qquad (A34)$$

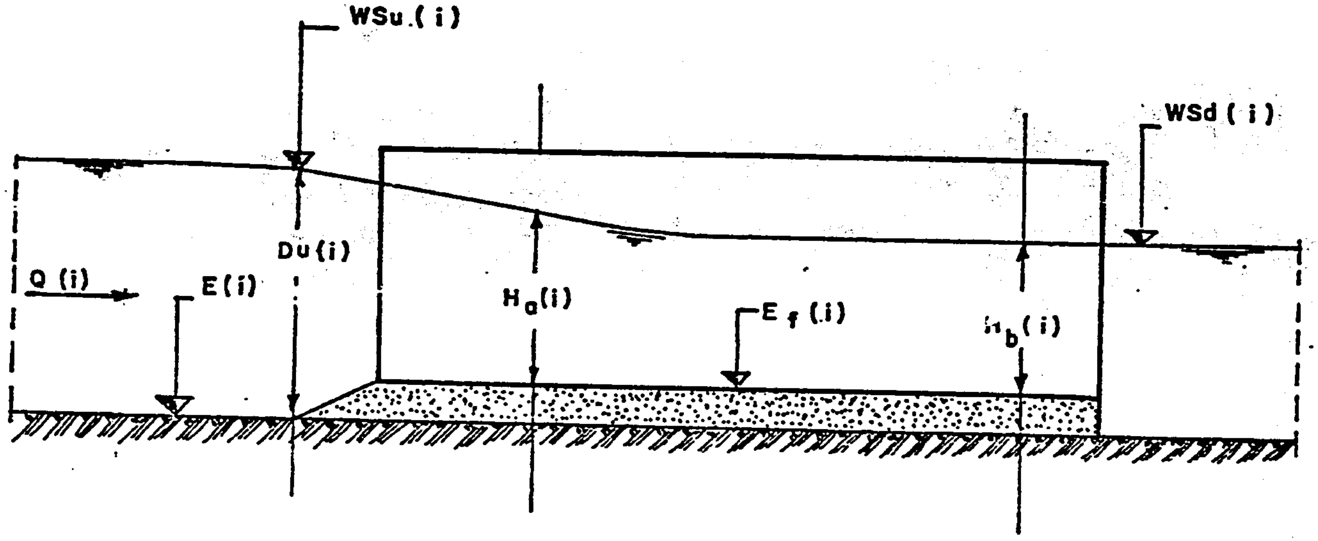

Figure A8. Definition sketch of flow through a cutthroat or trapezoidal flume at a STA(i) in a canal. (The sketch is also applicable to a STA(i,j) in a farm channel with the notation (i) replaced by (i,j)).

Compute the transition submergence, $SR_t(i,j)$, from the following equation.

$$SR_t(i,j) = 0.485 + 0.1887\ L_f(i,j) - 0.0269\ L_f(i,j)^2 + \left[\frac{0.0102}{L_f(i,j)^2}\right] \qquad \text{(A35a)}$$

Compute the upstream flow depth in the flume, $H_a(i,j)$ in meters, required for free flow using the following equation for free flow in a cutthroat flume.

$$Q(i,j) = 3.281^{(1.025+n_1-3.0)}\ K_1 W_f(i,j)^{1.025}\ H_a(i,j)^{n_1} \qquad \text{(A36a)}$$

Where

$$n_1 = 1.418 + (0.405/L_f(i,j)) \qquad \text{(A37)}$$

$$K_1 = 2.962 + (1.448/L_f(i,j)) \qquad \text{(A37a)}$$

Compute the submergence ratio for $H_b(i,j)$ computed from equation (A34) and $H_a(i,j)$ computed from equation (A36a)

$$SR(i,j) = H_b(i,j)/H_a(i,j) \qquad \text{(A35b)}$$

If $SR(i,j) \leq SR_t(i,j)$, the flow is free and the solution for $H_a(i,j)$ and $SR(i,j)$ is achieved.

If $SR(i,j) > SR_t(i,j)$, the flow is submerged and $H_a(i,j)$ must be recomputed by trial and error from the following equation for submerged flow in a cutthroat flume.

$$Q(i,j) = \frac{(3.281)^{n_1-1.975} K_2 W_f(i,j)^{1.025} (H_a(i,j)-H_b(i,j))^{n_1}}{-\left[\log \dfrac{H_b(i,j)}{H_a(i,j)}\right]^{n_2}} \qquad \text{(A36b)}$$

Where

$$K_2 = 2.51 - 0.801\ \ln\ (L_f(i,j)) \qquad \text{(A38)}$$

$$n_2 = 1/[0.748 - (0.064/L_f(i,j))] \qquad \text{(A39)}$$

Equations (A37), (A37a), (A38), and (A39) are valid for $0.46 \leq L_f(i,j) \leq 2.74$ meters.

Recompute SR(i,j) from equation (A35b).

Applying the Bernoulli energy equation to the flow between the section just upstream of the flume and that at the entrance to the flume where $H_a(i,j)$ is measured (Figure A8) gives

$$E_f(i,j) + H_a(i,j) + V_a(i,j)^2/2g + h_{lf} = E(i,j) + Du(i,j) + Vu(i,j)^2/2g \qquad \text{(A40)}$$

Where $V_a(i,j)$ = the average velocity of flow in the flume at STA(i,j) at the point where $H_a(i,j)$ is measured

h_{lf} = the energy loss due to friction between the section just upstream of the flume at STA(i,j) and the section where $H_a(i,j)$ is measured

Brater and King (1976) suggest that the head loss, h_{lf}, for a well designed transition can be estimated by the relation

$$h_{lf} = 0.1\ [(V_a(i,j)^2/2g) - (Vu(i,j)^2/2g)] \qquad \text{(A41)}$$

Now

$$V_a(i,j) = Q(i,j)/A_a(i,j) \qquad \text{(A42)}$$

Where $A_a(i,j)$ = the cross-sectional area of flow in the flume at STA(i,j) at the point where $H_a(i,j)$ is measured

The value of $A_a(i,j)$ may be computed from the following relation (Skogerboe et.al, 1973)

$$A_a(i,j) = [W_f(i,j) + (4\ L_f(i,j)/27)]\ H_a(i,j) \qquad \text{(A43)}$$

Now

$$\begin{aligned} Vu(i,j) &= Q(i,j)/Au(i,j) \\ &= Q(i,j)/[Du(i,j)\ W(i,j) + Du(i,j)^2\ Z(i,j)] \qquad \text{(A44)} \end{aligned}$$

Substitution of equations (A41) through (A44) into equation (A40) allows $Du(i,j)$ to be solved by trial and error since the values of all other variables are known. The value of $WSu(i,j)$ may then be computed from equation (A33).

If the submergence ratio, $SR(i,j)$, is specified for the cutthroat flume, then $Du(i,j)$, $WSu(i,j)$, and the flume floor elevation, $E_f(i,j)$ are computed as follows.

Compute the transition ratio, $SR_t(i,j)$, from equation (A35a).

Compute the submergence ratio, $SR(i)$, from equation (A35b).

If $SR(i,j) \quad SR_t(i,j)$, compute $H_a(i,j)$ from equation (A38a) for free flow and compute $H_b(i,j)$ from equation (A35b).

If $SR(i,j) > SR_t(i,j)$, combine the relations given in equations (A35b) and (A36b) to obtain the following equation for submerged flow.

$$Q(i,j) = \frac{(3.281)^{n_1-1.975} K_2 W_f(i,j)^{1.025}[(H_b(i,j)/SR(i,j)) - H_b(i,j)]^{n_1}}{(-\log SR(i,j))^{n_2}} \qquad \text{(A45)}$$

Solve equation (A45) for $H_b(i,j)$ by trial and error and compute $H_a(i,j)$ from equation (A35b).

Determine the flume floor elevation as

$$E_f(i,j) = WSd(i,j) - H_b(i,j) \qquad \text{(A46)}$$

Use equations (A40) through (A44) and equation (A33) to calculate $Du(i,j)$ and $WSu(i,j)$ as discussed above.

Type 4B, trapezoidal flume:

Note: Five different types of trapezoidal flumes have been calibrated and presented in the literature (Robinson, 1980). These flumes vary in size and in the flow range which they were designed to measure. The calibration equations and equations defining the flow cross-section geometry vary with the type of flume. The flume utilized in the model is flume E-2 which is designed for a flow range of 0.015 to 1.665 m^3/s.

If the flume floor elevation, $E_f(i,j)$, is specified, Du(i,j), WSu(i,j), and the submergence ratio SR(i,j) are computed as follows (refer to Figure A8).

Determine the downstream flow depth in the flume, $H_b(i,j)$ in meters, from equation (A34).

Compute by trial and error the upstream flow depth on the flume, $H_a(i,j)$ in meters, required for free flow from the free flow equation given in Robinson (1980).

$$Q(i,j) = 2.810\ H_a(i,j)^{2.5} - 1.359\ H_a(i,j)^2 + 1.325\ H_a(i,j)^{1.5} - 0.244\ H_a(i,j) + 0.036 \times H_a(i,j)^{0.5} - 0.002 \qquad \text{(A47a)}$$

Compute the submergence ratio from equation (A35b).

If SR(i,j) is less than or equal to the transition submergence of 0.85 for an E-2 flume, then the flow is free and the solution for Ha(i,j) and SR(i,j) is completed.

If SR(i,j) > 0.85, the flow is submerged and Ha(i,j) and SR(i,j) must be recomputed as follows:

α) Call the value of $H_a(i,j)$ computed for free flow from equation (A47a) by the notation $H_a(i,j)'$.

β) Compute $H_a(i,j)$ for submerged flow by trial and error from the following equation for submerged flow in an E-2 trapezoidal flume.

$$H_a(i,j) = H_a(i,j)'\ [1+5.083 \times 10^{-7} \exp(12.77 \times H_b(i,j)/\ H_a(i,j))] \qquad \text{(A47b)}$$

γ) Recompute SR(i,j) from equation (37b).

Compute Du(i,j) by trial and error from equation (A40) where h_{lt}, $V_a(i,j)$, and $V_u(i,j)$ are given by equations (A41), (A42), and (A44) respectively and where $A_a(i,j)$ is computed as (Robinson, 1980).

$$A_a(i,j) = 0.61\ H_a(i,j) + 1.25\ H_a(i,j)^2 \qquad \text{(A48)}$$

Compute WSu(i,j) from equation (A33)

If the submergence ratio, SR(i,j), is specified for the trapeziodal flume; Du(i,j), WSu(i,j), and the flume floor elevation, $E_f(i,j)$, are computed as follows:

If $SR(i,j) \leq 0.85$, compute $H_a(i,j)$ from equation (A47a) and $H_b(i,j)$ from equation (A35b).

If $SR(i,j) > 0.85$, compute $H_a(i,j)'$ from equation (A47a) and solve equation (A47b) for $H_a(i,j)$ where $[H_b(i,j)/H_a(i,j)] = SR(i,j)$. Compute $H_b(i,j)$ from equation (A35b).

Compute the flume floor elevation from equation (A46).

Use equations (A40), (A41), (A42), (A44), and (A48) to calculate Du(i,j) as discussed above.

Compute WSu(i,j) from equation (A33).

Type 4C, check structure:

Compute the downstream head over the crest of the check structure, $h_{c2}(i,j)$.

$$h_{c2}(i,j) = WSd(i,j) - E_c(i,j) \tag{A48a}$$

Compute the upstream head over the crest of the check structure, $h_{c1}(i,j)$, for a condition of free flow from the following equation for free flow over a broad crested weir.

$$Q(i,j) = 1.767\ L_c(i,j)\ h_{c1}(i,j)^{1.5} \tag{A48b}$$

Compute the submergence ratio for the check structure, $SR_c(i,j)$.

$$SR_c(i,j) = h_{c2}(i,j)/h_{c1}(i,j) \tag{A48c}$$

If $SR_c(i,j) > 0.65$, the upstream head over the crest structure must be recomputed for a condition of submerged flow by trial and error using the following equation (Varshney and Mohanty, 1973).

$$Q(i,j) = [1.767\ L_c(i,j)\ h_{c1}(i,j)^{1.5}]\ [9.81\left[\frac{hc2(i,j)}{h_{c1}(i,j)}\right] - 7.55\left[\frac{h_{c2}(i,j)}{h_{c1}(i,j)}\right]^2 - 2.26\ ]^{0.5} \tag{A48d}$$

Compute the upstream water surface elevation as

$$WSu(i,j) = h_{c1}(i,j) + E_c(i,j) \tag{A48e}$$

Compute the upstream flow depth using equation (A8) with j substituted for x.

iii) For stations of type 5, bend in the channel

Compute the head loss due to the bend, $h_{lb}(i,j)$ in meters, as a function of the velocity head just downstream of the bend.

$$h_{lb}(i,j) = K_b(i,j)\ KEd(i,j) \tag{A49}$$

Where $K_b(i,j)$ = bend head loss coefficient

Compute $WSu(i,j)$ as

$$WSu(i,j) = WSd(i,j) + h_{lb}(i,j) \tag{A50}$$

Compute $Du(i,j)$ as

$$Du(i,j) = Dd(i,j) + h_{lb}(i,j) \tag{A51}$$

iv) For stations of type 6

A station of type 6 would occur at a location in the channel where the dimensions and/or roughness of the channel section change over a relatively short distance. In the case of a change in the dimensions (enlargement or contraction) a head loss and change in water surface elevation would occur and are computed in the model. If only the roughness (due to vegetation or lining for example) or bottom slope changes, the water surface elevation is assumed to remain constant. In either case, a station of type 6 establishes a new set of channel section parameters (hydraulic roughness, side slope, bottom slope, bottom width).

Stations where an abrupt change in the bottom elevation of the channel occurs (i.e. drops or ramps) are not considered in the analysis.

Type 6A, enlargement of the channel section:

Applying the Bernoulli energy equation to STA(i,j) where a sudden horizontal enlargement of the channel section occurs gives (Figure A9)

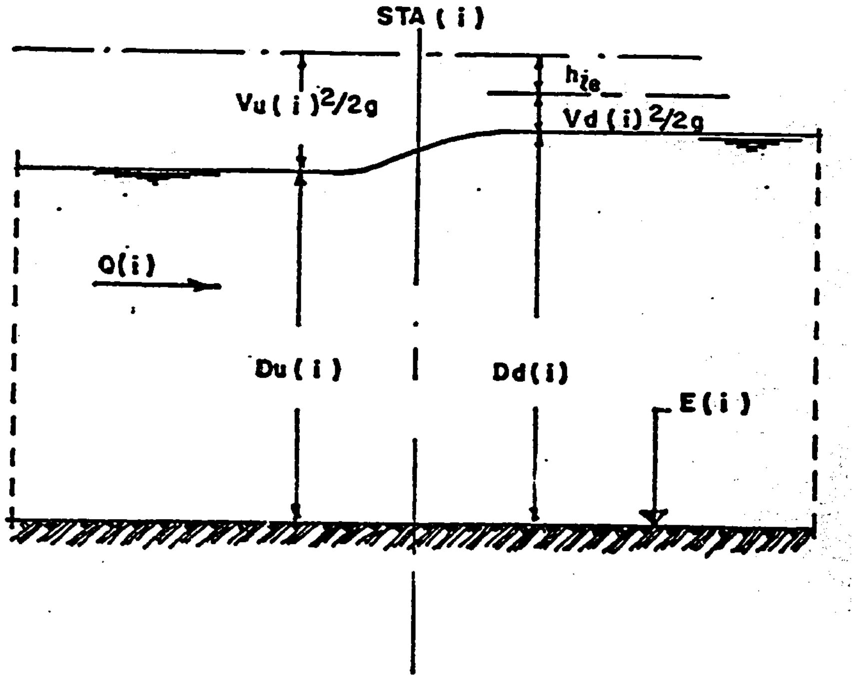

Figure A9. Definition sketch of flow through a sudden channel enlargement at a STA(i) in a canal. (The sketch is also applicable to a STA(i,j) in a farm channel with the notation (i) replaced by (i,j)).

$$Du(i,j)+Vu(i,j)^2/2g = Dd(i,j)+(Vd(i,j)^2/2g)+h_{le} \qquad \text{(A52)}$$

Where h_{le}= head loss due to sudden enlargement

$$= K_e(i,j)\ [(Vu(i,j)^2/2g) - (Vd(i,j)^2/2g)] \qquad \text{(A53)}$$

Substituting equations (A53) and (A44) into equation (A52) gives

$$Du(i,j) = Dd(i,j) + \frac{1}{2g}\left[\frac{Q(i,j)^2}{[Du(i,j)\ W(i,j-1)+Du(i,j)^2 Z(i,j-1)]^2} - Vd(i,j)^2\right] \times (K_e(i,j)-1) \qquad \text{(A54)}$$

Solve equation (A54) by trial and error for Du(i,j) and determine WSu(i,j) from equation (A33).

Contraction of the channel section:

Applying the Bernoulli energy equation to STA(i,j) where a sudden contraction of the channel section occurs gives (Figure A10)

$$Du(i,j)+(Vu(i,j)^2/2g) = Dd(i,j)+(Vd(i,j)^2/2g)+h_{lc} \qquad \text{(A55)}$$

Where h_{lc} = head loss due to sudden contraction

$$= K_c(i,j)\ [(Vd(i,j)^2/2g) - (Vu(i,j)^2/2g)] \qquad \text{(A56)}$$

Substituting equations (A56) and (A44) into equation (A55) gives

$$Du(i,j) = Dd(i,j) + \frac{1}{2g}\left[Vd(i,j)^2 - \frac{Q(i,j)^2}{[(Du(i,j)\ W(i-1,j)+Du(i,j)^2 Z(i-1,j)]^2}\right] \times (1+K_c(i,j)) \qquad \text{(A57)}$$

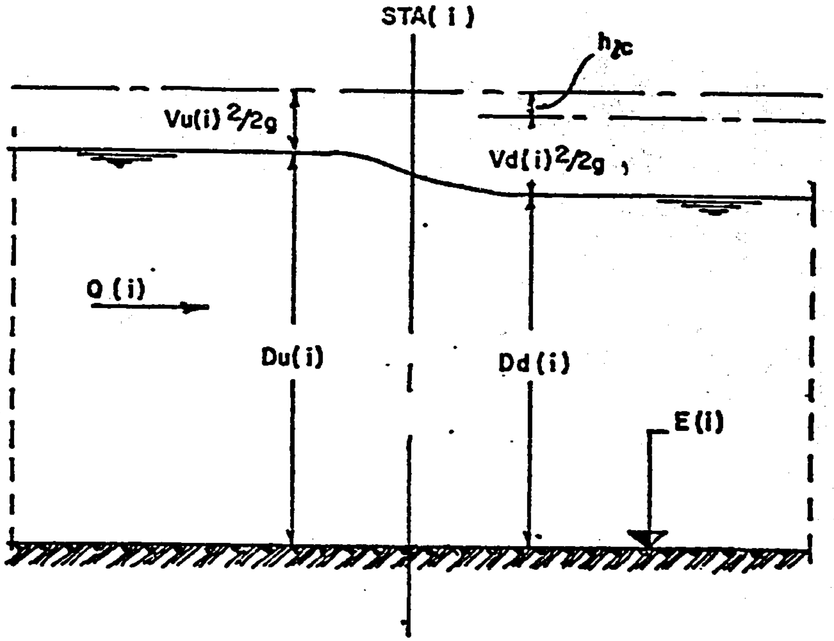

Figure A10. Definition sketch of flow through a sudden channel contraction at a STA(i) in a canal. (The sketch is also applicable to a STA(i,j) in a farm channel with the notation (i) replaced by (i,j)).

Solve equation (A57) by trial and error for Du (i,j) and determine WSu(i,j) from equation (A33).

Type 6B, change only in hydraulic roughness or bottom slope of the channel:

The depth and water surface elevation just upstream of any STA(i,j) is considered to be unaffected by a mere change in roughness, or transition from one mild slope to another.

That is :

$$Du(i,j) = Dd(i,j) \tag{A58}$$

and

$$WSu(i,j) = WSd(i,j) \tag{A59}$$

v) For stations of type 7, "dummy" computational station.

The flow conditions just upstream of a "dummy" station are the same as those just downstream. Thus, equations (A58) and (A59) are used to compute Du(i,j) and WSu(i,j) respectively.

vi) For stations of type 1, head of channel

The flow conditions just upstream of STA(i,1) at the head of the channel are the same as those just downstream. Thus Du(i,1) and WSu(i,1) are computed from equations (A58) and (A59) for j=1.

q) For stations of type 3, determine the head on the farm channel turnout, $H_t(i,j)$ in meters.

$$H_t(i,j) = WSu(i,j) - WS_t(i,j) \tag{A60}$$

r) For stations of type 3, determine the discharge rate through the turnout, q(i,j) in m^3/s, for a specified size of turnout (and gate setting for type 3A); or determine the size of turnout ($d_p(i,j)$, $d_s(i,j)$, or $W_b(i,j)$) required to pass a specified design discharge rate, $q_d(i,j)$; and/or determine the gate setting for a specified or computed size of pipe turnout, $d_p(i,j)$, and design discharge rate, $q_d(i,j)$.

i) Determine q(i,j) in m^3/s for a specified size of turnout.

Type 3A, pipe turnout:

Rearrange equations (A3), (A3a), and (A3b) to solve directly for q(i,j).

Type 3B, siphon tube turnout:

Combine equations (A4) and (A5) and rearrange to solve directly for q(i,j)

Type 3C, bank cut turnout:

Compute q(i,j) by the gradually varied flow analysis outlined in Appendix B.

ii) Determine the size of turnout (d_p(i,j), d_s(i,j), or W_b (i,j) in meters) required to pass a specified design discharge rate, q_d(i,j).

Pipes and siphon tubes are available from manufacturers in standard sizes. The model assumes the following available sizes:

- Pipes: 0.10 m I.D. to 1.00 m I.D. by 0.05 m increments. ments.
- Siphon tubes: 0.05 m I.D. to 0.20 m I.D. by 0.025 m increments.

These limits may be easily changed to fit existing conditions.

Since pipes and siphon tubes are available in incremental sizes, it is unlikely that an available size would pass the design flow rate exactly with the available head, H_t(i,j). Thus an available size is selected that will pass an actual flow rate closest to the design flow rate. In the case of pipes with gates, a gate setting may be computed that will control the inlet area of the selected pipe to pass an actual flow rate equal to the design flow rate with the available head, H_t(i,j).

Type 3A, pipe turnout with gate:

Select an initial pipe diameter size, $d_p(i,j)$ in meters, from the range of available sizes.

Compute the value of $q(i,j)$ from equations (A3) and (A3a) using the selected value of $d_p(i,j)$.

Compute the absolute difference between the design value of flow rate, $q_d(i,j)$, and the computed actual value, $q(i,j)$:

$$G_1 = \left| q_d(i,j) - q(i,j) \right| \tag{A61}$$

Select subsequent values of $d_p(i,j)$ and compute corresponding values of $q(i,j)$.

The value of $d_p(i,j)$ selected is the one that minimizes the value of G_1.

If the value of $q(i,j)$ computed from equation (A3) and (A3a) for the selected value of $d_p(i,j)$ is less than $q_d(i,j)$, increase the selected value of $d_p(i,j)$ by one size increment (eg. by 0.05 m).

Go to step (B2riii) with the selected value of $d_p(i,j)$ to determine a gate setting that will pass the design flow rate, $q_d(i,j)$.

Type 3B, siphon tube turnout:

Select an initial siphon tube diameter size, $d_s(i,j)$ in meters, from the range of available sizes.

Compute the value of $q(i,j)$ using equations (A4) and (A5) with the selected value of $d_s(i,j)$.

Use equation (A61) to compute the absolute difference between the design value of discharge, $q_d(i,j)$ and the computed actual value, $q(i,j)$.

Select subsequent values of $d_s(i,j)$ and compute corresponding values of $q(i,j)$ and G_1.

The value of $d_s(i,j)$ selected is the one that minimizes the value of G_1.

Type 3C, bank cut turnout:

Following a procedure similar to that described above for pipes and siphon tubes, incremental values of bank cut width, $W_b(i,j)$ in meters, are selected and the flow equations presented in Appendix B are solved to determine the width that will pass the design flow rate. It is assumed that any width of cut can be made in the field and thus a width may be selected that will pass an actual flow rate equal to the design flow rate.

iii) For a turnout of type 3A, determine the gate setting for a specified or computed size of pipe turnout, $d_p(i,j)$, and design flow rate, $q_d(i,j)$.

When a specified or computed value of pipe size, $d_p(i,j)$, will not pass the exact design flow rate, $q_d(i,j)$, for the computed head on the turnout, $H_t(i,j)$, a gate setting may be computed that will provide the desired control. The gate setting is specified as the height of the bottom of the gate above the pipe invert, $d_g(i,j)$ in meters (Figure A4). The value of $d_g(i,j)$ is computed from equations (A3) and (A3b).

If the actual discharge through the turnout, $q(i,j)$, computed in sections (B2ri) or (B2rii) is not equal to the design flow rate, $q_d(i,j)$, compute a new value of $Q(i,j)$ from equation (A29). Call this new computed value $Q(i,j)'$. Compare $Q(i,j)'$ with the old computed value, $Q(i,j)$:

$$G_2 = |Q(i,j) - Q(i,j)'| \qquad \text{(A62)}$$

If the difference is not sufficiently small (eg.$G_2 \leq 0.05 \times Q(i,j)$) then repeat the calculations in sections (B2p) and (B2r) with the new computed value, $Q(i,j)'$. This process is repeated until G_2 becomes sufficiently small.

s) Compute the cross-sectional area of flow just upstream of STA(i,j), Au(i,j) in m^2.

$$Au(i,j) = Du(i,j)\ W(i,j-1) + Du(i,j)^2\ Z(i,j-1) \quad \text{(A63)}$$

t) Compute the average velocity of flow just upstream of STA(i,j), Vu(i,j) in m/s.

$$Vu(i,j) = Q(i,j)/Au(i,j) \quad \text{(A64)}$$

u) Compute the kinetic energy of flow just upstream of STA(i,j), KEu(i,j) in meters.

$$KEu(i,j) = Vu(i,j)^2/2g \quad \text{(A65)}$$

v) Compute the energy line elevation just upstream of STA(i,j), ELu(i,j) in meters

$$ELu(i,j) = WSu(i,j) + KEu(i,j) \quad \text{(A66)}$$

w) Compute the wetted perimeter just upstream of STA(i,j), Pu(i,j) in meters

$$Pu(i,j) = W(i,j-1) + 2\ Du(i,j)\ [1+Z(i,j-1)^2]^{1/2} \quad \text{(A67)}$$

x) Compute the hydraulic radius just upstream of STA(i,j), Ru(i,j) in meters

$$Ru(i,j) = Au(i,j)/Pu(i,j) \quad \text{(A68)}$$

y) Compute the friction slope just upstream of STA(i,j), SFu(i,j).

From Manning's equation,

$$SFu(i,j) = Vu(i,j)^2\ n(i,j-1)^2/Ru(i,j)^{4/3} \quad \text{(A69)}$$

3. Selected hydraulic variables are computed at stations downstream of the last turnout at STA(i,x).

   a) Compute the water surface elevation just upstream and just downstream of each STA(i,j) downstream of STA(i,x), WSu(i,j) and WSd(i,j), respectively, in meters.

There is only seepage flow in the farm channel downstream of the last open turnout at STA(i,x). It is assumed that the hydraulic gradient due to this flow is very small and may be neglected. Thus, the water surface elevation at any STA(i,j) downstream of STA(i,x) is equal to that at STA(i,x). That is,

$$WSu(i,j) = WSd(i,j) = WSu(i,x) \tag{A70}$$

Where $x < j \leq N(i)$ and where the momentum change at the last open farm turnout is negligible.

b) Compute the bottom elevation of the farm channel at any STA(i,j) downstream of STA(i,x), E(i,j) in meters.

The bottom elevation at any STA(i,j) downstream of STA(i,x) is equal to the bottom elevation at the end of the farm channel at STA(i, N(i)) plus the total rise in the bottom elevation between STA(i,N(i)) and STA(i,j). That is

$$E(i,j) = E(i,N(i)) + \sum_{k=j}^{N(i)-1} [L(i,k+1) - L(i,k)]\, S_o(i,k) \tag{A71}$$

Where k = dummy counter

c) Compute the depth of water standing just upstream and just downstream of any STA(i,j) downstream of STA(i,x), Du(i,j) and Dd(i,j), respectively, in meters.

$$Du(i,j) = Dd(i,j) = WSu(i,j) - E(i,j) \tag{A72}$$

Where $x < j \leq N(i)$

C. Compute Hydraulic Variables in Distributary Canal with Refinement of Computations in Farm Channels

After values of hydraulic variables in each of the farm channels have been initially computed, similar computations are made for the distributary canal. Beginning with the station corresponding to the last farm channel taking water from the distributary canal (station type 3A), computations are made at each successive station moving in an upstream direction and ending with the station at the head of the canal (STA(1)). The hydraulic condition at the head of any farm channel must combine with the hydraulic condition in the canal at the outlet to the farm channel to produce an outlet flow rate that matches the flow rate in the farm channel computed in section B. Thus, iterative refinements of the computations of the flow conditions in each farm channel are required to achieve a balance with the flow conditions in the distributary canal when a fully open pipe outlet is specified.

A general description of the computational steps for each STA(i) on the distributary canal is given below. Included is a description of the iterative procedure for balancing the flow conditions in the farm channels with those in the distributary canal when a fully open pipe outlet is specified. The subscript i used in the notation refers to the number of the station on the distributary canal. The value of i reveals nothing of the type of station under consideration (except in the case of the first and last stations) but indicates the relative location of the station along the distributary canal and thus the place of that station in the computational sequence. However, since the hydraulics at any station are dependent upon its type, the type of each station determines the method of computation used.

It is assumed that the last farm channel taking water from the distributary canal is located at STA(y) where $1 < y < M$.

1) Initialize hydraulic computations at STA(y). The procedures followed are similar to those outlined in section B1 for the farm channels.

    a) Compute the total discharge in the distributary canal, between STA(y) and STA(y-1), Q(y) in m^3/s.

    $$Q(y) = Q(y+1) + q(y) + s[L(y+1) - L(y)] \qquad (A73)$$

    Now, $Q(y+1) = s[L(M) - L(y+1)]$ since there is only flow due to seepage in the distributary canal downstream of STA(y).

    Also, the flow rate from the distributary canal to the farm channel at STA(y) is equal to the computed total discharge at the head of the farm ditch. That is,

    $$q(y) = Q(y,1) \qquad (A74)$$

Thus,

$$Q(y) = s[L(M) - L(y+1)] + s[L(y+1) - L(y)] + Q(y,1) = Q(y,1) + s[L(M) - L(y)] \qquad (A75)$$

b) Compute the head loss, $H_t(y)$ in meters, to pass a flow rate, q(y), through the pipe outlet to the farm channel at STA(y). Substitute y for (i,j) in equations (A3), (A3a), and (A3b).

c) Compute the water surface elevation just upstream of STA(y), WSu(y) in meters.

$$WSu(y) = H_t(y) + WSt(y) \qquad (A76)$$

Now, the tailwater surface elevation on the pipe outlet to the farm channel at STA(y), WSt(y) in meters, is equal to the computed water surface elevation at the head of the farm channel, WSu(y,1). That is,

$$WSt(y) = WSu(y,1) \qquad (A77)$$

Combining equations (A76) and (A77) gives

$$WSu(y) = H_t(y) + WSu(y,1) \qquad (A78)$$

d) Compute the bottom elevation of the distributary canal at STA(y), E(y) in meters,

$$E(y) = E(M) + \sum_{i=y}^{M-1} [L(i+1) - L(i)]\ S_o(i) \qquad (A79)$$

e) Compute the flow depth just upstream of STA(y), Du(y) in meters; the cross-sectional area of flow just upstream of STA(y), Au(y) in m^2; the average velocity of flow just upstream of STA(y), Vu(y) in m/s; the kinetic energy of flow just upstream of STA(y), KEu(y) in meters; the energy line elevation just upstream of STA(y), ELu(y) in meters; the wetted perimeter just upstream of STA(y), Pu(y) in meters; the hydraulic radius just upstream of STA(y), Ru(y) in meters; and the friction slope just upstream of STA(y), SFu(y) from equations (A8) through (A15) respectively with the notation y substituted for (i,x).

2) After completing initial hydraulic computations at STA(y), calculations are made at successive upstream stations in the distribution canal; that is, for each STA(i) where $i = (y-1)$ to 1. The procedures followed are similar to those outlined in section B2 for the farm channels.

   a) Compute an initial trial value of water surface elevation just downstream of STA(i), WSd(i) in meters. This may be done by assuming uniform flow between STA(i) and the last computed station, STA(i+1).

   $$WSd(i) = WSu(i+1) + [L(i+1) - L(i)]\, S_o(i) \qquad \text{(A80)}$$

   b) Compute the bottom elevation at STA(i), E(i) in meters; the flow depth just downstream of STA(i), Dd(i) in meters; the cross-sectional area of flow just downstream of STA(i), Ad(i) in m^2; the average velocity of flow just downstream of STA(i), Vd(i) in m/s; the kinetic energy of flow just downstream of STA(i), KEd(i) in meters; the energy line elevation just downstream of STA(i), ELd(i) in meters; the wetted perimeter just downstream of STA(i), Pd(i) in meters; the hydraulic radius just downstream of STA(i), Rd(i) in meters; the friction slope just downstream of STA(i), SFd(i); the average friction slope for the section of the distributary canal between STA(i) and STA(i+1), $SF_a(i+1)$; and the head loss due to friction between STA(i) and STA(i+1), HL(i+1) in meters from equations (A17) through (A27) respectively with the notation i substituted for (i,j).

   c) Compute a new energy line elevation just downstream of STA(i), ELd(i)' in meters.

   $$ELd(i)' = ELu(i+1) + HL(i+1) \qquad \text{(A81)}$$

   d) Compare ELd(i) and ELd(i)' to determine if the trial value of WSd(i) is sufficiently accurate or if a new trial value needs to be selected

      i) If $|ELd(i) - ELd(i)'| \leq 0.001$, WSd(i) is sufficiently accurate. Go to section (C2e).

ii) If $|ELd(i) - ELd(i)'| > 0.001$, select a new trial value of WSd(i) and return to section (C2b)

e) Compute the flow rate just upstream of STA(i), Q(i) in m^3/s.

i) For stations of type 3,

$$Q(i) = Q(i+1) + q(i) + s[L(i+1) - L(i)] \tag{A82}$$

Now, the flow rate from the distributary canal to the farm channel at STA(i) is equal to the computed total discharge at the head of the farm channel. That is,

$$q(i) = Q(i,1) \tag{A83}$$

Thus,

$$Q(i) = Q(i+1) + Q(i,1) + s[L(i+1) - L(i)] \tag{A84}$$

ii) For stations not of type 3,

$$Q(i) = Q(i+1) + s[L(i+1) - L(i)] \tag{A85}$$

f) Compute the water surface elevation and flow depth just upstream of STA(i), WSu(i) and Du(i) respectively in meters.

i) For stations of type 3, consider the momentum change due to abruptly diminishing flow at the outlet to the farm channel to determine Du(i).

Equation (A32) with the notation i substituted for (i,j) is solved by trial and error to determine Du(i).

Determine WSu(i) as

$$WSu(i) = E(i) + Du(i) \tag{A86}$$

ii) For stations of type 4 (Type 4A, cutthroat flume; type 4B, trapezoidal flume; type 4C, check structure) the computational procedures described in section B2pii are followed with the notation i substituted for (i,j) in the variables.

iii) For stations of type 5, bend in the channel, the computational procedures described in section B2piii are followed with the notation i substituted for (i,j) in the variables.

iv) For stations of type 6

Type 6A, enlargement or contraction of the channel section: The computational procedures described in section B2piv for the farm channels are followed with the notation i substituted for (i,j) in the variables.

Type 6B, change only in hydraulic roughness or bottom slope of the channel:

The depth and water surface elevation just upstream of any STA(i) is considered to be unaffected by a mere change in roughness, or transition from one mild slope to another.

That is :

$$Du(i) = Dd(i) \tag{A87}$$

and

$$WSu(i) = WSd(i) \tag{A88}$$

v) For stations of type 7, "dummy" computational the station. The flow conditions just upstream of a "dummy" station are the same as those just downstream. Thus, equations (A87) and (A88) are used to compute Du(i) and WSu(i) respectively.

vi) For station of type 1, head of distribution canal

The flow conditions just upstream of STA(1) at the head of the distributary canal are the same as those just downstream. Thus Du(1) and WSu(1) are computed from equations (A87) and (A88) for i=1.

g) For stations of type 3, determine the head on the outlet to the farm channel, $H_t(i)$ in meters.

$$H_t(i) = WSu(i) - WS_t(i) \qquad (A89)$$
$$= WSu(i) - WSu(i,1) \qquad (A89a)$$

h) For stations of type 3, compute the height of the gate setting, $d_g(i)$ in meters, to pass the flow rate $q(i)$, with the computed value of head, $H_t(i)$, for a specified size of pipe inlet, d_p (i), that is partially closed; or recompute the flow rate to the farm channel, $q(i)$ in m^3/s, the head on the inlet, $H_t(i)$ in meters, and all hydraulic variables in the farm channel for a specified size of pipe outlet, $d_p(i)$, that is fully open; or compute the size of pipe outlet, $d_p(i)$ in meters, and gate setting, $d_g(i)$ in meters, to pass $q(i)$ with the computed value of $H_t(i)$.

i) For the case where the size of the pipe outlet, $d_p(i)$, is specified, compute from equations (A3), (A3a) and (A3b) the head on the pipe outlet, $H_t(i)$ in meters, required to pass the outlet flow rate, $q(i)$, for the case where the pipe is <u>fully open</u>. Call this computed value $H_t(i)'$.

If the value of $H_t(i)'$is <u>less</u> than the value of $H_t(i)$ computed from equation (A89), then determine the height to set the gate above the pipe invert, $d_g(i)$ in meters, to pass $q(i)$ with the available head, $H_t(i)$. The value of $d_g(i)$ is computed from equations (A3), (A3a), and (A3b) where the value of $H_t(i)$ is that computed from equation (A89).

If the value of $H_t(i)'$ is <u>greater</u> than the value of $H_t(i)$ computed from equation (A89), then the computed head on the pipe outlet, $H_t(i)$, is not adequate to pass $q(i)$ for the specified pipe size. Thus, the flow rate into the farm channel will be less than originally computed. The actual flow rate is dependent in part on the value of $H_t(i)$. However, the value of $H_t(i)$ is dependent upon the value of WSu(i) and the value of WSu(i,1) which is in turn dependent on the value of q(i).

Thus, a trial and error solution is required to balance the flow condition in the farm channel with that in the distributary canal. This involves recomputing the hydraulic variables in the farm channel until such a balance is achieved. The procedure followed is outlined below and

α) From equations (A3) and (A3a) compute a new value of flow rate to the farm ditch, q(i) in m^3/s, for the head, $H_t(i)$, computed from equation (A89) and the specified size of fully open outlet pipe, $d_p(i)$. Call this computed value q(i)'.

β) Compare the new value of flow rate, q(i)', with the old value, q(i), computed from equation (A83).

$$G_3 = | q(i) - q(i)' | \qquad \text{(A90)}$$

If the difference is sufficiently small (eg. $G_3 \leq 0.05\ q(i)$), go to section (C2i).

If the difference is not sufficiently small, go to section (C2hiγ) below.

γ) Compute a new set of "design" turnout flow rates, $q_d(i,j)$, for the farm channel. These new values are designated as $q_d(i,j)'$.

δ) Go to section (B) with the new values of design flow rate, $q_d(i,j)'$, and recompute the values of all of the hydraulic variables for the farm channel at STA(i).

ϵ) Go to section (C2e) with the new value of q(i) computed from equation (A83) and continue computations through section (C2hi)

The above procedure is repeated until G_3 becomes sufficiently small.

ii) For the case where the size of the pipe outlet, $d_p(i)$ in meters, and the height of the gate setting, $d_g(i)$ in meters, are to be determined:

Select an initial pipe outlet diameter size, $d_p(i)$ in meters, from the range of available sizes.

Compute the value of q(i) from equations (A3) and (A3a) using the selected value of $d_p(i)$. Call this computed value q(i)'.

Compute the absolute difference between q(i), computed from equation (A83), and q(i)' using equation (A90) for G_3.

Select subsequent values of $d_p(i)$ and compute corresponding values of q(i)' and G_3.

The value of $d_p(i)$ selected is the one that minimizes the value of G_3.

If the value of q(i)' computed from equations (A3) and (A3a) for the selected value of $d_p(i)$ is <u>less</u> than q(i) computed from equation (A83), increase the selected value of $d_p(i)$ by one size increment (eg. by 0.05 m).

Use the final selected value of $d_p(i)$ and the value of q(i) computed from equation (A83) to compute the height of the bottom of the gate from the pipe invert, $d_g(i)$ in meters, from equations (A3), (A3a), and (A3b).

i) Compute the cross-sectional area of flow just upstream of STA(i), Au(i) in m^2; the average velocity of flow just upstream of STA(i), Vu(i) in m/s; the kinetic energy of flow just upstream of STA(i,j), KEu(i) in meters; the energy line elevation just upstream of STA(i), ELu(i) in meters; the wetted perimeter just upstream of STA(i,j), Pu(i) in meters; the hydraulic radius just upstream of STA(i), Ru(i) in meters; and the friction slope just upstream of STA(i), SFu(i) from equations (A63) through (A69) respectively with the notation i substituted for (i,j).

3. Selected hydraulic variables are computed at stations downstream of the last turnout at STA(y).

   a) Compute the water surface elevation just upstream and just downstream of each STA(i) downstream of STA(y), WSu(i) and WSd(i) respectively in meters.

There is only seepage flow in the distributary canal downstream of the last open outlet at STA(y). It is assumed that the hydraulic gradient due to this flow is very small and may be neglected. Thus, the water surface elevation at any STA(i) downstream of STA(y) is equal to that at STA(i). That is,

$$WSu(i) = WSd(i) = WSu(y) \tag{A91}$$

Where $x < j < M$ and where the momentum change at the last open outlet is negligible.

b) Compute the bottom elevation of the distributary canal at any STA(i) downstream of STA(y), E(i) in meters.

The bottom elevation at any STA(i) downstream of STA(y) is equal to the bottom elevation at the end of the distributary canal at STA (M) plus the total rise in the bottom elevation between STA(i) and STA(M). That is

$$E(i) = E(M) + \sum_{k=i}^{M-1} [L(k+1) - L(k)]\, S_o(k) \tag{A92}$$

Where k = dummy counter

c) Compute the depth of water standing just upstream and just downstream of any STA(i) downstream of STA(y), Du(i) and Dd(i) respectively in meters.

$$Du(i) = Dd(i) = WSu(i) - E(i) \tag{A93}$$

Where $x < i \leq M$

D. Compute the water surface elevation required in the parent canal at the inlet to the distributary canal and the required headgate setting to pass Q(i) to the distributary canal. The appropriate calibrated equations relating Q(i) to the head loss through the gate for conditions of free and submerged flow should be used.

APPENDIX B: COMPUTATION OF FLOW THROUGH A BANKCUT

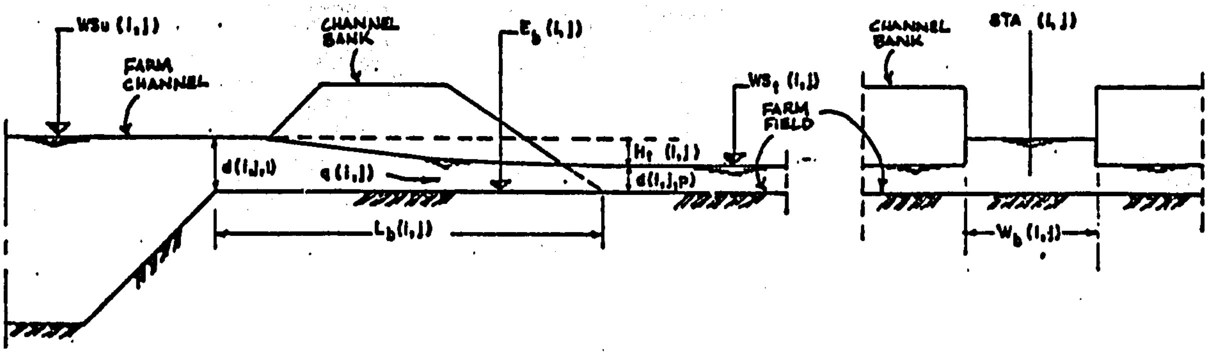

Figure B1. Flow through a bankcut turnout.

Often a farmer will make a cut through the bank of the farm channel to allow the water to flow directly to his field. An analysis of gradually varied flow through the small channel formed by a cut at STA(i,j) allows: (A) determination of the flow rate, q(i,j), for a specified width of cut or (B) determination of the width of cut, $W_b(i,j)$, required to pass a specified flow rate or (C) determination of the head loss through the turnout, $H_t(i,j)$ for a specified width of cut and flow rate. Reference is made to Figure B1 in the analysis presented.

For purpose of computation the bankcut channel at STA(i,j) is divided into P equally spaced stations. Each station along the bankcut channel, is designated as STA(i,j,k) where $1 \leq k \leq P$. The distance between each STA(i,j,k) is $L_b(i,j)/(P-1)$. The greater the total number of stations, P, selected, the greater will be the precision of the computations and the more computational time will be required.

Beginning with the station at the end of the bankcut where the flow enters the farm field, STA(i,j,P), computations are made at each successive station moving in an upstream direction and ending at STA(i,j,1) at the entrance to the bankcut. Trial and error procedures are used to achieve balanced solutions of the energy equations for the specified boundary conditions.

The bankcut cross-section is assumed to be rectangular. Its bottom is assumed to have zero grade.

A. Compute the flow rate, $q(i,j)$ in m^3/s, through the bankcut at $STA(i,j)$ for a specified width of cut, $W_b(i,j)$ in meters.

1. Select a trial value of flow rate, $q(i,j)$ in m^3/s.

2. Compute the hydraulic variables for each $STA(i,j,k)$ along the bankcut were $k = P$ to 1.

   a) Compute the depth of flow at $STA(i,j,k)$, $d(i,j,k)$ in meters

   For $k = P$,

   $$d(i,j,P) = WS_t(i,j) - E_b(i,j) \tag{B1}$$

   For $1 \leq k < P$, compute an initial trial value of flow depth as

   $$d(i,j,k) = d(i,j,k+1) + SF(i,j,k+1)[L_b(i,j)/(P-1)] \tag{B2}$$

   b) Compute the cross-sectional area of flow at $STA(i,j,k)$, $A(i,j,k)$ in m^2.

   $$A(i,j.k) = d(i,j,k)\ W_b(i,j) \tag{B3}$$

   c) Compute the average velocity of flow at $STA(i,j,k)$, $V(i,j,k)$ in m/s.

   $$V(i,j,k) = q(i,j)/A(i,j,k) \tag{B4}$$

   d) Compute the kinetic energy of flow at $STA(i,j,k)$, $KE(i,j,k)$ in meters.

   $$KE(i,j,k) = V(i,j,k)^2/2g \tag{B5}$$

   e) Compute the energy line elevation at $STA(i,j,k)$, $EL(i,j,k)$ in meters.

   For $k = P$,

   $$EL(i,j,P) = WS_t(i,j) + KE(i,j,k) \tag{B6}$$

For $1 \leq k < P$,

$$EL(i,j,k) = d(i,j,k) + E_b(i,j) + KE(i,j,k) \qquad (B7)$$

f) Compute the wetted perimeter at STA(i,j,k), P(i,j,k) in meters.

$$P(i,j,k) = 2d(i,j,k) + W_b(i,j) \qquad (B8)$$

g) Compute the hydraulic radius at STA(i,j,k), R(i,j,k) in meters.

$$R(i,j,k) = A(i,j,k)/P(i,j,k) \qquad (B9)$$

h) Compute the friction slope at STA(i,j,k), SF(i,j,k).

From Manning's equation,

$$SF(i,j,k) = V(i,j,k)^2 \, n_b(i,j)^2/R(i,j,k)^{4/3} \qquad (B10)$$

Note: Sections (A2i) through (A21) are only for $k < P$.

i) Compute the average friction slope between STA(i,j,k) and STA(i,j,k+1), $SF_a(i,j,k+1)$.

$$SF_a(i,j,k+1) = [SF(i,j,k) + SF(i,j,k+1)]/2 \qquad (B11)$$

j) Compute the head loss due to friction between STA(i,j,k) and STA(i,j,k+1), HL(i,j,k+1) in meters.

$$HL(i,j,k+1) = SF_a(i,j,k+1) \, [L_b(i,j)/(P-1)] \qquad (B12)$$

k) Compute a new energy line elevation at STA(i,j,k), EL(i,j,k)' in meters.

$$EL(i,j,k)' = EL(i,j,k+1) + HL(i,j,k+1) \qquad (B13)$$

l) Compare EL(i,j,k) and EL(i,j,k)' to determine if trial value of d(i,j,k) is sufficiently accurate or if new trial value needs to be selected.

   i) If $| EL(i,j,k) - EL(i,j,k)' | \leq 0.001$, d(i,j,k) is sufficiently accurate. If k=1, go to section (A3). If $k > 1$, return to section (A2a) and begin calculations for next upstream station, STA(i,j,k-1).

ii) If $|EL(i,j,k) - EL(i,j,k)'| > 0.001$, select a new trial value of $d(i,j,k)$ and return to section (A2b)

3. Compute the water surface elevation at the entrance to the bankcut at $STA(i,j)$, $WS(i,j,1)$ in meters.

$$WS(i,j,1) = d(i,j,1) + E_b(i,j) \tag{B16}$$

4. Compare $WS(i,j,1)$ and $WSu(i,j)$ to determine if the trial value of $q(i,j)$ is sufficiently accurate or if a new trial value needs to be selected.

   A solution is achieved when the computed value of the water surface elevation at the entrance to the bankcut, $WS(i,j,1)$, is sufficiently close to be considered equal to the value of the water surface elevation in the farm channel just upstream of the bankcut turnout, $WSu(i,j)$.

   i) If $|WSu(i,j) - WS(i,j,1)| \leq 0.001$, the value $q(i,j)$ is sufficiently accurate and a solution is achieved.

   ii) If $|WSu(i,j) - WS(i,j,1)| > 0.001$, select a new trial value of $q(i,j)$ and return to section (A2) to begin a new trial of gradually varied flow calculations.

B. Compute the width of cut at $STA(i,j)$, $W_b(i,j)$ in meters, required to pass a specified flow rate, $q(i,j)$, with the computed head loss, $H_t(i,j)$.

1. Select a trial value of cut width, $W_b(i,j)$ in meters.

2. Compute the hydraulic variables for each $STA(i,j,k)$ along the bankcut where $k = P$ to 1 using the same procedures outlined above in section (A2).

3. Compute from equation (B16) the water surface elevation at the entrance to the bankcut at $STA(i,j)$, $WS(i,j,1)$ in meters.

4. Compare $WS(i,j,1)$ and $WSu(i,j)$ to determine if the trial value of $W_b(i,j)$ is sufficiently accurate or if a new trial value needs to be selected.

i) If $|WSu(i,j) - WS(i,j,1)| \leq 0.001$, the value of $W_b(i,j)$ is sufficiently accurate and a solution is achieved.

ii) If $|WSu(i,j) - WS(i,j,1)| > 0.001$, select a new trial value of $W_b(i,j)$ and return to section (B2) to begin a new trial value of gradually varied flow calculations.

C. Compute the head loss through the bankcut turnout at STA(i,j), $H_t(i,j)$ in meters, for a specified cut width, $W_b(i,j)$, and flow rate, q(i,j).

1. Compute the hydraulic variables for each STA(i,j,k) along the bankcut where k = P to 1 using the same procedures outlined above in section (A2).

2. Compute the head loss through the bankcut turnout, $H_t(i,j)$ in meters.

$$\begin{aligned} H_t(i,j) &= WSu(i,j) - WSt(i,j) \\ &= WS(i,j,1) - WSt(i,j) \end{aligned} \qquad \text{(B17)}$$

APPENDIX C: APPLICATION OF THE MOMENTUM PRINCIPLE TO DETERMINE THE CHANGE IN FLOW DEPTH AT A TURNOUT

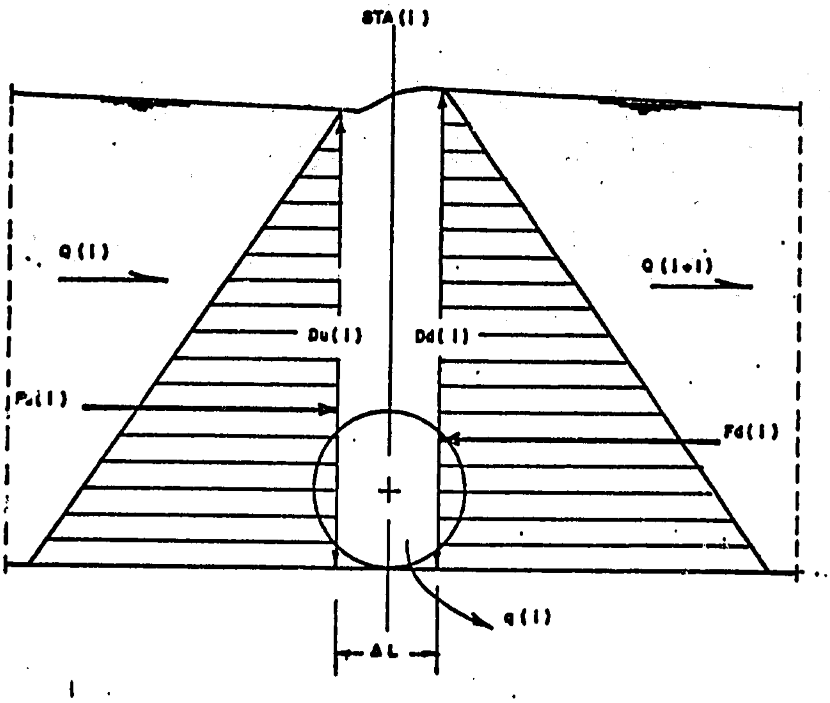

Figure C1. Application of the momentum principle at a STA(i) with an open turnout.

Consider the short channel section with length ΔL at a STA(i) with an open turnout (Figure C1). The upstream height of the section is defined by the depth of flow just upstream of STA(i), Du(i). The downstream height is defined by the depth of flow just downstream of STA(i), Dd(i). The momentum principle may be applied to the section to develop an equation that will allow the value of Du(i) to be determined from known values of hydraulic section parameters; the downstream flow depth, Dd(i); and the flow rates just upstream and just downstream of STA(i), Q(i) and Q(i+1) respectively. The following assumptions are made in the development of this equation:

1. The pressure distribution on both sides of the turnout at STA(i) is hydrostatic.

2. The forces on the section of length ΔL due to shear on the sides and bottom of the channel are negligible.

3. The bottom slope of the channel is very small and ΔL is small;

thus, the force on the section due to the weight component in the direction of flow is negligible.

4. The velocity and momentum coefficients are unity.

5. The density of the water is constant.

According to Newtons second law of motion, the rate of change of momentum in a body of water flowing in a channel is equal to the resultant of all the external forces acting on the body. Applying this principle to the short section of channel with length ΔL at a STA(i) with an open turnout gives

$$Fd(i) - Fu(i) = \rho Q(i)Vu(i) - \rho Q(i+1)Vd(i) \qquad (C1)$$

Where Fd(i) = the resultant force in the line of flow due to the water pressure on the section just downstream of STA(i)

Fu(i) = the resultant force in the line of flow due to the water pressure on the section just upstream of STA(i)

ρ = the density of water

A resultant force, F, acting in the line of flow due to the water pressure on a section in the channel is the product of the cross-sectional area of flow, A, and the pressure on the center of gravity of the section. That is,

$$F = A\rho gD_{cg} \qquad (C2)$$

Where D_{cg} = the depth from the water surface to the center of gravity of the section.

A sketch of a cross-section in a trapezoidal channel is shown in Figure C2. The depth to the center of gravity of the section, D_{cg}, may be determined as a function of the depth of flow, D; the side slope, Z; and the bottom width, W. The cross-section is divided into three parts for purpose of analysis: part A, part B, and part C. Parts A and C are of equal area. Moments are taken for each part about the line 0-0 coincident with the water surface as given in Table C1.

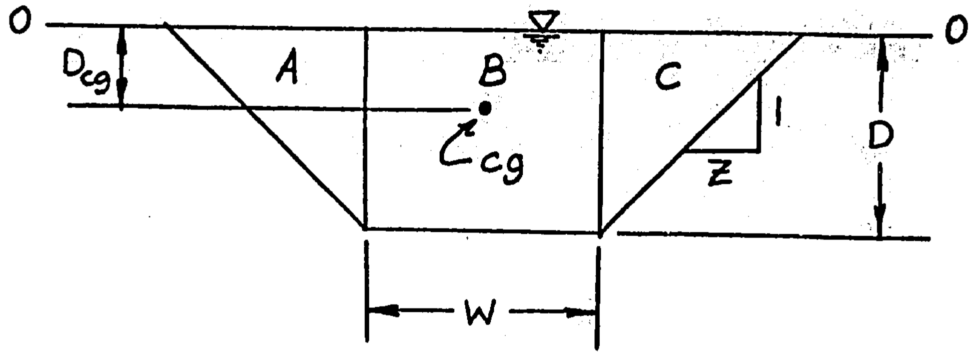

Figure C2. Flow cross section in a trapezoidal channel with center of gravity, cg, and depth from water surface to center of gravity, D_{cg}.

Table C1. Determination of D_{cg} by Area-Moment Method

Part	Area	Moment Arm	Area Moment
A	$D^2Z/2$	$D/3$	$D^3Z/6$
B	WD	$D/2$	$WD^2/2$
C	$D^2Z/2$	$D/3$	$D^3Z/6$
	$WD+D^2Z$	D_{cg}	$(WD^2/2)+(D^3Z/3)$

The relation for D_{cg} is thereby determined as

$$D_{cg} = [(WD^2/2 + (D^3Z/3)]/(WD+D^2Z)$$
$$= (3WD + 2D^2Z)/6(W+DZ) \qquad (C3)$$

Applying equations (C2) and (C3) to the cross-sections just upstream and just downstream of STA(i) gives

$$Fu(i) = Au(i)\rho g[(3W(i-1)Du(i) + 2Du(i)^2Z(i-1))/6(W(i-1) + Du(i)Z(i-1))] \qquad (C4)$$

and

$$Fd(i) = Ad(i)\rho g[(3W(i)Dd(i)+2Dd(i)^2Z(i))/6(W(i)+Dd(i)Z(i))] \qquad (C5)$$

Relations for Au(i) and Ad(i) as a function of flow depth are given in equations (A63) and (A19). Substituting the relation given in equation (A63) for Au(i) into equation (C4) gives

$$\mathrm{Fu}(i) = [W(i)\mathrm{Du}(i-1) + \mathrm{Du}(i)^2 Z(i-1)] \times \left[\frac{3W(i-1)\mathrm{Du}(i) + 2\mathrm{Du}(i)^2 Z(i-1)}{6(W(i-1) + \mathrm{Du}(i)Z(i-1))}\right]\rho g \qquad \text{(C6)}$$

Relations for Vu(i) and Vd(i) as a function of the flow rate in the channel are given in equations (A64) and (A20) with the notation i substituted for (i,j) and repeated here

$$\mathrm{Vu}(i) = Q(i)/\mathrm{Au}(i) \qquad \text{(A64)}$$

$$= Q(i)/[W(i-1)\mathrm{Du}(i) + \mathrm{Du}(i)^2 Z(i-1)] \qquad \text{(C7)}$$

and

$$\mathrm{Vd}(i) = Q(i+1)/\mathrm{Ad}(i) \qquad \text{(A20)}$$

Substituting the relations given in equations (C5), (C6), (C7), and (A20) for Fd(i), Fu(i), Vu(i), and Vd(i) respectively in equation (C1) gives

$$\mathrm{Ad}(i)\left[\frac{3W(i)\,\mathrm{Dd}(i) + 2\mathrm{Dd}(i)^2 Z(i)}{6(W(i) + \mathrm{Dd}(i)Z(i))}\right] g \; -$$

$$[W(i-1)\mathrm{Du}(i) + \mathrm{Du}(i)^2 Z(i-1)]\left[\frac{3W(i-1)\mathrm{Du}(i) + 2\mathrm{Du}(i)^2 Z(i-1)}{6(W(i-1) + \mathrm{Du}(i)Z(i-1))}\right] g$$

$$= \left[\frac{Q(i)^2}{W(i)\mathrm{Du}(i-1) + \mathrm{Du}(i)^2 Z(i-1)}\right] - \left[\frac{Q(i+1)^2}{\mathrm{Ad}(i)}\right] \qquad \text{(C8)}$$

For a STA(i,j) in a farm channel, equation (C8) takes the form presented in equation (A32) in Appendix A.

APPENDIX D: GROSS DAILY FLOW RATES AND FLOW ROTATION SCHEDULES

Table D1. GROSS DAILY FLOW RATES FOR THE MONTH OF JANUARY FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL FOR AREA DISTRIBUTION ALTERNATIVES 1 AND 2.

Mesqa No.	Turnout No.	Gross Daily Flow Rate (m^3/s)	
		Alternative 1	Alternative 2
1		0.0080	0.0080
2		0.0024	0.0024
3		0.0040	0.0040
4		0.0719	0.0719
5		0.0400	0.0400
6		0.0048	0.0048
7		0.0725	0.0725
8		0.0120	0.0120
--		--	--
10		0.0064	0.0064
11		0.0663	0.0871
12		0.0096	0.0096
13		0.0463	--
14		0.0501	0.1039
	1	0.0020	0.0020
15		0.0512	--
16		0.0545	0.1104
	2	0.0018	0.0018
	3	0.0028	0.0028
	4	0.0040	0.0040
	5	0.0022	0.0022
	6	0.0020	0.0020
17		0.0056	0.0056
--		--	--
	7	0.0018	0.0018
19		0.0080	0.0110
	8	0.0016	0.0016
	9	0.0020	0.0020
20		0.0675	--
21		0.0520	0.0836
22		0.0943	0.0943
23		0.0519	0.0519
--		--	--
25		0.0395	0.0395
26		0.0317	0.0317
27		0.0242	0.0356
28		0.0225	--
29		0.0229	0.0439
30		0.0292	--
31		--	0.0193
Total		0.970	0.970

Table D2. GROSS DAILY FLOW RATES FOR THE MONTH OF FEBRUARY FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL FOR AREA DISTRIBUTION ALTERNATIVES 1 AND 2.

Mesqa No.	Turnout No.	Gross Daily Flow Rate (m^3/s) Alternative 1	Alternative 2
1		0.0046	0.0046
2		0.0014	0.0014
3		0.0023	0.0023
4		0.0415	0.0415
5		0.0231	0.0231
6		0.0028	0.0028
7		0.0419	0.0419
8		0.0069	0.0069
--		--	--
10		0.0037	0.0037
11		0.0383	0.0503
12		0.0055	0.0055
13		0.0268	--
14		0.0289	0.0600
	1	0.0012	0.0012
15		0.0296	--
16		0.0315	0.0638
	2	0.0011	0.0011
	3	0.0016	0.0016
	4	0.0023	0.0023
	5	0.0013	0.0013
	6	0.0012	0.0012
17		0.0032	0.0032
--		--	--
	7	0.0011	0.0011
19		0.0046	0.0064
	8	0.0009	0.0009
	9	0.0009	0.0009
20		0.0390	--
21		0.0301	0.0483
22		0.0545	0.0545
23		0.0300	0.0300
--		--	--
25		0.0228	0.0228
26		0.0183	0.0183
27		0.0140	0.0206
28		0.0130	--
29		0.0132	0.0253
30		0.0169	--
31		--	0.0111
Total		0.560	0.560

Table D3. GROSS DAILY FLOW RATES FOR THE MONTH OF MARCH FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL FOR AREA DISTRIBUTION ALTERNATIVES 1 AND 2.

Mesqa No.	Turnout No.	Gross Daily Flow Rate (m^3/s)	
		Alternative 1	Alternative 2
1		0.0060	0.0060
2		0.0018	0.0018
3		0.0030	0.0030
4		0.0539	0.0539
5		0.0299	0.0299
6		0.0036	0.0036
7		0.0543	0.0543
8		0.0090	0.0090
--		--	--
10		0.0048	0.0048
11		0.0497	0.0652
12		0.0072	0.0072
13		0.0347	--
14		0.0375	0.0778
	1	0.0015	0.0015
15		0.0384	--
16		0.0408	0.0827
	2	0.0014	0.0014
	3	0.0021	0.0021
	4	0.0030	0.0030
	5	0.0017	0.0017
	6	0.0015	0.0015
17		0.0042	0.0042
--		--	--
	7	0.0014	0.0014
19		0.0060	0.0083
	8	0.0012	0.0012
	9	0.0015	0.0015
20		0.0506	--
21		0.0390	0.0626
22		0.0706	0.0706
23		0.0389	0.0389
--		--	--
25		0.0296	0.0296
26		0.0238	0.0238
27		0.0181	0.0267
28		0.0169	--
29		0.0171	0.0329
30		0.0218	--
31		--	0.0144
Total		0.726	0.726

Table D4. GROSS DAILY FLOW RATES FOR THE MONTH OF APRIL FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL FOR AREA DISTRIBUTION ALTERNATIVES 1 AND 2.

Mesqa No.	Turnout No.	Gross Daily Flow Rate (m^3/s)	
		Alternative 1	Alternative 2
1		0.0063	0.0063
2		0.0019	0.0019
3		0.0032	0.0032
4		0.0570	0.0570
5		0.0317	0.0317
6		0.0038	0.0038
7		0.0575	0.0575
8		0.0095	0.0095
--		--	--
10		0.0051	0.0051
11		0.0526	0.0691
12		0.0076	0.0076
13		0.0368	--
14		0.0397	0.0824
	1	0.0016	0.0016
15		0.0406	--
16		0.0432	0.0876
	2	0.0015	0.0015
	3	0.0022	0.0022
	4	0.0032	0.0032
	5	0.0018	0.0018
	6	0.0016	0.0016
17		0.0044	0.0044
--		--	--
	7	0.0015	0.0015
19		0.0063	0.0087
	8	0.0013	0.0013
	9	0.0016	0.0016
20		0.0536	--
21		0.0413	0.0663
22		0.0748	0.0748
23		0.0412	0.0412
--		--	--
25		0.0313	0.0313
26		0.0252	0.0252
27		0.0192	0.0283
28		0.0179	--
29		0.0181	0.0348
30		0.0231	--
31		--	0.0153
Total		0.769	0.769

Table D5. GROSS DAILY FLOW RATES FOR THE MONTH OF MAY FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL FOR AREA DISTRIBUTION ALTERNATIVES 1 AND 2.

Mesqa No.	Turnout No.	Gross Daily Flow Rate (m^3/s) Alternative 1	Gross Daily Flow Rate (m^3/s) Alternative 2
1		0.0056	0.0056
2		0.0017	0.0017
3		0.0028	0.0028
4		0.0505	0.0505
5		0.0281	0.0281
6		0.0034	0.0034
7		0.0509	0.0509
8		0.0084	0.0084
--		--	--
10		0.0045	0.0045
11		0.0466	0.0612
12		0.0067	0.0067
13		0.0325	--
14		0.0352	0.0730
	1	0.0014	0.0014
15		0.0360	--
16		0.0383	0.0776
	2	0.0013	0.0013
	3	0.0020	0.0020
	4	0.0028	0.0028
	5	0.0016	0.0016
	6	0.0014	0.0014
17		0.0039	0.0039
--		--	--
	7	0.0013	0.0013
19		0.0056	0.0077
	8	0.0011	0.0011
	9	0.0014	0.0014
20		0.0474	--
21		0.0365	0.0587
22		0.0662	0.0662
23		0.0365	0.0365
--		--	--
25		0.0277	0.0277
26		0.0223	0.0223
27		0.0170	0.0250
28		0.0158	--
29		0.0160	0.0308
30		0.0205	--
31		--	0.0135
Total		0.681	0.681

Table D6. GROSS DAILY FLOW RATES FOR THE MONTH OF JUNE FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL FOR AREA DISTRIBUTION ALTERNATIVES 1 AND 2.

Mesqa No.	Turnout No.	Gross Daily Flow Rate (m^3/s)	
		Alternative 1	Alternative 2
1		0.0089	0.0089
2		0.0027	0.0027
3		0.0044	0.0044
4		0.0800	0.0800
5		0.0444	0.0444
6		0.0053	0.0053
7		0.0806	0.0806
8		0.0133	0.0133
--		--	--
10		0.0071	0.0071
11		0.0737	0.0968
12		0.0107	0.0107
13		0.0515	--
14		0.0557	0.1155
	1	0.0022	0.0022
15		0.0569	--
16		0.0606	0.1228
	2	0.0020	0.0020
	3	0.0031	0.0031
	4	0.0044	0.0044
	5	0.0025	0.0025
	6	0.0022	0.0022
17		0.0062	0.0062
--			--
	7	0.0020	0.0020
19		0.0089	0.0123
	8	0.0018	0.0018
	9	0.0022	0.0022
20		0.0751	--
21		0.0578	0.0929
22		0.1048	0.1048
23		0.0577	0.0577
--			--
25		0.0439	0.0439
26		0.0353	0.0353
27		0.0269	0.0396
28		0.0251	--
29		0.0254	0.0488
30		0.0324	--
31		--	0.0214
Total		1.078	1.078

Table D7. GROSS DAILY FLOW RATES FOR THE MONTH OF JULY FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL FOR AREA DISTRIBUTION ALTERNATIVES 1 AND 2.

Mesqa No.	Turnout No.	Gross Daily Flow Rate (m^3/s)	
		Alternative 1	Alternative 2
1		0.0114	0.0114
2		0.0034	0.0034
3		0.0057	0.0057
4		0.1030	0.1030
5		0.0572	0.0572
6		0.0069	0.0069
7		0.1038	0.1038
8		0.0172	0.0172
--		--	--
10		0.0092	0.0092
11		0.0950	0.1247
12		0.0137	0.0137
13		0.0664	--
14		0.0717	0.1487
	1	0.0029	0.0029
15		0.0733	--
16		0.0780	0.1581
	2	0.0026	0.0026
	3	0.0040	0.0040
	4	0.0057	0.0057
	5	0.0032	0.0032
	6	0.0029	0.0029
17		0.0080	0.0080
--		--	--
	7	0.0026	0.0026
19		0.0114	0.0158
	8	0.0023	0.0023
	9	0.0029	0.0029
20		0.0967	--
21		0.0745	0.1197
22		0.1350	0.1350
23		0.0744	0.0744
--		--	--
25		0.0565	0.0565
26		0.0454	0.0454
27		0.0347	0.0510
28		0.0323	--
29		0.0327	0.0628
30		0.0418	--
31		--	0.0276
Total		1.388	1.388

Table D8. GROSS DAILY FLOW RATES FOR THE MONTH OF AUGUST FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL FOR AREA DISTRIBUTION ALTERNATIVES 1 AND 2.

Mesqa No.	Turnout No.	Gross Daily Flow Rate (m^3/s) Alternative 1	Alternative 2
1		0.0084	0.0084
2		0.0025	0.0025
3		0.0042	0.0042
4		0.0756	0.0756
5		0.0420	0.0420
6		0.0050	0.0050
7		0.0762	0.0762
8		0.0126	0.0126
--		--	--
10		0.0067	0.0067
11		0.0697	0.0916
12		0.0101	0.0101
13		0.0487	--
14		0.0527	0.1092
	1	0.0021	0.0021
15		0.0538	--
16		0.0573	0.1161
	2	0.0019	0.0019
	3	0.0029	0.0029
	4	0.0042	0.0042
	5	0.0024	0.0024
	6	0.0021	0.0021
17		0.0059	0.0059
--		--	--
	7	0.0019	0.0019
19		0.0084	0.0116
	8	0.0017	0.0017
	9	0.0021	0.0021
20		0.0710	--
21		0.0547	0.0879
22		0.0991	0.0991
23		0.0546	0.0546
--		--	--
25		0.0415	0.0415
26		0.0334	0.0334
27		0.0255	0.0375
28		0.0237	--
29		0.0240	0.0461
30		0.0307	--
31		--	0.0202
Total		1.019	1.019

Table D9. GROSS DAILY FLOW RATES FOR THE MONTH OF SEPTEMBER FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL FOR AREA DISTRIBUTION ALTERNATIVES 1 AND 2.

Mesqa No.	Turnout No.	Gross Daily Flow Rate (m^3/s) Alternative 1	Gross Daily Flow Rate (m^3/s) Alternative 2
1		0.0057	0.0057
2		0.0017	0.0017
3		0.0029	0.0029
4		0.0514	0.0514
5		0.0285	0.0285
6		0.0034	0.0034
7		0.0518	0.0518
8		0.0086	0.0086
--		--	--
10		0.0046	0.0046
11		0.0474	0.0622
12		0.0068	0.0068
13		0.0331	--
14		0.0358	0.0742
	1	0.0014	0.0014
15		0.0366	--
16		0.0389	0.0789
	2	0.0013	0.0013
	3	0.0020	0.0020
	4	0.0029	0.0029
	5	0.0016	0.0016
	6	0.0014	0.0014
17		0.0040	0.0040
--		--	--
	7	0.0013	0.0013
19		0.0057	0.0079
	8	0.0011	0.0011
	9	0.0014	0.0014
20		0.0482	--
21		0.0372	0.0597
22		0.0674	0.0674
23		0.0371	0.0371
--		--	--
25		0.0282	0.0282
26		0.0227	0.0227
27		0.0173	0.0255
28		0.0161	--
29		0.0163	0.0313
30		0.0208	--
31		--	0.0138
Total		0.693	0.693

Table D10. GROSS DAILY FLOW RATES FOR THE MONTH OF OCTOBER FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL FOR AREA DISTRIBUTION ALTERNATIVES 1 AND 2.

Mesqa No.	Turnout No.	Gross Daily Flow Rate (m^3/s)	
		Alternative 1	Alternative 2
1		0.0017	0.0017
2		0.0005	0.0005
3		0.0009	0.0009
4		0.0157	0.0157
5		0.0087	0.0087
6		0.0010	0.0010
7		0.0158	0.0158
8		0.0026	0.0026
--		--	--
10		0.0014	0.0014
11		0.0144	0.0190
12		0.0021	0.0021
13		0.0101	--
14		0.0109	0.0226
	1	0.0004	0.0004
15		0.0112	--
16		0.0119	0.0240
	2	0.0004	0.0004
	3	0.0006	0.0006
	4	0.0009	0.0009
	5	0.0005	0.0005
	6	0.0004	0.0004
17		0.0012	0.0012
--		--	--
	7	0.0004	0.0004
19		0.0017	0.0024
	8	0.0003	0.0003
	9	0.0004	0.0004
20		0.0147	--
21		0.0113	0.0182
22		0.0205	0.0205
23		0.0113	0.0113
--		--	--
25		0.0086	0.0086
26		0.0069	0.0069
27		0.0053	0.0078
28		0.0049	--
29		0.0050	0.0096
30		0.0063	--
31		--	0.0042
Total		0.211	0.211

Table D11. GROSS DAILY FLOW RATES FOR THE MONTH OF NOVEMBER FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL FOR AREA DISTRIBUTION ALTERNATIVES 1 AND 2.

Mesqa No.	Turnout No.	Gross Daily Flow Rate (m^3/s)	
		Alternative 1	Alternative 2
1		0.0030	0.0030
2		0.0009	0.0009
3		0.0015	0.0015
4		0.0268	0.0268
5		0.0149	0.0149
6		0.0018	0.0018
7		0.0270	0.0270
8		0.0045	0.0045
--		--	--
10		0.0024	0.0024
11		0.0247	0.0324
12		0.0036	0.0036
13		0.0172	--
14		0.0186	0.0386
	1	0.0007	0.0007
15		0.0191	--
16		0.0203	0.0411
	2	0.0007	0.0007
	3	0.0010	0.0010
	4	0.0015	0.0015
	5	0.0008	0.0008
	6	0.0007	0.0007
17		0.0021	0.0021
--		--	--
	7	0.0007	0.0007
19		0.0030	0.0041
	8	0.0006	0.0006
	9	0.0007	0.0007
20		0.0251	--
21		0.0194	0.0311
22		0.0351	0.0351
23		0.0193	0.0193
--		--	--
25		0.0147	0.0147
26		0.0118	0.0118
27		0.0090	0.0133
28		0.0084	--
29		0.0085	0.0163
30		0.0109	--
31		--	0.0072
Total		0.361	0.361

Table D12. GROSS DAILY FLOW RATES FOR THE MONTH OF DECEMBER FOR *MESQAS* AND TURNOUTS ON ABYUHA CANAL FOR AREA DISTRIBUTION ALTERNATIVES 1 AND 2.

Mesqa No.	Turnout No.	Gross Daily Flow Rate (m^3/s)	
		Alternative 1	Alternative 2
1		0.0033	0.0033
2		0.0010	0.0010
3		0.0017	0.0017
4		0.0301	0.0301
5		0.0167	0.0167
6		0.0020	0.0020
7		0.0303	0.0303
8		0.0050	0.0050
--		--	--
10		0.0027	0.0027
11		0.0278	0.0364
12		0.0040	0.0040
13		0.0194	--
14		0.0210	0.0435
	1	0.0008	0.0008
15		0.0214	--
16		0.0228	0.0462
	2	0.0008	0.0008
	3	0.0012	0.0012
	4	0.0017	0.0017
	5	0.0009	0.0009
	6	0.0009	0.0009
17		0.0023	0.0023
--		--	--
	7	0.0008	0.0008
19		0.0033	0.0046
	8	0.0007	0.0007
	9	0.0008	0.0008
20		0.0283	--
21		0.0218	0.0350
22		0.0395	0.0395
23		0.0217	0.0217
--		--	--
25		0.0165	0.0165
26		0.0133	0.0133
27		0.0101	0.0149
28		0.0094	--
29		0.0096	0.0184
30		0.0122	--
31		--	0.0081
Total		0.406	0.406

Table D13. JANUARY FLOW ROTATION SCHEDULES FOR ABYUHA CANAL FOR THE TWO AREA DISTRIBUTION ALTERNATIVES.

Mesqa No.	Turnout No.	Flow Rates (*l*ps)	
		Alternative 1	Alternative 2
		Rotation 1	Rotation 1
1		20	20
2		20	20
3		20	20
4		72	72
5		40	40
6		20	20
7		73	73
8		20	20
--		--	--
10		20	20
11		66	87
12		20	20
13		46	--
14		50	104
	1	20	20
15		51	--
16		55	110
	2	20	20
	3	20	20
	4	20	20
	5	20	20
	6	20	20
17		20	20
--		--	--
	7	20	20
19		20	20
	8	20	20
	9	20	20
20		68	--
21		52	84
22		94	94
23		52	52
--		--	--
25		40	40
26		32	32
27		24	36
28		23	--
29		23	44
30		30	--
31		--	20
Canal Total		1251	1248

Table D14. FEBRUARY FLOW ROTATION SCHEDULES FOR ABYUHA CANAL FOR THE TWO AREA DISTRIBUTION ALTERNATIVES.

Mesqa No.	Turnout No.	Flow Rates (*l*ps)									
		Alternative 1					Alternative 2				
		Rot1	Rot2	Rot3	Rot4	Rot5	Rot1	Rot2	Rot3	Rot4	Rot5
1		23					23				
2		20					20				
3		20					20				
4		208					208				
5		116					116				
6		20					20				
7		210					210				
8			35					35			
--			--					--			
10			20					20			
11			192					252			
12			28					28			
13			134					--			
14			145					300			
	1		20						20		
15				148					--		
16				158					319		
	2			20					20		
	3			20					20		
	4			20					20		
	5			20					20		
	6			20					20		
17				20					20		
--				--					--		
	7			20					20		
19				23					32		
	8			20					20		
	9			20					20		
20					195					--	
21					151					242	
22					273					273	
23						150					150
--						--					--
25						114					114
26						92					92
27						70					103
28						65					--
29						66					127
30						85					--
31						--					56
Canal Total		617	574	509	619	642	617	635	551	515	642

Table D15. MARCH FLOW ROTATION SCHEDULES FOR ABYUHA CANAL FOR THE TWO AREA DISTRIBUTION ALTERNATIVES.

Mesqa No.	Turnout No.	Flow Rates (*l*ps)					
		Alternative 1			Alternative 2		
		Rot 1	Rot 2	Rot 3	Rot 1	Rot 2	Rote 3
1		20			20		
2		20			20		
3		20			20		
4		162			162		
5		90			90		
6		20			20		
7		163			163		
8		27			27		
--		--			--		
10		20			20		
11		149			196		
12		22			22		
13		104			--		
14			113			233	
	1		20			20	
15			115			--	
16			122			248	
	2		20			20	
	3		20			20	
	4		20			20	
	5		20			20	
	6		20			20	
17			20			20	
--			--			--	
	7		20			20	
19			20			20	
	8		20			20	
	9		20			20	
20			152			--	
21				117		188	
22				212			212
23				117			117
--				--			--
25				89			89
26				71			71
27				54			80
28				51			--
29				51			99
30				65			--
31				--			43
Canal Total		817	722	827	760	711	889

Table D16. APRIL FLOW ROTATION SCHEDULES FOR ABYUHA CANAL FOR THE TWO AREA DISTRIBUTION ALTERNATIVES.

Mesqa No.	Turnout No.	Flow Rates (*l*ps)					
		Alternative 1			Alternative 2		
		Rot 1	Rot 2	Rot 3	Rot 1	Rot 2	Rote 3
1		20			20		
2		20			20		
3		20			20		
4		171			171		
5		95			95		
6		20			20		
7		173			173		
8		29			29		
--		--			--		
10		20			20		
11		158			207		
12		23			23		
13		110			--		
14			119			247	
	1		20			20	
15			122			--	
16			130			263	
	2		20			20	
	3		20			20	
	4		20			20	
	5		20			20	
	6		20			20	
17			20			20	
--			--			--	
	7		20			20	
19			20			20	
	8		20			20	
	9		20			20	
20			161			--	
21				124		199	
22				224			224
23				124			124
--				--			--
25				94			94
26				76			76
27				58			85
28				54			--
29				54			104
30				69			--
31				--			46
Canal Total		859	752	877	798	929	753

Table D17. MAY FLOW ROTATION SCHEDULES FOR ABYUHA CANAL FOR THE TWO AREA DISTRIBUTION ALTERNATIVES.

Mesqa No.	Turnout No.	Flow Rates (ps)							
		Alternative 1				Alternative 2			
		Rot1	Rot2	Rot3	Rot4	Rot1	Rot2	Rot3	Rot4
1		22				22			
2		20				20			
3		20				20			
4		202				202			
5		112				112			
6		20				20			
7		204				204			
8			34				34		
--			--				--		
10			20				20		
11			186				245		
12			27				27		
13			130				--		
14			141				292		
	1		20				20		
15				144				--	
16				153				310	
	2			20				20	
	3			20				20	
	4			20				20	
	5			20				20	
	6			20				20	
17				20				20	
--				--				--	
	7			20				20	
19				22				31	
	8			20				20	
	9			20				20	
20				190				--	
21				146				235	
22					265				265
23					146				146
--					--				--
25					111				111
26					89				89
27					68				100
28					63				--
29					64				123
30					82				--
31					--				54
Canal Total		600	558	835	888	600	638	756	888

Table D18. JUNE FLOW ROTATION SCHEDULES FOR ABYUHA CANAL FOR THE TWO AREA DISTRIBUTION ALTERNATIVES.

Mesqa No.	Turnout No.	Flow Rates (*l*ps)			
		Alternative 1		Alternative 2	
		Rot 1	Rot 2	Rot 1	Rot 2
1		20		20	
2		20		20	
3		20		20	
4		160		160	
5		89		89	
6		20		20	
7		161		161	
8		27		27	
--		--		--	
10		20		20	
11		147		194	
12		21		21	
13		103		--	
14		111		231	
	1	20		20	
15		114		--	
16		121		246	
	2		20		20
	3		20		20
	4		20		20
	5		20		20
	6		20		20
17			20		20
--			--		--
	7		20		20
19			20		25
	8		20		20
	9		20		20
20			150		--
21			116		186
22			210		210
23			115		115
--			--		--
25			88		88
26			71		71
27			54		79
28			50		--
29			51		98
30			65		--
31			--		43
Canal Total		1174	1170	1249	1095

Table D19. JULY FLOW ROTATION SCHEDULES FOR ABYUHA CANAL FOR THE TWO AREA DISTRIBUTION ALTERNATIVES.

Mesqa No.	Turnout No.	Flow Rates (*l*ps)			
		Alternative 1		Alternative 2	
		Rot 1	Rot 2	Rot 1	Rot 2
1		23		23	
2		20		20	
3		20		20	
4		206		206	
5		114		114	
6		20		20	
7		208		208	
8		34		34	
--		--		--	
10		20		20	
11		190		249	
12		27		27	
13		133		--	
14		143		297	
	1	20		20	
15		147		--	
16		156		316	
	2		20		20
	3		20		20
	4		20		20
	5		20		20
	6		20		20
17			20		20
--			--		--
	7		20		20
19			23		32
	8		20		20
	9		20		20
20			193		--
21			149		239
22			270		270
23			149		149
--			--		--
25			113		113
26			91		91
27			69		102
28			64		--
29			65		126
30			84		--
31			--		55
Canal Total		1481	1450	1574	1357

Table D20. AUGUST FLOW ROTATION SCHEDULES FOR ABYUHA CANAL FOR THE TWO AREA DISTRIBUTION ALTERNATIVES.

Mesqa No.	Turnout No.	Flow Rates (*l*ps)			
		Alternative 1		Alternative 2	
		Rot 1	Rot 2	Rot 1	Rot 2
1		20		20	
2		20		20	
3		20		20	
4		151		151	
5		84		84	
6		20		20	
7		152		152	
8		25		25	
--		--		--	
10		20		20	
11		139		183	
12		20		20	
13		97		--	
14		105		218	
	1	20		20	
15		108		--	
16		115		232	
	2		20		20
	3		20		20
	4		20		20
	5		20		20
	6		20		20
17			20		20
--			--		--
	7		20		20
19			20		23
	8		20		20
	9		20		20
20			142		--
21			109		176
22			198		198
23			109		109
--			--		--
25			83		83
26			67		67
27			51		175
28			47		--
29			48		92
30			61		--
31			--		40
Canal Total		1116	1115	1165	1043

Table D21. SEPTEMBER FLOW ROTATION SCHEDULES FOR ABYUHA CANAL FOR THE TWO AREA DISTRIBUTION ALTERNATIVES.

Mesqa No.	Turnout No.	Flow Rates (*l*ps)							
		Alternative 1				Alternative 2			
		Rot1	Rot2	Rot3	Rot4	Rot1	Rot2	Rot3	Rot4
1		23				23			
2		20				20			
3		20				20			
4		206				206			
5		114				114			
6		20				20			
7		207				207			
8			34				34		
--			--				--		
10			20				20		
11			190				249		
12			27				27		
13			132				--		
14			143				297		
	1		20				20		
15				146				--	
16				156				316	
	2			20				20	
	3			20				20	
	4			20				20	
	5			20				20	
	6			20				20	
17				20				20	
--				--				--	
	7			20				20	
19				23				32	
	8			20				20	
	9			20				20	
20				193				--	
21				149				239	
22					270				270
23					148				148
--					--				--
25					113				113
26					91				91
27					69				102
28					64				--
29					65				125
30					83				--
31					--				55
Canal Total		610	566	847	903	610	647	767	904

Table D22. OCTOBER FLOW ROTATION SCHEDULES FOR ABYUHA CANAL FOR THE TWO AREA DISTRIBUTION ALTERNATIVES.

Mesqa No.	Turnout No.	Flow Rates (*l*ps)									
		Alternative 1					Alternative 2				
		Rot1	Rot2	Rot3	Rot4	Rot5	Rot1	Rot2	Rot3	Rot4	Rot5
1		20					20				
2		20					20				
3		20					20				
4		79					79				
5		44					44				
6		20					20				
7		79					79				
8			20					20			
--			--					--			
10			20					20			
11			72					95			
12			20					20			
13			51					--			
14			55					113			
	1		20					20			
15				56					--		
16				60					120		
	2			20					20		
	3			20					20		
	4			20					20		
	5			20					20		
	6			20					20		
17				20					20		
--				--					20		
	7			20					20		
19				20					20		
	8			20					20		
	9			20					20		
20					74					--	
21					57					91	
22					103					103	
23						57					57
--						--					--
25						43					43
26						35					35
27						27					39
28						25					--
29						25					48
30						32					--
31						--					21
Canal Total		282	258	316	234	244	282	288	320	194	243

Table D23. NOVEMBER FLOW ROTATION SCHEDULES FOR ABYUHA CANAL FOR THE TWO AREA DISTRIBUTION ALTERNATIVES.

Mesqa No.	Turnout No.	Flow Rates (*l*ps)									
		Alternative 1					Alternative 2				
		Rot1	Rot2	Rot3	Rot4	Rot5	Rot1	Rot2	Rot3	Rot4	Rot5
1		20					20				
2		20					20				
3		20					20				
4		134					134				
5		75					75				
6		20					20				
7		135					135				
8			23					23			
--			--					--			
10			20					20			
11			124					162			
12			20					20			
13			86					--			
14			93					193			
	1		20					20			
15				96					--		
16				102					206		
	2			20					20		
	3			20					20		
	4			20					20		
	5			20					20		
	6			20					20		
17				20					20		
--				--					--		
	7			20					20		
19				20					20		
	8			20					21		
	9			20					20		
20					126					--	
21					97					156	
22					176					176	
23						97					97
--						--					--
25						74					74
26						59					59
27						45					67
28						42					--
29						43					82
30						55					--
31						--					36
Canal Total		424	386	398	399	415	424	438	407	332	415

Table D24. DECEMBER FLOW ROTATION SCHEDULES FOR ABYUHA CANAL FOR THE TWO AREA DISTRIBUTION ALTERNATIVES.

Mesqa No.	Turnout No.	Flow Rates (*l*ps)									
		Alternative 1					Alternative 2				
		Rot1	Rot2	Rot3	Rot4	Rot5	Rot1	Rot2	Rot3	Rot4	Rot5
1		20					20				
2		20					20				
3		20					20				
4		151					151				
5		84					84				
6		20					20				
7		152					152				
8			20					20			
--			--					--			
10			20					20			
11			139					182			
12			20					20			
13			97					--			
14			105					218			
	1		20					20			
15				107					--		
16				114					231		
	2			20					20		
	3			20					20		
	4			20					20		
	5			20					20		
	6			20					20		
17				20					20		
--				--					--		
	7			20					20		
19				20					23		
	8			20					20		
	9			20					20		
20					142					--	
21					109					175	
22					198					198	
23						109					109
--						--					--
25						83					83
26						67					67
27						51					75
28						47					--
29						48					92
30						61					--
31						--					41
Canal Total		467	421	421	449	466	467	480	434	373	467

APPENDIX E: EXAMPLE COMPUTER PRINTOUTS OF HYDRAULIC ANALYSES OF ABYUHA SYSTEM

Table E1

ARYUHA/JUL/KUT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL T2

PARAMETER	PARAMETER VALUES FOR EACH STATION STA(1)	 STA(2)	 STA(3)
STATION TYPE	1	3C	2
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	-	-	40.25.
SECTION PARAMETERS:			
HYDRAULIC ROUGHNESS	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	0.20	0.20	0.20
TURNOUT PARAMETERS:			
DESIGN FLOW RATE (m↑3/s)	-	0.020	-
FIELD WS ELEV (m)	-	40.74	-
PIPE TURNOUT			
FRICTION FACTOR	-	-	-
PIPE LENGTH (m)	-	-	-
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
ROUGHNESS COEFF	-	-	-
ENTRANCE COEFF	-	-	-
SIPHON LENGTH (m)	-	-	-
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
ROUGHNESS COEFF	-	0.020	-
BANKCUT LENGTH (m)	-	1.000	-
BANKCUT ELEV (m)	-	40.62	-
BANKCUT WIDTH (m)	-	0.200	-
FLUME PARAMETERS:			
FLUME LENGTH (m)	-	-	-
FLUME WIDTH (m)	-	-	-
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK PARAMETERS:			
CREST LENGTH (m)	-	-	-
CREST ELEVATION (m)	-	-	-
BEND LOSS COEFFICIENT	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-
CONTRACTION LOSS COEFF	-	-	-

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Table E2

E 2

ABYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL T3

PARAMETER	PARAMETER VALUES FOR EACH STATION STA(1)	 STA(2)	 STA(3)
STATION TYPE	1	3C	2
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	-	-	40.25
SECTION PARAMETERS:			
HYDRAULIC ROUGHNESS	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	0.20	0.20	0.20
TURNOUT PARAMETERS:			
DESIGN			
FLOW RATE (m†3/s)	-	0.020	-
FIELD WS ELEV (m)	-	40.74	-
PIPE TURNOUT			
FRICTION FACTOR	-	-	-
PIPE LENGTH (m)	-	-	-
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
ROUGHNESS COEFF	-	-	-
ENTRANCE COEFF	-	-	-
SIPHON LENGTH (m)	-	-	-
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
ROUGHNESS COEFF	-	0.020	-
BANKCUT LENGTH (m)	-	1.000	-
BANKCUT ELEV (m)	-	40.62	-
BANKCUT WIDTH (m)	-	0.200	-
FLUME PARAMETERS:			
FLUME LENGTH (m)	-	-	-
FLUME WIDTH (m)	-	-	-
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK PARAMETERS:			
CREST LENGTH (m)	-	-	-
CREST ELEVATION (m)	-	-	-
BEND LOSS COEFFICIENT	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-
CONTRACTION LOSS COEFF	-	-	-

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Table E3

ABYUHA/JUL/ROT2

HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL T4

PARAMETER	STA(1)	STA(2)	STA(3)
	PARAMETER VALUES FOR EACH STATION		
STATION TYPE	1	3C	2
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	-	-	40.25
SECTION PARAMETERS:			
HYDRAULIC ROUGHNESS	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	0.20	0.20	0.20
TURNOUT PARAMETERS:			
DESIGN FLOW RATE (m↑3/s)	-	0.020	-
FIELD WS ELEV (m)	-	40.74	-
PIPE TURNOUT			
FRICTION FACTOR	-	-	-
PIPE LENGTH (m)	-	-	-
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
ROUGHNESS COEFF	-	-	-
ENTRANCE COEFF	-	-	-
SIPHON LENGTH (m)	-	-	-
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
ROUGHNESS COEFF	-	0.020	-
BANKCUT LENGTH (m)	-	1.000	-
BANKCUT ELEV (m)	-	40.62	-
BANKCUT WIDTH (m)	-	0.200	-
FLUME PARAMETERS:			
FLUME LENGTH (m)	-	-	-
FLUME WIDTH (m)	-	-	-
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK PARAMETERS:			
CREST LENGTH (m)	-	-	-
CREST ELEVATION (m)	-	-	-
BEND LOSS COEFFICIENT	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-
CONTRACTION LOSS COEFF	-	-	-

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Table E4

ABYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL T5

PARAMETER	PARAMETER VALUES FOR EACH STATION STA(1)	STA(2)	STA(3)
STATION TYPE	1	3C	2
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	-	-	40.25
SECTION PARAMETERS:			
HYDRAULIC ROUGHNESS	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	0.20	0.20	0.20
TURNOUT PARAMETERS:			
DESIGN FLOW RATE (m↑3/s)	-	0.020	-
FIELD WS ELEV (m)	-	40.74	-
PIPE TURNOUT			
FRICTION FACTOR	-	-	-
PIPE LENGTH (m)	-	-	-
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
ROUGHNESS COEFF	-	-	-
ENTRANCE COEFF	-	-	-
SIPHON LENGTH (m)	-	-	-
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
ROUGHNESS COEFF	-	0.020	-
BANKCUT LENGTH (m)	-	1.000	-
BANKCUT ELEV (m)	-	40.62	-
BANKCUT WIDTH (m)	-	0.200	-
FLUME PARAMETERS:			
FLUME LENGTH (m)	-	-	-
FLUME WIDTH (m)	-	-	-
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK PARAMETERS:			
CREST LENGTH (m)	-	-	-
CREST ELEVATION (m)	-	-	-
BEND LOSS COEFFICIENT	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-
CONTRACTION LOSS COEFF	-	-	-

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Table E5

ABYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL T6

PARAMETER	STA(1)	STA(2)	STA(3)
	PARAMETER VALUES FOR EACH STATION		
STATION TYPE	1	3C	2
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	-	-	40.25
SECTION PARAMETERS:			
HYDRAULIC ROUGHNESS	0.043	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	0.20	0.20	0.20
TURNOUT PARAMETERS:			
DESIGN			
FLOW RATE (m↑3/s)	-	0.020	-
FIELD WS ELEV (m)	-	40.74	-
PIPE TURNOUT			
FRICTION FACTOR	-	-	-
PIPE LENGTH (m)	-	-	-
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
ROUGHNESS COEFF	-	-	-
ENTRANCE COEFF	-	-	-
SIPHON LENGTH (m)	-	-	-
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
ROUGHNESS COEFF	-	0.020	-
BANKCUT LENGTH (m)	-	[illegible].000	-
BANKCUT ELEV (m)	-	40.62	-
BANKCUT WIDTH (m)	-	0.200	-
FLUME PARAMETERS:			
FLUME LENGTH (m)	-	-	-
FLUME WIDTH (m)	-	-	-
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK PARAMETERS:			
CREST LENGTH (m)	-	-	-
CREST ELEVATION (m)	-	-	-
BEND LOSS COEFFICIENT	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-
CONTRACTION LOSS COEFF	-	-	-

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Table E6

ABYUHA/JUL/ROT2

HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 17

PARAMETER	PARAMETER VALUES FOR EACH STATION			
	STA(1)	STA(2)	STA(3)	STA(4)
STATION TYPE	1	7	3C	2
DISTANCE TO STATION (m)	0	50	99	100
BOTTOM ELEV AT STATION (m)	-	-	-	40.44
SECTION PARAMETERS:				
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00020	0.00020	0.00020	0.00020
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35
TURNOUT PARAMETERS:				
DESIGN				
FLOW RATE (m↑3/s)	-	-	0.020	-
FIELD WS ELEV (m)	-	-	40.72	-
PIPE TURNOUT				
FRICTION FACTOR	-	-	-	-
PIPE LENGTH (m)	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-
GATE SETTING (m)	-	-	-	-
SIPHON TUBE TURNOUT				
ROUGHNESS COEFF	-	-	-	-
ENTRANCE COEFF	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-
SIPHON DIA (m)	-	-	-	-
BANKCUT TURNOUT				
ROUGHNESS COEFF	-	-	0.020	-
BANKCUT LENGTH (m)	-	-	1.600	-
BANKCUT ELEV (m)	-	-	40.60	-
BANKCUT WIDTH (m)	-	-	0.200	-
FLUME PARAMETERS:				
FLUME LENGTH (m)	-	-	-	-
FLUME WIDTH (m)	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-
CHECK PARAMETERS:				
CREST LENGTH (m)	-	-	-	-
CREST ELEVATION (m)	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-

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Table E7

[illegible]
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 12

PARAMETER	STA(1)	STA(2)	STA(3)
		PARAMETER VALUES FOR EACH STATION	
STATION TYPE	1	3C	2
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	-	-	40.25
SECTION PARAMETERS:			
HYDRAULIC ROUGHNESS	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	0.20	0.20	0.20
TURNOUT PARAMETERS:			
DESIGN FLOW RATE (m↑3/s)	-	0.020	-
FIELD US ELEV (m)	-	40.74	-
PIPE TURNOUT			
FRICTION FACTOR	-	-	-
PIPE LENGTH (m)	-	-	-
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
ROUGHNESS COEFF	-	-	-
ENTRANCE COEFF	-	-	-
SIPHON LENGTH (m)	-	-	-
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
ROUGHNESS COEFF	-	0.020	-
BANKCUT LENGTH (m)	-	1.000	-
BANKCUT ELEV (m)	-	40.62	-
BANKCUT WIDTH (m)	-	0.200	-
FLUME PARAMETERS:			
FLUME LENGTH (m)	-	-	-
FLUME WIDTH (m)	-	-	-
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK PARAMETERS:			
CREST LENGTH (m)	-	-	-
CREST ELEVATION (m)	-	-	-
BEND LOSS COEFFICIENT	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-
CONTRACTION LOSS COEFF	-	-	-

Table E8

ABYUHA/JUL/RUT2

HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 19

PARAMETER	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)
	PARAMETER VALUES FOR EACH STATION				
STATION TYPE	1	7	7	3C	2
DISTANCE TO STATION (m)	0	108	125	150	260
BOTTOM ELEV AT STATION (m)	-	-	-	-	40.28
SECTION PARAMETERS:					
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00030	0.00030	0.00030	0.00030	0.00030
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35	0.35
TURNOUT PARAMETERS:					
DESIGN FLOW RATE (m↑3/s)	-	-	-	0.023	-
FIELD WS ELEV (m)	-	-	-	40.69	-
PIPE TURNOUT					
FRICTION FACTOR	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-
SIPHON TUBE TURNOUT					
ROUGHNESS COEFF	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-
BANKCUT TURNOUT					
ROUGHNESS COEFF	-	-	-	0.020	-
BANKCUT LENGTH (m)	-	-	-	1.600	-
BANKCUT ELEV (m)	-	-	-	40.57	-
BANKCUT WIDTH (m)	-	-	-	0.200	-
FLUME PARAMETERS:					
FLUME LENGTH (m)	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-
CHECK PARAMETERS:					
CREST LENGTH (m)	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-

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Table E9

ABYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL T8

PARAMETER	STA(1)	STA(2)	STA(3)
	PARAMETER VALUES FOR EACH STATION		
STATION TYPE	1	3C	2
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	-	-	40.25
SECTION PARAMETERS:			
HYDRAULIC ROUGHNESS	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	0.20	0.20	0.20
TURNOUT PARAMETERS:			
DESIGN			
FLOW RATE (m†3/s)	-	0.020	-
FIELD WS ELEV (m)	-	40.74	-
PIPE TURNOUT			
FRICTION FACTOR	-	-	-
PIPE LENGTH (m)	-	-	-
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
ROUGHNESS COEFF	-	-	-
ENTRANCE COEFF	-	-	-
SIPHON LENGTH (m)	-	-	-
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
ROUGHNESS COEFF	-	0.020	-
BANKCUT LENGTH (m)	-	1.000	-
BANKCUT ELEV (m)	-	40.62	-
BANKCUT WIDTH (m)	-	0.200	-
FLUME PARAMETERS:			
FLUME LENGTH (m)	-	-	-
FLUME WIDTH (m)	-	-	-
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK PARAMETERS:			
CREST LENGTH (m)	-	-	-
CREST ELEVATION (m)	-	-	-
BEND LOSS COEFFICIENT	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-
CONTRACTION LOSS COEFF	-	-	-

Table E10

ABYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL T9

PARAMETER	STA(1)	STA(2)	STA(3)
	PARAMETER VALUES FOR EACH STATION		
STATION TYPE	1	3C	2
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	-	-	40.25
SECTION PARAMETERS:			
HYDRAULIC ROUGHNESS	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	0.20	0.20	0.20
TURNOUT PARAMETERS:			
DESIGN FLOW RATE (m↑3/s)	-	0.020	-
FIELD WS ELEV (m)	-	40.74	-
PIPE TURNOUT			
FRICTION FACTOR	-	-	-
PIPE LENGTH (m)	-	-	-
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
ROUGHNESS COEFF	-	-	-
ENTRANCE COEFF	-	-	-
SIPHON LENGTH (m)	-	-	-
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
ROUGHNESS COEFF	-	0.020	-
BANKCUT LENGTH (m)	-	1.000	-
BANKCUT ELEV (m)	-	40.62	-
BANKCUT WIDTH (m)	-	0.200	-
FLUME PARAMETERS:			
FLUME LENGTH (m)	-	-	-
FLUME WIDTH (m)	-	-	-
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK PARAMETERS:			
CREST LENGTH (m)	-	-	-
CREST ELEVATION (m)	-	-	-
BEND LOSS COEFFICIENT	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-
CONTRACTION LOSS COEFF	-	-	-

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Table E11

ABYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 20

PARAMETER	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	STA(8)	STA(9)	STA(10)
	PARAMETER VALUES FOR EACH STATION									
STATION TYPE	1	7	7	7	7	7	7	7	7	7
DISTANCE TO STATION (m)	0	100	200	300	400	500	600	700	800	900
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	-	-	-	-
SECTION PARAMETERS:										
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
TURNOUT PARAMETERS:										
DESIGN FLOW RATE (m↑3/s)	-	-	-	-	-	-	-	-	-	-
FIELD WS ELEV (m)	-	-	-	-	-	-	-	-	-	-
PIPE TURNOUT										
FRICTION FACTOR	-	-	-	-	-	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
BANKCUT LENGTH (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT ELEV (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME PARAMETERS:										
FLUME LENGTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK PARAMETERS:										
CREST LENGTH (m)	-	-	-	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-	-	-	-	-

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Table E11 (Cont.)

[illegible]
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 20 (CONTINUED)

PARAMETER	STA(11)	STA(12)	STA(13)	STA(14)	STA(15)	STA(16)	STA(17)	STA(18)	STA(19)	STA(20)
	PARAMETER VALUES FOR EACH STATION									
STATION TYPE	3C	3C	3C	3C	3C	3C	3C	3C	3C	2
DISTANCE TO STATION (m)	1044	1051	1058	1065	1072	1079	1086	1093	1100	2110
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	-	-	-	39.27
SECTION PARAMETERS:										
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
TURNOUT PARAMETERS:										
DESIGN										
FLOW RATE (m↑3/s)	0.024	0.024	0.024	0.024	0.024	0.025	0.024	0.024	0.024	-
FIELD WS ELEV (m)	40.51	40.51	40.51	40.51	40.51	40.51	40.51	40.51	40.51	-
PIPE TURNOUT										
FRICTION FACTOR	-	-	-	-	-	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
ROUGHNESS COEFF	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	-
BANKCUT LENGTH (m)	1.600	1.600	1.600	1.600	1.600	1.600	1.600	1.600	1.600	-
BANKCUT ELEV (m)	40.39	40.39	40.39	40.39	40.37	40.39	40.39	40.37	40.39	-
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	0.200	-
FLUME PARAMETERS:										
FLUME LENGTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK PARAMETERS:										
CREST LENGTH (m)	-	-	-	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-	-	-	-	-

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Table E12

ABYUNIA/JUL/ROT?
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 21

PARAMETER	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	STA(8)	STA(9)	STA(10)
	PARAMETER VALUES FOR EACH STATION									
STATION TYPE	1	7	7	7	7	7	7	7	7	3C
DISTANCE TO STATION (m)	0	100	200	300	400	500	600	700	800	915
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	-	-	-	-
SECTION PARAMETERS:										
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
TURNOUT PARAMETERS:										
DESIGN FLOW RATE (m3/s)	-	-	-	-	-	-	-	-	-	0.025
FIELD WS ELEV (m)	-	-	-	-	-	-	-	-	-	40.51
PIPE TURNOUT										
FRICTION FACTOR	-	-	-	-	-	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	0.028
BANKCUT LENGTH (m)	-	-	-	-	-	-	-	-	-	1.600
BANKCUT ELEV (m)	-	-	-	-	-	-	-	-	-	40.39
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME PARAMETERS:										
FLUME LENGTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK PARAMETERS:										
CREST LENGTH (m)	-	-	-	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-	-	-	-	-

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Table E12 (Cont.)

ABYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 21 (CONTINUED)

PARAMETER	STA(11)	STA(12)	STA(13)	STA(14)	STA(15)	STA(16)
	PARAMETER VALULS FOR EACH STATION					
STATION TYPE	3C	3C	3C	3C	3C	2
DISTANCE TO STATION (m)	922	929	936	943	950	1895
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	39.42
SECTION PARAMETERS:						
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35	0.35	0.35
TURNOUT PARAMETERS:						
DESIGN FLOW RATE (m3/s)	0.025	0.025	0.025	0.025	0.025	-
FIELD US ELEV (m)	40.51	40.51	40.51	40.51	40.51	-
PIPE TURNOUT						
FRICTION FACTOR	-	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-
SIPHON TUBE TURNOUT						
ROUGHNESS COEFF	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-
BANKCUT TURNOUT						
ROUGHNESS COEFF	0.020	0.020	0.020	0.020	0.020	-
BANKCUT LENGTH (m)	1.600	1.600	1.600	1.600	1.600	-
BANKCUT ELEV (m)	40.39	40.39	40.39	40.39	40.37	-
BANKCUT WIDTH (m)	-	-	-	-	0.200	-
FLUME PARAMETERS:						
FLUME LENGTH (m)	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-
CHECK PARAMETERS:						
CHECK LENGTH (m)	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-

Table E13

[illegible]
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 22

PARAMETER	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	STA(8)	STA(9)	STA(10)
	PARAMETER VALUES FOR EACH STATION									
STATION TYPE	1	7	7	7	7	7	7	7	7	3C
DISTANCE TO STATION (m)	0	100	200	300	400	500	600	700	800	930
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	-	-	-	-
SECTION PARAMETERS:										
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
TURNOUT PARAMETERS:										
DESIGN FLOW RATE (m†3/s)	-	-	-	-	-	-	-	-	-	0.025
FIELD WS ELEV (m)	-	-	-	-	-	-	-	-	-	40.44
PIPE TURNOUT										
FRICTION FACTOR	-	-	-	-	-	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	0.020
BANKCUT LENGTH (m)	-	-	-	-	-	-	-	-	-	1.650
BANKCUT ELEV (m)	-	-	-	-	-	-	-	-	-	40.32
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME PARAMETERS:										
FLUME LENGTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK PARAMETERS:										
CREST LENGTH (m)	-	-	-	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-	-	-	-	-

[illegible] SEPTEMBER [illegible]

Table E13 (Cont.)

[illegible]
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL #2 (CONTINUED)

PARAMETER	STA(11)	STA(12)	STA(13)	STA(14)	STA(15)	STA(16)	STA(17)	STA(18)	STA(19)	STA(20)
STATION TYPE	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C
DISTANCE TO STATION (m)	937	944	951	958	965	972	979	986	993	1000
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	-	-	-	-
SECTION PARAMETERS:										
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
TURNOUT PARAMETERS:										
DESIGN FLOW RATE (m3/s)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
FIELD WS ELEV (m)	40.44	40.44	40.44	40.44	40.44	40.44	40.44	40.44	40.44	40.44
PIPE TURNOUT										
FRICTION FACTOR	-	-	-	-	-	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
ROUGHNESS COEFF	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
BANKCUT LENGTH (m)	1.600	1.600	1.600	1.600	1.600	1.600	1.600	1.600	1.600	1.600
BANKCUT ELEV (m)	40.32	40.32	40.32	40.32	40.32	40.32	40.32	40.32	40.32	40.32
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	0.200
FLUME PARAMETERS:										
FLUME LENGTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK PARAMETERS:										
CREST LENGTH (m)	-	-	-	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-	-	-	-	-

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Table E13 (Cont.)

ABYUHA/JUL/ROT2

HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 22 (CONTINUED)

PARAMETER	PARAMETER VALUES FOR EACH STATION STA(21)
STATION TYPE	2
DISTANCE TO STATION (m)	2085
BOTTOM ELEV AT STATION (m)	39.10
SECTION PARAMETERS:	
HYDRAULIC ROUGHNESS	0.040
SIDE SLOPE	1.00
BOTTOM SLOPE (m/m)	0.00030
BOTTOM WIDTH (m)	0.35
TURNOUT PARAMETERS:	
DESIGN FLOW RATE (m↑3/s)	-
FIELD WS ELEV (m)	-
PIPE TURNOUT	
FRICTION FACTOR	-
PIPE LENGTH (m)	-
PIPE DIAMETER (m)	-
GATE SETTING (m)	-
SIPHON TUBE TURNOUT	
ROUGHNESS COEFF	-
ENTRANCE COEFF	-
SIPHON LENGTH (m)	-
SIPHON DIA (m)	-
BANKCUT TURNOUT	
ROUGHNESS COEFF	-
BANKCUT LENGTH (m)	-
BANKCUT ELEV (m)	-
BANKCUT WIDTH (m)	-
FLUME PARAMETERS:	
FLUME LENGTH (m)	-
FLUME WIDTH (m)	-
SUBMERGENCE RATIO	-
FLUME FLOOR ELEV (m)	-
CHECK PARAMETERS.	
CREST LENGTH (m)	-
CREST ELEVATION (m)	-
BEND LOSS COEFFICIENT	-
ENLARGEMENT LOSS COEFF	-
CONTRACTION LOSS COEFF	-

13 SEPTEMBER 1983

Table E14

ABYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 23

PARAMETER	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	STA(8)	STA(9)
	PARAMETER VALUES FOR EACH STATION								
STATION TYPE	1	3C	3C	3C	3C	3C	3C	3C	2
DISTANCE TO STATION (m)	0	40	50	60	70	80	90	100	2080
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	-	-	39.16 ~~37.34~~ c.k
SECTION PARAMETERS:									
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
TURNOUT/CULVERT PARAMETERS:									
DESIGN FLOW RATE (m†3/s)	-	0.021	0.021	0.021	0.021	0.021	0.021	0.021	-
FIELD WS ELEV (m)	-	40.66	40.66	40.66	40.66	40.66	40.66	40.66	-
PIPE TURNT OR CULVT									
FRICTION FACTOR	-	-	-	-	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT									
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT									
ROUGHNESS COEFF	-	0.020	0.020	0.020	0.020	0.020	0.020	0.020	-
BANKCUT LENGTH (m)	-	1.600	1.600	1.600	1.600	1.600	1.600	1.600	-
BANKCUT ELEV (m)	-	40.54	40.54	40.54	40.54	40.54	40.54	40.54	-
BANKCUT WIDTH (m)	-	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-
FLUME PARAMETERS:									
FLUME LENGTH (m)	-	-	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-
CHECK PARAMETERS:									
CREST LENGTH (m)	-	-	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-	-	-	-

01 JANUARY 1984

Table E15

ADYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 25

PARAMETER	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)
	PARAMETER VALUES FOR EACH STATION						
STATION TYPE	1	3C	3C	3C	3C	3C	2
DISTANCE TO STATION (m)	0	72	79	86	93	100	985
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	39.68
SECTION PARAMETERS:							
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35
TURNOUT PARAMETERS:							
DESIGN FLOW RATE (m†3/s)	-	0.023	0.023	0.023	0.023	0.023	-
FIELD WS ELEV (m)	-	40.75	40.75	40.75	40.75	40.75	-
PIPE TURNOUT							
FRICTION FACTOR	-	-	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT							
ROUGHNESS COEFF	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-
BANKCUT TURNOUT							
ROUGHNESS COEFF	-	0.020	0.020	0.020	0.020	0.020	-
BANKCUT LENGTH (m)	-	1.600	1.600	1.600	1.600	1.600	-
BANKCUT ELEV (m)	-	40.63	40.63	40.63	40.63	40.63	-
BANKCUT WIDTH (m)	-	-	-	-	-	0.200	-
FLUME PARAMETERS:							
FLUME LENGTH (m)	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-
CHECK PARAMETERS:							
CREST LENGTH (m)	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-	-

Best Available Document

Table E16

ABYUHA/JUL/R012
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 26

PARAMETER	PARAMETER VALUES FOR EACH STATION							
	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	
STATION TYPE	1	7	7	3A	3A	3A	2	
DISTANCE TO STATION (m)	0	100	200	320	360	400	850	
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	40.07	
SECTION PARAMETERS:								
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040	
SIDE SLOPE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
BOTTOM SLOPE (m/m)	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	.0002
BOTTOM WIDTH (m)	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
TURNOUT PARAMETERS:								
DESIGN FLOW RATE (m3/s)	-	-	-	0.030	0.030	0.030	-	
FIELD WS ELEV (m)	-	-	-	40.69	40.67	40.69	-	
PIPE TURNOUT								
FRICTION FACTOR	-	-	-	0.030	0.030	0.030	-	
PIPE LENGTH (m)	-	-	-	2.00	2.00	2.00	-	
PIPE DIAMETER (m)	-	-	-	0.20	0.20	0.20	-	
GATE SETTING (m)	-	-	-	-	-	0.20	-	
SIPHON TUBE TURNOUT								
ROUGHNESS COEFF	-	-	-	-	-	-		
ENTRANCE COEFF	-	-	-	-	-	-		
SIPHON LENGTH (m)	-	-	-	-	-	-		
SIPHON DIA (m)	-	-	-	-	-	-		
BANKCUT TURNOUT								
ROUGHNESS COEFF	-	-	-	-	-	-		
BANKCUT LENGTH (m)	-	-	-	-	-	-		
BANKCUT ELEV (m)	-	-	-	-	-	-		
BANKCUT WIDTH (m)	-	-	-	-	-	-		
FLUME PARAMETERS:								
FLUME LENGTH (m)	-	-	-	-	-	-		
FLUME WIDTH (m)	-	-	-	-	-	-		
SIDE SLOPE RATIO	-	-	-	-	-	-		
FLUME FLOOR ELEV (m)	-	-	-	-	-	-		
CHECK PARAMETERS:								
CREST LENGTH (m)	-	-	-	-	-	-		
CREST ELEVATION (m)	-	-	-	-	-	-		
BEND LOSS COEFFICIENT	-	-	-	-	-	-		
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-		
CONTRACTION LOSS COEFF	-	-	-	-	-	-		

13 SEPTEMBER 1982

Table E17

ADYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 27

PARAMETER	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)
	PARAMETER VALUES FOR EACH STATION				
STATION TYPE	1	3A	3A	3A	2
DISTANCE TO STATION (m)	0	60	80	100	802
BOTTOM ELEV AT STATION (m)	-	-	-	-	40.00
SECTION PARAMETERS:					
HYDRAULIC ROUGHNESS	0.020	0.020	0.020	0.020	0.020
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00030	0.00030	0.00030	0.00030	0.00030
BOTTOM WIDTH (m)	0.30	0.30	0.30	0.30	0.30
TURNOUT PARAMETERS:					
DESIGN FLOW RATE (m↑3/s)	-	0.023	0.023	0.023	-
FIELD WS ELEV (m)	-	40.75	40.75	40.75	-
PIPE TURNOUT					
FRICTION FACTOR	-	0.030	0.030	0.030	-
PIPE LENGTH (m)	-	2.00	2.00	2.00	-
PIPE DIAMETER (m)	-	0.20	0.20	0.20	-
GATE SETTING (m)	-	0.20	0.20	0.20	-
SIPHON TUBE TURNOUT					
ROUGHNESS COEFF	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-
BANKCUT TURNOUT					
ROUGHNESS COEFF	-	-	-	-	-
BANKCUT LENGTH (m)	-	-	-	-	-
BANKCUT ELEV (m)	-	-	-	-	-
BANKCUT WIDTH (m)	-	-	-	-	-
FLUME PARAMETERS:					
FLUME LENGTH (m)	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-
CHECK PARAMETERS:					
CREST LENGTH (m)	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-
[illegible]		-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-

19 OCTOBER 1984

Table E18

ABYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 28

PARAMETER	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)
STATION TYPE	1	7	7	3C	3C	3C	2
DISTANCE TO STATION (m)	0	100	200	236	243	250	780
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	39.94
SECTION PARAMETERS:							
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35
TURNOUT PARAMETERS:							
DESIGN							
FLOW RATE (m†3/s)	-	-	-	0.021	0.021	0.021	-
FIELD WS ELEV (m)	-	-	-	40.02	40.02	40.02	-
PIPE TURNOUT							
FRICTION FACTOR	-	-	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT							
ROUGHNESS COEFF	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-
BANKCUT TURNOUT							
ROUGHNESS COEFF	-	-	-	0.020	0.020	0.020	-
BANKCUT LENGTH (m)	-	-	-	1.600	1.600	1.600	-
BANKCUT ELEV (m)	-	-	-	40.70	40.70	40.70	-
BANKCUT WIDTH (m)	-	-	-	-	-	0.200	-
FLUME PARAMETERS:							
FLUME LENGTH (m)	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-
CHECK PARAMETERS							
CREST LENGTH (m)	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-	-

Table E19

HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 2?

PARAMETER	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	STA(8)
	PARAMETER VALUES FOR EACH STATION							
STATION TYPE	1	7	7	7	3C	3C	3C	2
DISTANCE TO STATION (m)	0	100	200	300	336	343	350	670
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	-	39.85
SECTION PARAMETERS:								
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030	0.00030
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
TURNOUT PARAMETERS:								
DESIGN								
FLOW RATE (m13/s)	-	-	-	-	0.022	0.022	0.022	-
FIELD WS ELEV (m)	-	-	-	-	40.64	40.64	40.64	-
PIPE TURNOUT								
FRICTION FACTOR	-	-	-	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT								
ROUGHNESS COEFF	-	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-	-
BANKCUT TURNOUT								
ROUGHNESS COEFF	-	-	-	-	0.020	0.020	0.020	-
BANKCUT LENGTH (m)	-	-	-	-	1.500	1.600	1.600	-
BANKCUT ELEV (m)	-	-	-	-	40.52	40.52	40.52	-
BANKCUT WIDTH (m)	-	-	-	-	-	-	0.200	-
FLUME PARAMETERS:								
FLUME LENGTH (m)	-	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-	-
SIDE SLOPE RATIO	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-
CHECK PARAMETERS:								
CHECK LENGTH (m)	-	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-	-	-

13 SEPTEMBER 1983

Table E20.

ABYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON FARM CHANNEL 30

PARAMETER	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)
	PARAMETER VALUES FOR EACH STATION					
STATION TYPE	1	3C	3C	3C	3C	2
DISTANCE TO STATION (m)	0	36	43	50	57	600
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	39.86
SECTION PARAMETERS:						
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020
BOTTOM WIDTH (m)	0.35	0.35	0.35	0.35	0.35	0.35
TURNOUT PARAMETERS:						
DESIGN FLOW RATE (m↑3/s)	-	0.021	0.021	0.021	0.021	-
FIELD WS ELEV (m)	-	40.68	40.68	40.68	40.68	-
PIPE TURNOUT						
FRICTION FACTOR	-	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-
SIPHON TUBE TURNOUT						
ROUGHNESS COEFF	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-
BANKCUT TURNOUT						
ROUGHNESS COEFF	-	0.020	0.020	0.020	0.020	-
BANKCUT LENGTH (m)	-	1.600	1.600	1.600	1.600	-
BANKCUT ELEV (m)	-	40.56	40.56	40.56	40.56	-
BANKCUT WIDTH (m)	-	-	-	-	0.200	-
FLUME PARAMETERS:						
FLUME LENGTH (m)	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-
CHECK PARAMETERS:						
CREST LENGTH (m)	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-

Table E21

ABYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON DISTRIBUTION CANAL

PARAMETER	PARAMETER VALUES FOR EACH STATION									
	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	STA(8)	STA(9)	STA(10)
STATION TYPE	1	6A	7	7	4B	5	7	7	7	7
FARM CHANNEL CODE NO.										
DISTANCE TO STATION (m)	0	14	100	200	300	410	500	600	700	800
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	-	-	-	-
SECTION PARAMETERS:										
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	2.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
TURNOUT PARAMETERS:										
PIPE TURNOUT										
FRICTION FACTOR	-	-	-	-	-	-	-	-	-	-
PIPE LENGTH (m)	-	-	-	-	-	-	-	-	-	-
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
BANKCUT LENGTH (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT ELEV (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME PARAMETERS:										
FLUME LENGTH (m)	-	-	-	-	3.660	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	0.305	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	0.850	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK PARAMETERS:										
CREST LENGTH (m)	-	-	-	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	0.250	-	-	-	-
ENLARGEMENT LOSS COEFF	-	1.000	-	-	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-	-	-	-	-

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Table E21(Cont.)

ABYUHA/JUL/FOT2

HYDRAULIC PARAMETER VALUES FOR STATIONS ON DISTRIBUTION CANAL (CONTINUED)

PARAMETER	PARAMETER VALUES FOR EACH STATION									
	STA(11)	STA(12)	STA(13)	STA(14)	STA(15)	STA(16)	STA(17)	STA(18)	STA(19)	STA(20)
STATION TYPE	6B	6B	6A	6A	7	7	5	3A	3A	3A
FARM CHANNEL CODE NO.								T2	T3	T4
DISTANCE TO STATION (m)	940	982	1000	1096	1200	1300	1435	1470	1564	1565
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	-	-	-	-
SECTION PARAMETERS:										
HYDRAULIC ROUGHNESS	0.030	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
TURNOUT PARAMETERS:										
PIPE TURNOUT										
FRICTION FACTOR	-	-	-	-	-	-	-	0.030	0.030	0.030
PIPE LENGTH (m)	-	-	-	-	-	-	-	7.00	7.00	7.00
PIPE DIAMETER (m)	-	-	-	-	-	-	-	0.20	0.20	0.20
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
BANKCUT LENGTH (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT ELEV (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME PARAMETERS:										
FLUME LENGTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK PARAMETERS:										
CREST LENGTH (m)	-	-	-	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-	0.250	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	0.500	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	0.250	-	-	-	-	-	-	-

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Table E21 (Cont.)

ABYUHA/JUL/KOT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON DISTRIBUTION CANAL (CONTINUED)

PARAMETER	PARAMETER VALUES FOR EACH STATION									
	STA(21)	STA(22)	STA(23)	STA(24)	STA(25)	STA(26)	STA(27)	STA(28)	STA(29)	STA(30)
STATION TYPE	3A	3A	3A	5	3A	5	3A	3A	3A	5
FARM CHANNEL CODE NO.	T5	T6	17		T7		19	T8	T9	
DISTANCE TO STATION (m)	1600	1642	1700	1710	1716	1815	1850	1080	1881	1990
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	-	-	-	-
SECTION PARAMETERS:										
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
TURNOUT PARAMETERS:										
PIPE TURNOUT										
FRICTION FACTOR	0.030	0.030	0.030	-	0.030	-	0.030	0.030	0.030	-
PIPE LENGTH (m)	7.00	7.00	6.00	-	7.00	-	7.00	7.00	7.00	-
PIPE DIAMETER (m)	0.20	0.20	0.20	-	0.20	-	0.20	0.20	0.20	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
BANKCUT LENGTH (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT ELEV (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME PARAMETERS:										
FLUME LENGTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK PARAMETERS:										
CREST LENGTH (m)	-	-	-	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	0.250	-	0.250	-	-	-	0.250
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-	-	-	-	-	-

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Table E21 (Cont.)

ARYHUA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON DISTRIBUTION CANAL (CONTINUED)

PARAMETER	PARAMETER VALUES FOR EACH STATION									
	STA(31)	STA(32)	STA(33)	STA(34)	STA(35)	STA(36)	STA(37)	STA(38)	STA(39)	STA(40)
STATION TYPE	6A	6A	3A	6A	3A	[illegible]	3A	6A	6A	3A
FARM CHANNEL CODE NO.			20		21		22			23
DISTANCE TO STATION (m)	2020	2029	2177	2275	2330	2400	2545	2627	2637	2756
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	-	-	-	-
SECTION PARAMETERS:										
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	2.00	3.00	3.00	2.00	2.00	2.00	2.00	1.50	2.00	2.00
TURNOUT PARAMETERS:										
PIPE TURNOUT										
FRICTION FACTOR	-	-	0.020	-	0.024	-	0.022	-	-	0.020
PIPE LENGTH (m)	-	-	8.00	-	9.00	-	7.00	-	-	8.00
PIPE DIAMETER (m)	-	-	0.70	-	0.40	-	0.65	-	-	0.70
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
BANKCUT LENGTH (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT ELEV (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME PARAMETERS:										
FLUME LENGTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK PARAMETERS:										
CREST LENGTH (m)	-	-	-	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	1.000	-	-	-	-	-	-	1.000	-
CONTRACTION LOSS COEFF	0.500	-	-	0.100	-	-	-	0.500	-	-

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Table E21(Cont.)

ABYUHA/JUL/FOT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON DISTRIBUTION CANAL (CONTINUED)

PARAMETER	STA(41)	STA(42)	STA(43)	STA(44)	STA(45)	STA(46)	STA(47)	STA(48)	STA(49)	STA(50)
	PARAMETER VALUES FOR EACH STATION									
STATION TYPE	7	3A	7	3A	6A	3A	7	6A	6A	3A
FARM CHANNEL CODE NO.		25		26		27				28
DISTANCE TO STATION (m)	2856	2950	3050	3173	3200	3337	3430	3515	3525	3526
BOTTOM ELEV AT STATION (m)	-	-	-	-	-	-	-	-	-	-
SECTION PARAMETERS:										
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	2.00	2.00	2.00	2.00	1.50	1.50	1.50	1.50	1.50	1.50
TURNOUT PARAMETERS:										
PIPE TURNOUT										
FRICTION FACTOR	-	0.026	-	0.026	-	0.026	-	-	-	0.026
PIPE LENGTH (m)	-	7.00	-	9.00	-	7.00	-	-	-	7.00
PIPE DIAMETER (m)	-	0.30	-	0.35	-	0.35	-	-	-	0.30
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
ROUGHNESS COEFF	-	-	-	-	-	-	-	-	-	-
BANKCUT LENGTH (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT ELEV (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME PARAMETERS:										
FLUME LENGTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK PARAMETERS:										
CREST LENGTH (m)	-	-	-	-	-	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-	-	-	-	1.000	-
CONTRACTION LOSS COEFF	-	-	-	-	0.100	-	-	0.500	-	-

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Table E21 (Cont.)

ABYUHA/JUL/ROT2
HYDRAULIC PARAMETER VALUES FOR STATIONS ON DISTRIBUTARY CANAL (CONTINUED)

PARAMETER	PARAMETER VALUES FOR EACH STATION STA(51)	 STA(52)	 STA(53)	 STA(54)	 STA(55)
STATION TYPE	7	3A	7	3A	2
FARM CHANNEL CODE NO.		29		30	
DISTANCE TO STATION (m)	3625	3734	3830	3918	4081
BOTTOM ELEV AT STATION (m)	-	-	-	-	39.49
SECTION PARAMETERS:					
HYDRAULIC ROUGHNESS	0.040	0.040	0.040	0.040	0.040
SIDE SLOPE	1.00	1.00	1.00	1.00	1.00
BOTTOM SLOPE (m/m)	0.00010	0.00010	0.00010	0.00010	0.00010
BOTTOM WIDTH (m)	1.50	1.50	1.50	1.50	1.50
TURNOUT/CULVERT PARAMETERS:					
PIPE TURNT OR CULVT					
FRICTION FACTOR	-	0.024	-	0.026	-
PIPE LENGTH (m)	-	8.00	-	8.00	-
PIPE DIAMETER (m)	-	0.40	-	0.30	-
GATE SETTING (m)	-	-	-	0.18	-
SIPHON TUBE TURNOUT					
ROUGHNESS COEFF	-	-	-	-	-
ENTRANCE COEFF	-	-	-	-	-
SIPHON LENGTH (m)	-	-	-	-	-
SIPHON DIA (m)	-	-	-	-	-
BANKCUT TURNOUT					
ROUGHNESS COEFF	-	-	-	-	-
BANKCUT LENGTH (m)	-	-	-	-	-
BANKCUT ELEV (m)	-	-	-	-	-
BANKCUT WIDTH (m)	-	-	-	-	-
FLUME PARAMETERS:					
FLUME LENGTH (m)	-	-	-	-	-
FLUME WIDTH (m)	-	-	-	-	-
SUBMERGENCE RATIO	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-
CHECK PARAMETERS:					
CREST LENGTH (m)	-	-	-	-	-
CREST ELEVATION (m)	-	-	-	-	-
BEND LOSS COEFFICIENT	-	-	-	-	-
ENLARGEMENT LOSS COEFF	-	-	-	-	-
CONTRACTION LOSS COEFF	-	-	-	-	-

Table E22

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FCT2

VARIABLE	VARIABLE VALUES FOR EACH STATION		
	STA(1)	STA(2)	STA(3)
STATION TYPE	1	3C	2
FARM CHANNEL CODE NO.			
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	40.25	40.25	40.25
FLOW RATE IN SECTION (m†3/s)	0.020	0.020	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00004	0.00000
FLOW VARIABLES UPSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0568	0.0000
FLOW VARIABLES DOWNSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0000	0.0000
TURNOUT VARIABLES			
ACTUAL FLOW RATE (m†3/s)	-	0.020	-
TRNT HEAD LOSS (m)	-	0.012	-
PIPE TURNOUT			
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
BANKCUT WIDTH (m)	-	0.200	-
FLUME VARIABLES			
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK VARIABLES			
CREST ELEVATION (m)	-	-	-
CULVERT HEAD LOSS			

Table E23

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FCT3

VARIABLE	VARIABLE VALUES FOR EACH STATION STA(1)	STA(2)	STA(3)
STATION TYPE	1	3C	2
FARM CHANNEL CODE NO.			
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	40.25	40.25	40.25
FLOW RATE IN SECTION (m↑3/s)	0.020	0.020	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00004	0.00000
FLOW VARIABLES UPSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0568	0.0000
FLOW VARIABLES DOWNSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0000	0.0000
TURNOUT VARIABLES			
ACTUAL FLOW RATE (m↑3/s)	-	0.020	-
TRNT HEAD LOSS (m)	-	0.012	-
PIPE TURNOUT			
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
BANKCUT WIDTH (m)	-	0.200	-
FLUME VARIABLES			
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK VARIABLES			
CREST ELEVATION (m)	-	-	-
CULVERT HEAD LOSS			

Table E24

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FCT4

VARIABLE	VARIABLE VALUES FOR EACH STATION		
	STA(1)	STA(2)	STA(3)
STATION TYPE	1	3C	2
FARM CHANNEL CODE NO.			
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	40.25	40.25	40.25
FLOW RATE IN SECTION (m†3/s)	0.020	0.020	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00004	0.00000
FLOW VARIABLES UPSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0568	0.0000
FLOW VARIABLES DOWNSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0000	0.0000
TURNOUT VARIABLES			
ACTUAL FLOW RATE (m†3/s)	-	0.020	-
TRNT HEAD LOSS (m)	-	0.012	-
PIPE TURNOUT			
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
BANKCUT WIDTH (m)	-	0.200	-
FLUME VARIABLES			
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK VARIABLES			
CREST ELEVATION (m)	-	-	-
CULVERT HEAD LOSS			

Table E25

ABYUHA/JUL/ROT2
HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FCT5

VARIABLE	STA(1)	STA(2)	STA(3)
	VARIABLE VALUES FOR EACH STATION		
STATION TYPE	1	3C	2
FARM CHANNEL CODE NO.			
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	40.25	40.25	40.25
FLOW RATE IN SECTION (m†3/s)	0.020	0.020	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00004	0.00000
FLOW VARIABLES UPSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0568	0.0000
FLOW VARIABLES DOWNSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0000	0.0000
TURNOUT VARIABLES			
ACTUAL FLOW RATE (m†3/s)	-	0.020	-
TRNT HEAD LOSS (m)	-	0.012	-
PIPE TURNOUT			
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
BANKCUT WIDTH (m)	-	0.200	-
FLUME VARIABLES			
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK VARIABLES			
CREST ELEVATION (m)	-	-	-
CULVERT HEAD LOSS			

Table E26

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FCT6

VARIABLE	STA(1)	STA(2)	STA(3)
	VARIABLE VALUES FOR EACH STATION		
STATION TYPE	1	3C	2
FARM CHANNEL CODE NO.			
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	40.25	40.25	40.25
FLOW RATE IN SECTION (m↑3/s)	0.020	0.020	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00004	0.00000
FLOW VARIABLES UPSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0568	0.0000
FLOW VARIABLES DOWNSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0000	0.0000
TURNOUT VARIABLES			
ACTUAL FLOW RATE (m↑3/s)	-	0.020	-
TRNT HEAD LOSS (m)	-	0.012	-
PIPE TURNOUT			
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
BANKCUT WIDTH (m)	-	0.200	-
FLUME VARIABLES			
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK VARIABLES			
CREST ELEVATION (m)	-	-	-
CULVERT HEAD LOSS			

Table E27

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC17

VARIABLE	VARIABLE VALUES FOR EACH STATION			
	STA(1)	STA(2)	STA(3)	STA(4)
STATION TYPE	1	7	3C	2
FARM CHANNEL CODE NO.				
DISTANCE TO STATION (m)	0	50	99	100
BOTTOM ELEV AT STATION (m)	40.46	40.45	40.44	40.44
FLOW RATE IN SECTION (m↑3/s)	0.020	0.020	0.020	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00020	0.00020	0.00000
FLOW VARIABLES UPSTREAM				
WATER SURF ELEV (m)	40.757	40.747	40.738	40.738
FLOW DEPTH (m)	0.297	0.297	0.298	0.298
FLOW VELOCITY (m/s)	0.1042	0.1041	0.1037	0.0000
FLOW VARIABLES DOWNSTREAM				
WATER SURF ELEV (m)	40.757	40.747	40.738	40.738
FLOW DEPTH (m)	0.297	0.297	0.298	0.298
FLOW VELOCITY (m/s)	0.1042	0.1039	0.0000	0.0000
TURNOUT VARIABLES				
ACTUAL FLOW RATE (m↑3/s)	-	-	0.020	-
TRNT HEAD LOSS (m)	-	-	0.018	-
PIPE TURNOUT				
PIPE DIAMETER (m)	-	-	-	-
GATE SETTING (m)	-	-	-	-
SIPHON TUBE TURNOUT				
SIPHON DIA (m)	-	-	-	-
BANKCUT TURNOUT				
BANKCUT WIDTH (m)	-	-	0.200	-
FLUME VARIABLES				
SUBMERGENCE RATIO	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-
CHECK VARIABLES				
CREST ELEVATION (m)	-	-	-	-
CULVERT HEAD LOSS				

Table E28

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FCT7

VARIABLE	VARIABLE VALUES FOR EACH STATION STA(1)	STA(2)	STA(3)
STATION TYPE	1	3C	2
FARM CHANNEL CODE NO.			
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	40.25	40.25	40.25
FLOW RATE IN SECTION (m↑3/s)	0.020	0.020	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00004	0.00000
FLOW VARIABLES UPSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0568	0.0000
FLOW VARIABLES DOWNSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0000	0.0000
TURNOUT VARIABLES			
ACTUAL FLOW RATE (m↑3/s)	-	0.020	-
TRNT HEAD LOSS (m)	-	0.012	-
PIPE TURNOUT			
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
BANKCUT WIDTH (m)	-	0.200	-
FLUME VARIABLES			
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK VARIABLES			
CREST ELEVATION (m)	-	-	-
CULVERT HEAD LOSS			

Table E29

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC19

VARIABLE	VARIABLE VALUES FOR EACH STATION				
	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)
STATION TYPE	1	7	7	3C	2
FARM CHANNEL CODE NO.					
DISTANCE TO STATION (m)	0	100	125	150	260
BOTTOM ELEV AT STATION (m)	40.36	40.33	40.32	40.31	40.28
FLOW RATE IN SECTION (m↑3/s)	0.023	0.023	0.023	0.023	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00010	0.00009	0.00008	0.00000
FLOW VARIABLES UPSTREAM					
WATER SURF ELEV (m)	40.727	40.717	40.715	40.713	40.713
FLOW DEPTH (m)	0.369	0.389	0.394	0.400	0.433
FLOW VELOCITY (m/s)	0.0873	0.0806	0.0789	0.0771	0.0000
FLOW VARIABLES DOWNSTREAM					
WATER SURF ELEV (m)	40.727	40.717	40.715	40.713	40.713
FLOW DEPTH (m)	0.369	0.389	0.394	0.400	0.433
FLOW VELOCITY (m/s)	0.0873	0.0805	0.0788	0.0000	0.0000
TURNOUT VARIABLES					
ACTUAL FLOW RATE (m↑3/s)	-	-	-	0.023	-
TRNT HEAD LOSS (m)	-	-	-	0.023	-
PIPE TURNOUT					
PIPE DIAMETER (m)	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-
SIPHON TUBE TURNOUT					
SIPHON DIA (m)	-	-	-	-	-
BANKCUT TURNOUT					
BANKCUT WIDTH (m)	-	-	-	0.200	-
FLUME VARIABLES					
SUBMERGENCE RATIO	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-
CHECK VARIABLES					
CREST ELEVATION (m)	-	-	-	-	-
CULVERT HEAD LOSS					

Table E30

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FCT8

VARIABLE	VARIABLE VALUES FOR EACH STATION		
	STA(1)	STA(2)	STA(3)
STATION TYPE	1	3C	2
FARM CHANNEL CODE NO.			
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	40.25	40.25	40.25
FLOW RATE IN SECTION (m†3/s)	0.020	0.020	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00004	0.00000
FLOW VARIABLES UPSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0568	0.0000
FLOW VARIABLES DOWNSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0000	0.0000
TURNOUT VARIABLES			
ACTUAL FLOW RATE (m†3/s)	-	0.020	-
TRNT HEAD LOSS (m)	-	0.012	-
PIPE TURNOUT			
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
BANKCUT WIDTH (m)	-	0.200	-
FLUME VARIABLES			
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK VARIABLES			
CREST ELEVATION (m)	-	-	-
CULVERT HEAD LOSS			

Table E31

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FCT9

VARIABLE	VARIABLE VALUES FOR EACH STATION		
	STA(1)	STA(2)	STA(3)
STATION TYPE	1	3C	2
FARM CHANNEL CODE NO.			
DISTANCE TO STATION (m)	0	29	30
BOTTOM ELEV AT STATION (m)	40.25	40.25	40.25
FLOW RATE IN SECTION (m↑3/s)	0.020	0.020	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00004	0.00000
FLOW VARIABLES UPSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0568	0.0000
FLOW VARIABLES DOWNSTREAM			
WATER SURF ELEV (m)	40.753	40.752	40.752
FLOW DEPTH (m)	0.500	0.502	0.502
FLOW VELOCITY (m/s)	0.0571	0.0000	0.0000
TURNOUT VARIABLES			
ACTUAL FLOW RATE (m↑3/s)	-	0.020	-
TRNT HEAD LOSS (m)	-	0.012	-
PIPE TURNOUT			
PIPE DIAMETER (m)	-	-	-
GATE SETTING (m)	-	-	-
SIPHON TUBE TURNOUT			
SIPHON DIA (m)	-	-	-
BANKCUT TURNOUT			
BANKCUT WIDTH (m)	-	0.200	-
FLUME VARIABLES			
SUBMERGENCE RATIO	-	-	-
FLUME FLOOR ELEV (m)	-	-	-
CHECK VARIABLES			
CREST ELEVATION (m)	-	-	-
CULVERT HEAD LOSS			

Table E32

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC20

VARIABLE	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	STA(8)	STA(9)	STA(10)
STATION TYPE	1	7	7	7	7	7	7	7	7	7
FARM CHANNEL CODE NO.										
DISTANCE TO STATION (m)	0	100	200	300	400	500	600	700	800	900
BOTTOM ELEV AT STATION (m)	39.92	39.89	39.86	39.83	39.80	39.77	39.74	39.71	39.68	39.65
FLOW RATE IN SECTION (m†3/s)	0.194	0.194	0.194	0.194	0.194	0.194	0.194	0.193	0.193	0.193
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00025	0.00024	0.00023	0.00022	0.00021	0.00020	0.00019	0.00018	0.00017
FLOW VARIABLES UPSTREAM										
WATER SURF ELEV (m)	40.746	40.721	40.697	40.674	40.652	40.630	40.610	40.591	40.573	40.556
FLOW DEPTH (m)	0.823	0.828	0.834	0.841	0.849	0.857	0.867	0.878	0.890	0.903
FLOW VELOCITY (m/s)	0.2011	0.1990	0.1964	0.1936	0.1905	0.1871	0.1834	0.1795	0.1753	0.1709
FLOW VARIABLES DOWNSTREAM										
WATER SURF ELEV (m)	40.746	40.721	40.697	40.674	40.652	40.630	40.610	40.591	40.573	40.556
FLOW DEPTH (m)	0.823	0.828	0.834	0.841	0.849	0.857	0.867	0.878	0.890	0.903
FLOW VELOCITY (m/s)	0.2011	0.1989	0.1963	0.1935	0.1904	0.1870	0.1833	0.1794	0.1752	0.1708
TURNOUT VARIABLES										
ACTUAL FLOW RATE (m†3/s)	-	-	-	-	-	-	-	-	-	-
TRNT HEAD LOSS (m)	-	-	-	-	-	-	-	-	-	-
PIPE TURNOUT										
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME VARIABLES										
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK VARIABLES										
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
CULVERT HEAD LOSS										

Table E32 (Cont.)

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC20 (CONTINUED)

VARIABLE	VARIABLE VALUES FOR EACH STATION									
	STA(11)	STA(12)	STA(13)	STA(14)	STA(15)	STA(16)	STA(17)	STA(18)	STA(19)	STA(20)
STATION TYPE	7	3C	3C	3C	3C	3C	3C	3C	3C	2
FARM CHANNEL CODE NO.								T2	T3	T4
DISTANCE TO STATION (m)	1000	1051	1058	1065	1072	1079	1086	1093	1100	2110
BOTTOM ELEV AT STATION (m)	39.60	39.59	39.59	39.58	39.58	39.58	39.58	39.58	39.57	39.27
FLOW RATE IN SECTION (m†3/s)	0.193	0.193	0.169	0.145	0.121	0.097	0.073	0.049	0.025	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00015	0.00013	0.00010	0.00007	0.00005	0.00003	0.00002	0.00001	0.00000	0.00000
FLOW VARIABLES UPSTREAM										
WATER SURF ELEV (m)	40.541	40.534	40.534	40.534	40.534	40.534	40.534	40.534	40.534	40.534
FLOW DEPTH (m)	0.938	0.946	0.948	0.950	0.953	0.955	0.957	0.959	0.961	1.264
FLOW VELOCITY (m/s)	0.1599	0.1574	0.1373	0.1174	0.0976	0.0779	0.0584	0.0390	0.0198	0.0000
FLOW VARIABLES DOWNSTREAM										
WATER SURF ELEV (m)	40.541	40.535	40.534	40.534	40.534	40.534	40.534	40.534	40.534	40.534
FLOW DEPTH (m)	0.938	0.947	0.949	0.951	0.953	0.955	0.957	0.959	0.961	1.264
FLOW VELOCITY (m/s)	0.1598	0.1377	0.1177	0.0979	0.0782	0.0586	0.0392	0.0199	0.0000	0.0000
TURNOUT VARIABLES										
ACTUAL FLOW RATE (m†3/s)	–	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	–
TRNT HEAD LOSS (m)	–	0.024	0.024	0.024	0.024	0.024	0.024	0.024	0.024	–
PIPE TURNOUT										
PIPE DIAMETER (m)	–	–	–	–	–	–	–	–	–	–
GATE SETTING (m)	–	–	–	–	–	–	–	–	–	–
SIPHON TUBE TURNOUT										
SIPHON DIA (m)	–	–	–	–	–	–	–	–	–	–
BANKCUT TURNOUT										
BANKCUT WIDTH (m)	–	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	–
FLUME VARIABLES										
SUBMERGENCE RATIO	–	–	–	–	–	–	–	–	–	–
FLUME FLOOR ELEV (m)	–	–	–	–	–	–	–	–	–	–
CHECK VARIABLES										
CREST ELEVATION (m)	–	–	–	–	–	–	–	–	–	–
CULVERT HEAD LOSS										

Table E33

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC21

VARIABLE	VARIABLE VALUES FOR EACH STATION									
	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	STA(8)	STA(9)	STA(10)
STATION TYPE	1	7	7	7	7	7	7	7	7	3C
FARM CHANNEL CODE NO.										
DISTANCE TO STATION (m)	0	100	200	300	400	500	600	700	800	915
BOTTOM ELEV AT STATION (m)	40.01	39.98	39.95	39.92	39.89	39.86	39.83	39.80	39.77	39.73
FLOW RATE IN SECTION (m↑3/s)	0.152	0.152	0.152	0.152	0.151	0.151	0.151	0.151	0.151	0.151
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00026	0.00025	0.00025	0.00024	0.00023	0.00022	0.00020	0.00019	0.00018
FLOW VARIABLES UPSTREAM										
WATER SURF ELEV (m)	40.739	40.713	40.688	40.663	40.639	40.617	40.595	40.575	40.556	40.535
FLOW DEPTH (m)	0.730	0.734	0.739	0.744	0.751	0.758	0.767	0.776	0.787	0.801
FLOW VELOCITY (m/s)	0.1924	0.1906	0.1885	0.1860	0.1833	0.1802	0.1767	0.1729	0.1688	0.1637
FLOW VARIABLES DOWNSTREAM										
WATER SURF ELEV (m)	40.739	40.713	40.688	40.663	40.639	40.617	40.595	40.575	40.556	40.536
FLOW DEPTH (m)	0.730	0.734	0.739	0.744	0.751	0.758	0.767	0.776	0.787	0.802
FLOW VELOCITY (m/s)	0.1924	0.1905	0.1884	0.1859	0.1831	0.1800	0.1766	0.1728	0.1687	0.1364
TURNOUT VARIABLES										
ACTUAL FLOW RATE (m↑3/s)	-	-	-	-	-	-	-	-	-	0.025
TRNT HEAD LOSS (m)	-	-	-	-	-	-	-	-	-	0.025
PIPE TURNOUT										
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	0.200
FLUME VARIABLES										
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK VARIABLES										
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
CULVERT HEAD LOSS	-	-	-	-	-	-	-	-	-	-

Table E33 (Cont.)

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC21 (CONTINUED)

VARIABLE	STA(11)	STA(12)	STA(13)	STA(14)	STA(15)	STA(16)
	VARIABLE VALUES FOR EACH STATION					
STATION TYPE	3C	3C	3C	3C	3C	2
FARM CHANNEL CODE NO.						
DISTANCE TO STATION (m)	922	929	936	943	950	1895
BOTTOM ELEV AT STATION (m)	39.71	39.71	39.71	39.71	39.70	39.42
FLOW RATE IN SECTION (m†3/s)	0.126	0.101	0.076	0.051	0.026	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00011	0.00007	0.00004	0.00002	0.00000	0.00000
FLOW VARIABLES UPSTREAM						
WATER SURF ELEV (m)	40.535	40.535	40.536	40.536	40.536	40.536
FLOW DEPTH (m)	0.823	0.825	0.828	0.830	0.832	1.116
FLOW VELOCITY (m/s)	0.1304	0.1041	0.0779	0.0520	0.0264	0.0000
FLOW VARIABLES DOWNSTREAM						
WATER SURF ELEV (m)	40.536	40.536	40.536	40.536	40.536	40.536
FLOW DEPTH (m)	0.824	0.826	0.828	0.830	0.832	1.116
FLOW VELOCITY (m/s)	0.1044	0.0782	0.0522	0.0265	0.0000	0.0000
TURNOUT VARIABLES						
ACTUAL FLOW RATE (m†3/s)	0.025	0.025	0.025	0.025	0.025	-
TRNT HEAD LOSS (m)	0.025	0.025	0.026	0.026	0.026	-
PIPE TURNOUT						
PIPE DIAMETER (m)	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-
SIPHON TUBE TURNOUT						
SIPHON DIA (m)	-	-	-	-	-	-
BANKOUT TURNOUT						
BANKOUT WIDTH (m)	0.200	0.200	0.200	0.200	0.200	-
FLUME VARIABLES						
SUBMERGENCE RATIO	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-
CHECK VARIABLES						
CREST ELEVATION (m)	-	-	-	-	-	-
CULVERT HEAD LOSS						

Table E34

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC22

VARIABLE	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	STA(8)	STA(9)	STA(10)
	VARIABLE VALUES FOR EACH STATION									
STATION TYPE	1	7	7	7	7	7	7	7	7	3C
FARM CHANNEL CODE NO.										
DISTANCE TO STATION (m)	0	100	200	300	400	500	600	700	800	930
BOTTOM ELEV AT STATION (m)	39.75	39.72	39.69	39.66	39.63	39.60	39.57	39.54	39.51	39.47
FLOW RATE IN SECTION (m3/s)	0.277	0.277	0.277	0.277	0.277	0.277	0.276	0.276	0.276	0.276
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00027	0.00026	0.00026	0.00025	0.00025	0.00024	0.00023	0.00023	0.00022
FLOW VARIABLES UPSTREAM										
WATER SURF ELEV (m)	40.693	40.666	40.640	40.614	40.588	40.564	40.540	40.516	40.494	40.466
FLOW DEPTH (m)	0.947	0.951	0.954	0.958	0.963	0.968	0.974	0.981	0.988	0.999
FLOW VELOCITY (m/s)	0.2253	0.2240	0.2225	0.2200	0.2189	0.2167	0.2143	0.2117	0.2089	0.2047
FLOW VARIABLES DOWNSTREAM										
WATER SURF ELEV (m)	40.693	40.666	40.640	40.614	40.588	40.564	40.540	40.516	40.494	40.457
FLOW DEPTH (m)	0.947	0.951	0.954	0.958	0.963	0.968	0.974	0.991	0.988	1.000
FLOW VELOCITY (m/s)	0.2253	0.2240	0.2224	0.2207	0.2100	0.2166	0.2143	0.2116	0.2088	0.1860
TURNOUT VARIABLES										
ACTUAL FLOW RATE (m3/s)	-	-	-	-	-	-	-	-	-	0.025
TRNT HEAD LOSS (m)	-	-	-	-	-	-	-	-	-	0.026
PIPE TURNOUT										
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKOUT TURNOUT										
BANKOUT WIDTH (m)	-	-	-	-	-	-	-	-	-	0.200
FLUME VARIABLES										
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK VARIABLES										
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
CULVERT HEAD LOSS	-	-	-	-	-	-	-	-	-	-

Table E34 (Cont.)

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC22 (CONTINUED)

VARIABLE	VARIABLE VALUES FOR EACH STATION									
	STA(11)	STA(12)	STA(13)	STA(14)	STA(15)	STA(16)	STA(17)	STA(18)	STA(19)	STA(20)
STATION TYPE	3C	3C	3C	3C	3C	3C	3C	3C	3C	3C
FARM CHANNEL CODE NO.								T2	T3	T4
DISTANCE TO STATION (m)	937	944	951	958	965	972	979	986	993	1000
BOTTOM ELEV AT STATION (m)	39.44	39.44	39.44	39.44	39.44	39.43	39.43	39.43	39.43	39.43
FLOW RATE IN SECTION (m↑3/s)	0.251	0.226	0.201	0.176	0.151	0.126	0.101	0.076	0.051	0.026
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00017	0.00013	0.00010	0.00008	0.00006	0.00004	0.00002	0.00001	0.00001	0.00000
FLOW VARIABLES UPSTREAM										
WATER SURF ELEV (m) FLOW DEPTH (m) FLOW VELOCITY (m/s)	40.466 1.021 0.1793	40.465 1.023 0.1610	40.465 1.025 0.1427	40.465 1.027 0.1245	40.465 1.029 0.1064	40.465 1.032 0.0885	40.466 1.034 0.0707	40.466 1.036 0.0530	40.466 1.038 0.0355	40.466 1.040 0.0180
FLOW VARIABLES DOWNSTREAM										
WATER SURF ELEV (m) FLOW DEPTH (m) FLOW VELOCITY (m/s)	40.466 1.022 0.1613	40.466 1.024 0.1430	40.466 1.026 0.1248	40.466 1.028 0.1068	40.466 1.030 0.0880	40.466 1.032 0.0709	40.466 1.034 0.0532	40.466 1.036 0.0356	40.466 1.038 0.0181	40.465 1.040 0.0030
TURNOUT VARIABLES										
ACTUAL FLOW RATE (m↑3/s)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
TRNT HEAD LOSS (m)	0.026	0.025	0.025	0.025	0.025	0.025	0.026	0.026	0.026	0.026
PIPE TURNOUT										
PIPE DIAMETER (m) GATE SETTING (m)	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
SIPHON TUBE TURNOUT										
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKOUT TURNOUT										
BANKOUT WIDTH (m)	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200
FLUME VARIABLES										
SUBMERGENCE RATIO FLUME FLOOR ELEV (m)	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
CHECK VARIABLES										
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
CULVERT HEAD LOSS	-	-	-	-	-	-	-	-	-	-

Table E34 (Cont.)

ARYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC22 (CONTINUED)

VARIABLE	VARIABLE VALUES FOR EACH STATION STA(21)	
STATION TYPE	2	
FARM CHANNEL CODE NO.	T5	
DISTANCE TO STATION (m)	2005	
BOTTOM ELEV AT STATION (m)	39.10	39.10
FLOW RATE IN SECTION (m↑3/s)	0.000	
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	
FLOW VARIABLES UPSTREAM		
WATER SURF ELEV (m)	40.466	
FLOW DEPTH (m)	1.366	
FLOW VELOCITY (m/s)	0.0000	
FLOW VARIABLES DOWNSTREAM		
WATER SURF ELEV (m)	40.466	
FLOW DEPTH (m)	1.366	
FLOW VELOCITY (m/s)	0.0000	
TURNOUT VARIABLES		
ACTUAL FLOW RATE (m↑3/s)	-	
TRNT HEAD LOSS (m)	-	
PIPE TURNOUT		
PIPE DIAMETER (m)	-	
GATE SETTING (m)	-	
SIPHON TUBE TURNOUT		
SIPHON DIA (m)	-	
BANKCUT TURNOUT		
BANKCUT WIDTH (m)	-	
FLUME VARIABLES		
SUBMERGENCE RATIO	-	
FLUME FLOOR ELEV (m)	-	
CHECK VARIABLES		
CREST ELEVATION (m)	-	
CULVERT HEAD LOSS		

Table E35

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC23

VARIABLE	VARIABLE VALUES FOR EACH STATION								
	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	STA(8)	STA(9)
STATION TYPE	1	3C	3C	3C	3C	3C	3C	3C	2
FARM CHANNEL CODE NO.									
DISTANCE TO STATION (m)	0	40	50	60	70	80	90	100	2080
BOTTOM ELEV AT STATION (m)	39.78	39.77	39.77	39.77	39.76	39.76	39.76	39.75	39.16
FLOW RATE IN SECTION (m†3/s)	0.147	0.147	0.126	0.105	0.084	0.063	0.042	0.021	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00009	0.00007	0.00005	0.00003	0.00002	0.00001	0.00000	0.00000
FLOW VARIABLES UPSTREAM									
WATER SURF ELEV (m)	40.688	40.685	40.685	40.684	40.685	40.685	40.685	40.685	40.685
FLOW DEPTH (m)	0.904	0.913	0.916	0.918	0.922	0.925	0.928	0.931	1.525
FLOW VELOCITY (m/s)	0.1296	0.1275	0.1087	0.0901	0.0717	0.0535	0.0354	0.0176	0.0000
FLOW VARIABLES DOWNSTREAM									
WATER SURF ELEV (m)	40.688	40.685	40.685	40.685	40.685	40.685	40.685	40.685	40.685
FLOW DEPTH (m)	0.904	0.913	0.916	0.919	0.922	0.925	0.928	0.931	1.525
FLOW VELOCITY (m/s)	0.1296	0.1092	0.0906	0.0721	0.0537	0.0356	0.0177	0.0000	0.0000
TURNOUT VARIABLES									
ACTUAL FLOW RATE (m†3/s)	-	0.021	0.021	0.021	0.021	0.021	0.021	0.021	-
TRNT HEAD LOSS (m)	-	0.025	0.025	0.024	0.025	0.025	0.025	0.025	-
PIPE TURNOUT									
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT									
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT									
BANKCUT WIDTH (m)	-	0.180	0.180	0.180	0.180	0.180	0.180	0.180	-
FLUME VARIABLES									
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-
CHECK VARIABLES									
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-
CULVERT HEAD LOSS									

Table E36

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC25

VARIABLE	VARIABLE VALUES FOR EACH STATION						
	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)
STATION TYPE	1	3C	3C	3C	3C	3C	2
FARM CHANNEL CODE NO.							
DISTANCE TO STATION (m)	0	72	79	86	93	100	985
BOTTOM ELEV AT STATION (m)	39.98	39.95	39.95	39.95	39.95	39.95	39.60
FLOW RATE IN SECTION (m↑3/s)	0.116	0.116	0.093	0.070	0.047	0.024	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00010	0.00006	0.00003	0.00001	0.00000	0.00000
FLOW VARIABLES UPSTREAM							
WATER SURF ELEV (m) FLOW DEPTH (m) FLOW VELOCITY (m/s)	40.779 0.803 0.1251	40.772 0.818 0.1213	40.772 0.820 0.0968	40.772 0.823 0.0725	40.773 0.825 0.0484	40.773 0.827 0.0245	40.773 1.093 0.0000
FLOW VARIABLES DOWNSTREAM							
WATER SURF ELEV (m) FLOW DEPTH (m) FLOW VELOCITY (m/s)	40.779 0.803 0.1251	40.773 0.819 0.0971	40.773 0.821 0.0727	40.773 0.823 0.0486	40.773 0.825 0.0246	40.773 0.827 0.0000	40.773 1.093 0.0000
TURNOUT VARIABLES							
ACTUAL FLOW RATE (m↑3/s)	-	0.023	0.023	0.023	0.023	0.023	-
TRNT HEAD LOSS (m)	-	0.022	0.022	0.022	0.023	0.023	-
PIPE TURNOUT							
PIPE DIAMETER (m) GATE SETTING (m)	- -	- -	- -	- -	- -	- -	- -
SIPHON TUBE TURNOUT							
SIPHON DIA (m)	-	-	-	-	-	-	-
BANKCUT TURNOUT							
BANKCUT WIDTH (m)	-	0.200	0.200	0.200	0.200	0.200	-
FLUME VARIABLES							
SUBMERGENCE RATIO FLUME HEAD LOSS (m)		- -	- -	- -	- -		- -
CHECK VARIABLES							
CREST ELEVATION (m)	-	-	-	-	-	-	-
CULVERT HEAD LOSS							

Table E37

ABYUHA/JUI /PUT2
HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC26

VARIABLE	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)
STATION TYPE FARM CHANNEL CODE NO.	1	7	7	3A	3A	3A	2
DISTANCE TO STATION (m)	0	100	200	320	360	400	850
BOTTOM ELEV AT STATION (m)	40.24	40.22	40.20	40.18	40.17	40.[illegible]	40.07
FLOW RATE IN SECTION (m†3/s)	0.091	0.091	0.091	0.091	0.060	0.039	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00016	0.00016	0.00015	0.00007	0.00002	0.00000
FLOW VARIABLES UPSTREAM							
WATER SURF ELEV (m)	40.825	40.809	40.793	40.774	40.773	40.773	40.773
FLOW DEPTH (m)	0.585	0.589	0.593	0.590	0.605	0.613	0.703
FLOW VELOCITY (m/s)	0.1429	0.1415	0.1399	0.1377	0.0705	0.0447	0.0000
FLOW VARIABLES DOWNSTREAM							
WATER SURF ELEV (m)	40.825	40.809	40.[illegible]3	40.775	40.773	40.773	40.773
FLOW DEPTH (m)	0.585	0.589	0.593	0.599	0.605	0.613	0.703
FLOW VELOCITY (m/s)	0.1429	0.1414	0.1397	0.0918	0.0455	0.0000	0.0000
TURNOUT VARIABLES							
ACTUAL FLOW RATE (m†3/s)	-	-	-	0.030	0.029	0.030	-
TRNT HEAD LOSS (m)	-	-	-	0.004	0.003	0.003	-
PIPE TURNOUT							
PIPE DIAMETER (m)	-	-	-	0.20	0.20	0.20	-
GATE SETTING (m)	-	-	-	0.20	0.17	0.20	-
SIPHON TUBE TURNOUT							
SIPHON DIA (m)	-	-	-	-	-	-	-
BANKCUT TURNOUT							
BANKCUT WIDTH (m)	-	-		-	-	-	-
FLUME VARIABLES							
[illegible]	-	-	-	-	-	-	-
[illegible] (m)		-	-	-		-	-
CHECK VARIABLES							
CREST ELEVATION (m)	-	-	-	-	-	-	-
CULVERT HEAD LOSS (m)							

Table E38

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC27

VARIABLE	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)
	VARIABLE VALUES FOR EACH STATION				
STATION TYPE	1	3A	3A	3A	2
FARM CHANNEL CODE NO.					
DISTANCE TO STATION (m)	0	60	80	100	802
BOTTOM ELEV AT STATION (m)	40.24	40.22	40.22	40.21	40.00
FLOW RATE IN SECTION (m↑3/s)	0.069	0.069	0.046	0.023	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00005	0.00002	0.00000	0.00000
FLOW VARIABLES UPSTREAM					
WATER SURF ELEV (m)	40.804	40.801	40.800	40.799	40.799
FLOW DEPTH (m)	0.564	0.578	0.583	0.588	0.799
FLOW VELOCITY (m/s)	0.1418	0.1360	0.0893	0.0440	0.0000
FLOW VARIABLES DOWNSTREAM					
WATER SURF ELEV (m)	40.804	40.801	40.800	40.799	40.799
FLOW DEPTH (m)	0.564	0.578	0.583	0.588	0.799
FLOW VELOCITY (m/s)	0.1418	0.0906	0.0447	0.0000	0.0000
TURNOUT VARIABLES					
ACTUAL FLOW RATE (m↑3/s)	–	0.023	0.023	0.023	–
TRNT HEAD LOSS (m)	–	0.051	0.050	0.049	–
PIPE TURNOUT					
PIPE DIAMETER (m)	–	0.20	0.20	0.20	–
GATE SETTING (m)	–	0.20	0.20	0.20	–
SIPHON TUBE TURNOUT					
SIPHON DIA (m)	–	–	–	–	–
BANKCUT TURNOUT					
BANKCUT WIDTH (m)	–	–	–	–	–
FLUME VARIABLES					
SUBMERGENCE RATIO	–	–	–	–	–
FLUME FLR ELEV (m)	–	–	–	–	–
CHECK VARIABLES					
CREST ELEVATION (m)	–	–	–	–	–

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Table E39

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC28

VARIABLE	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)
STATION TYPE	1	7	7	3C	3C	3C	2
FARM CHANNEL CODE NO.							
DISTANCE TO STATION (m)	0	100	200	236	243	250	700
BOTTOM ELEV AT STATION (m)	40.17	40.14	40.11	40.10	40.10	40.10	39.94
FLOW RATE IN SECTION (m†3/s)	0.064	0.064	0.064	0.064	0.043	0.022	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00006	0.00005	0.00005	0.00002	0.00001	0.00000
FLOW VARIABLES UPSTREAM							
WATER SURF ELEV (m)	40.852	40.846	40.841	40.839	40.839	40.839	40.839
FLOW DEPTH (m)	0.678	0.702	0.727	0.736	0.738	0.740	0.899
FLOW VELOCITY (m/s)	0.0914	0.0863	0.0812	0.0795	0.0529	0.0267	0.0000
FLOW VARIABLES DOWNSTREAM							
WATER SURF ELEV (m)	40.852	40.846	40.841	40.840	40.840	40.839	40.839
FLOW DEPTH (m)	0.678	0.702	0.727	0.736	0.738	0.740	0.899
FLOW VELOCITY (m/s)	0.0914	0.0861	0.0812	0.0532	0.0268	0.0000	0.0000
TURNOUT VARIABLES							
ACTUAL FLOW RATE (m†3/s)	-	-	-	0.021	0.021	0.021	-
TRNT HEAD LOSS (m)	-	-	-	0.019	0.019	0.019	-
PIPE TURNOUT							
PIPE DIAMETER (m)	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT							
SIPHON DIA (m)	-	-	-	-	-	-	-
BANKCUT TURNOUT							
BANKCUT WIDTH (m)	-	-	-	0.200	0.200	0.200	-
FLUME VARIABLES							
SUBMERGENCE RATIO	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-
CHECK VARIABLES							
CREST ELEVATION (m)	-	-	-	-	-	-	-
CULVERT HEAD LOSS							

Table E40

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC29

VARIABLE	VARIABLE VALUES FOR EACH STATION							
	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	STA(8)
STATION TYPE	1	7	7	7	3C	3C	3C	2
FARM CHANNEL CODE NO.								
DISTANCE TO STATION (m)	0	100	200	300	336	343	350	678
BOTTOM ELEV AT STATION (m)	40.05	40.02	39.99	39.96	39.95	39.95	39.95	39.65
FLOW RATE IN SECTION (m†3/s)	0.067	0.067	0.066	0.066	0.066	0.044	0.022	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00009	0.00008	0.00007	0.00006	0.00003	0.00001	0.00000
FLOW VARIABLES UPSTREAM								
WATER SURF ELEV (m)	40.685	40.677	40.669	40.663	40.661	40.661	40.661	40.661
FLOW DEPTH (m)	0.634	0.656	0.678	0.702	0.710	0.713	0.715	0.811
FLOW VELOCITY (m/s)	0.1066	0.1010	0.0953	0.0899	0.0880	0.0585	0.0293	0.0000
FLOW VARIABLES DOWNSTREAM								
WATER SURF ELEV (m)	40.685	40.677	40.669	40.663	40.661	40.661	40.661	40.661
FLOW DEPTH (m)	0.634	0.656	0.678	0.702	0.711	0.713	0.715	0.811
FLOW VELOCITY (m/s)	0.1066	0.1008	0.0952	0.0899	0.0588	0.0294	0.0000	0.0000
TURNOUT VARIABLES								
ACTUAL FLOW RATE (m†3/s)	-	-	-	-	0.022	0.022	0.022	-
TRNT HEAD LOSS (m)	-	-	-	-	0.021	0.021	0.021	-
PIPE TURNOUT								
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT								
SIPHON DIA (m)	-	-	-	-	-	-	-	-
BANKCUT TURNOUT								
BANKCUT WIDTH (m)	-	-	-	-	0.200	0.200	0.200	-
FLUME VARIABLES								
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-
CHECK VARIABLES								
CREST ELEVATION (m)	-	-	-	-	-	-	-	-
CULVERT HEAD LOSS								

Table E41

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON FARM CHANNEL FC30

VARIABLE	VARIABLE VALUES FOR EACH STATION					
	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)
STATION TYPE	1	3C	3C	3C	3C	2
FARM CHANNEL CODE NO.						
DISTANCE TO STATION (m)	0	36	43	50	57	600
BOTTOM ELEV AT STATION (m)	39.98	39.97	39.97	39.97	39.97	39.8[illegible]
FLOW RATE IN SECTION (m†3/s)	0.085	0.085	0.064	0.043	0.022	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00008	0.00005	0.00002	0.00001	0.00000
FLOW VARIABLES UPSTREAM						
WATER SURF ELEV (m)	40.702	40.699	40.699	40.699	40.699	40.699
FLOW DEPTH (m)	0.722	0.726	0.728	0.729	0.731	0.839
FLOW VELOCITY (m/s)	0.1093	0.1082	0.0811	0.0541	0.0273	0.0000
FLOW VARIABLES DOWNSTREAM						
WATER SURF ELEV (m)	40.702	40.699	40.699	40.699	40.699	40.699
FLOW DEPTH (m)	0.722	0.727	0.728	0.729	0.731	0.839
FLOW VELOCITY (m/s)	0.1093	0.0813	0.0542	0.0274	0.0000	0.0000
TURNOUT VARIABLES						
ACTUAL FLOW RATE (m†3/s)	-	0.021	0.021	0.021	0.021	-
TRNT HEAD LOSS (m)	-	0.019	0.019	0.019	0.019	-
PIPE TURNOUT						
PIPE DIAMETER (m)	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-
SIPHON TUBE TURNOUT						
SIPHON DIA (m)	-	-	-	-	-	-
BANKCUT TURNOUT						
BANKCUT WIDTH (m)	-	0.200	0.200	0.200	0.200	-
FLUME VARIABLES						
SUBMERGENCE RATIO	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-
CHECK VARIABLES						
CREST ELEVATION (m)	-	-	-	-	-	-
CULVERT HEAD LOSS						

Table E42

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON DISTRIBUTARY CANAL

VARIABLE	STA(1)	STA(2)	STA(3)	STA(4)	STA(5)	STA(6)	STA(7)	STA(8)	STA(9)	STA(10)
STATION TYPE	1	6A	7	7	4B	5	7	7	7	7
FARM CHANNEL CODE NO.										
DISTANCE TO STATION (m)	0	14	100	200	300	410	500	600	700	800
BOTTOM ELEV AT STATION (m)	39.92	39.92	39.91	39.90	39.89	39.88	39.87	39.86	39.85	39.84
FLOW RATE IN SECTION (m3/s)	1.473	1.473	1.473	1.473	1.473	1.472	1.472	1.472	1.472	1.472
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00067	0.00007	0.00007	0.00007	0.00011	0.00011	0.00011	0.00011	0.00011
FLOW VARIABLES UPSTREAM										
WATER SURF ELEV (m)	41.504	41.495	41.493	41.486	41.480	41.273	41.262	41.252	41.241	41.230
FLOW DEPTH (m)	1.586	1.578	1.585	1.508	1.592	1.396	1.394	1.393	1.392	1.392
FLOW VELOCITY (m/s)	0.4643	0.4667	0.2026	0.2021	0.2015	0.2399	0.2403	0.2404	0.2406	0.2408
FLOW VARIABLES DOWNSTREAM										
WATER SURF ELEV (m)	41.504	41.499	41.493	41.486	41.205	41.272	41.262	41.252	41.241	41.230
FLOW DEPTH (m)	1.586	1.582	1.585	1.588	1.397	1.395	1.394	1.393	1.392	1.392
FLOW VELOCITY (m/s)	0.4643	0.2031	0.2026	0.2021	0.2397	0.2401	0.2402	0.2404	0.2406	0.2408
TURNOUT VARIABLES										
ACTUAL FLOW RATE (m3/s)	-	-	-	-	-	-	-	-	-	-
TRNT HEAD LOSS (m)	-	-	-	-	-	-	-	-	-	-
PIPE TURNOUT										
PIPE DIAMETER (m)	-	-	-	-	-	-	-	-	-	-
GATE SETTING (m)	-	-	-	-	-	-	-	-	-	-
SIPHON TUBE TURNOUT										
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKOUT TURNOUT										
BANKOUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME VARIABLES										
SUBMERGENCE RATIO	-	-	-	-	0.050	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	40.61	-	-	-	-	-
CHECK VARIABLES										
CREST ELEVATION (m)	-	[illegible]	-	[illegible]	[illegible]	[illegible]	-	-	-	-
CULVERT HEAD LOSS										

Table E42 (Cont.)

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON DISTRIBUTARY CANAL (CONTINUED)

VARIABLE	VARIABLE VALUES FOR EACH STATION									
	STA(11)	STA(12)	STA(13)	STA(14)	STA(15)	STA(16)	STA(17)	STA(18)	STA(19)	STA(20)
STATION TYPE	6B	6B	6A	6A	7	7	5	3A	3A	3A
FARM CHANNEL CODE NO.								T2	T3	T4
DISTANCE TO STATION (m)	940	982	1088	1096	1200	1300	1435	1470	1564	1565
BOTTOM ELEV AT STATION (m)	39.80	39.80	39.79	39.79	39.78	39.7[illegible]	39.75	39.75	39.74	39.74
FLOW RATE IN SECTION (m3/s)	1.471	1.471	1.471	1.471	1.471	1.471	1.470	1.470	1.450	1.430
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00011	0.00006	0.00010	0.00030	0.00011	0.00011	0.00011	0.00011	0.00010	0.00010
FLOW VARIABLES UPSTREAM										
WATER SURF ELEV (m)	41.215	41.212	41.201	41.186	41.181	41.[illegible]	41.156	41.151	41.142	41.142
FLOW DEPTH (m)	1.411	1.412	1.412	1.398	1.403	1.4[illegible]	1.401	1.400	1.4[illegible]	1.4[illegible]
FLOW VELOCITY (m/s)	0.2365	0.2361	0.2362	0.3508	0.2381	0.238[illegible]	0.2384	0.2386	0.2354	0.2321
FLOW VARIABLES DOWNSTREAM										
WATER SURF ELEV (m)	41.215	41.212	41.189	41.192	41.181	41.170	41.155	41.152	41.14[illegible]	41.142
FLOW DEPTH (m)	1.411	1.412	1.399	1.404	1.403	1.402	1.401	1.400	1.4[illegible]	1.400
FLOW VELOCITY (m/s)	0.2365	0.2361	0.3504	0.2380	0.2381	0.2382	0.2305	0.2353	0.23[illegible]	0.2288
TURNOUT VARIABLES										
ACTUAL FLOW RATE (m3/s)	-	-	-	-	-	-	-	0.020	0.020	0.020
TRNT HEAD LOSS (m)	-	-	-	-		-	-	0.398	0.3[illegible]	0.3[illegible]7
PIPE TURNOUT										
PIPE DIAMETER (m)	-	-	-	-		-	-	0.20	0.20	0.20
GATE SETTING (m)	-	-	-	-		-	-	0.07	0.07	0.07
SIPHON TUBE TURNOUT										
SIPHON DIA (m)		-	-			-	-	-		-
BANKCUT TURNOUT										
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME VARIABLES										
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME [illegible] ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK VARIABLES										
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-

[illegible]

Table E42 (Cont.)

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON DISTRIBUTARY CANAL (CONTINUED)

VARIABLE	VARIABLE VALUES FOR EACH STATION									
	STA(21)	STA(22)	STA(23)	STA(24)	STA(25)	STA(26)	STA(27)	STA(28)	STA(29)	STA(30)
STATION TYPE	3A	3A	3A	5	3A	5	3A	3A	3A	5
FARM CHANNEL CODE NO.	T5	T6	17		T7		19	T8	T9	
DISTANCE TO STATION (m)	1600	1642	1700	1710	1716	1815	1850	1880	1881	1990
BOTTOM ELEV AT STATION (m)	39.74	39.73	39.73	39.73	39.73	39.72	39.71	39.71	39.71	39.70
FLOW RATE IN SECTION (m↑3/s)	1.410	1.390	1.370	1.350	1.350	1.330	1.329	1.306	1.286	1.266
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00010	0.00010	0.00009	0.00009	0.00009	0.00009	0.00009	0.00008	0.00008	0.00008
FLOW VARIABLES UPSTREAM										
WATER SURF ELEV (m)	41.139	41.135	41.130	41.129	41.128	41.119	41.115	41.113	41.113	41.105
FLOW DEPTH (m)	1.400	1.401	1.401	1.402	1.401	1.402	1.402	1.403	1.403	1.406
FLOW VELOCITY (m/s)	0.2288	0.2255	0.2221	0.2188	0.2189	0.2153	0.2153	0.2115	0.2062	0.2045
FLOW VARIABLES DOWNSTREAM										
WATER SURF ELEV (m)	41.139	41.135	41.130	41.128	41.128	41.119	41.116	41.113	41.113	41.104
FLOW DEPTH (m)	1.401	1.401	1.402	1.401	1.401	1.402	1.403	1.403	1.403	1.405
FLOW VELOCITY (m/s)	0.2255	0.2222	0.2188	0.2189	0.2156	0.2154	0.2116	0.2082	0.2049	0.2046
TURNOUT VARIABLES										
ACTUAL FLOW RATE (m↑3/s)	0.020	0.020	0.020	-	0.020	-	0.026	0.019	0.019	-
TRNT HEAD LOSS (m)	0.386	0.382	0.373	-	0.375	-	0.388	0.360	0.360	-
PIPE TURNOUT										
PIPE DIAMETER (m)	0.20	0.20	0.20	-	0.20	-	0.20	0.20	0.20	-
GATE SETTING (m)	0.07	0.07	0.07	-	0.07	-	0.08	0.07	0.07	-
SIPHON TUBE TURNOUT										
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKOUT TURNOUT										
BANKOUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME VARIABLES										
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-		
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK VARIABLES										
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
CULVERT HEAD LOSS										

Table E42 (Cont.)

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON DISTRIBUTARY CANAL (CONTINUED)

VARIABLE	VARIABLE VALUES FOR EACH STATION									
	STA(31)	STA(32)	STA(33)	STA(34)	STA(35)	STA(36)	STA(37)	STA(38)	STA(39)	STA(40)
STATION TYPE	6A	6A	3A	6A	3A	7	3A	6A	6A	3A
FARM CHANNEL CODE NO.			20		21		22			23
DISTANCE TO STATION (m)	2020	2029	2177	2275	2330	2400	2545	2627	2637	2756
BOTTOM ELEV AT STATION (m)	39.70	39.70	39.68	39.67	39.67	39.66	39.64	39.64	39.63	39.62
FLOW RATE IN SECTION (m↑3/s)	1.266	1.266	1.266	1.072	1.072	0.919	0.919	0.642	0.642	0.642
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00008	0.00069	0.00008	0.00006	0.00011	0.00008	0.00008	0.00004	0.00040	0.00004
FLOW VARIABLES UPSTREAM										
WATER SURF ELEV (m)	41.102	41.074	41.066	41.062	41.050	41.046	41.034	41.033	41.019	41.016
FLOW DEPTH (m)	1.406	1.379	1.386	1.391	1.385	1.388	1.390	1.397	1.385	1.394
FLOW VELOCITY (m/s)	0.2044	0.4591	0.2083	0.1754	0.2205	0.1956	0.1950	0.1352	0.3871	0.1357
FLOW VARIABLES DOWNSTREAM										
WATER SURF ELEV (m)	41.080	41.079	41.068	41.056	41.052	41.046	41.036	41.023	41.021	41.017
FLOW DEPTH (m)	1.384	1.383	1.387	1.386	1.387	1.388	1.392	1.388	1.386	1.394
FLOW VELOCITY (m/s)	0.4573	0.2087	0.1761	0.2283	0.1958	0.1955	0.1359	0.3084	0.1367	0.1045
TURNOUT VARIABLES										
ACTUAL FLOW RATE (m↑3/s)	-	-	0.201	-	0.156	-	0.286	-	-	0.141
TRNT HEAD LOSS (m)	-	-	0.320	-	0.311	-	0.341	-	-	0.327
PIPE TURNOUT										
PIPE DIAMETER (m)	-	-	0.70	-	0.40	-	0.65	-	-	0.70
GATE SETTING (m)	-	-	0.21	-	0.24	-	0.27	-	-	0.17
SIPHON TUBE TURNOUT										
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME VARIABLES										
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK VARIABLES										
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-
CULVERT HEAD LOSS										

Table E42 (Cont.)

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON DISTRIBUTARY CANAL (CONTINUED)

VARIABLE	STA(41)	STA(42)	STA(43)	STA(44)	STA(45)	STA(46)	STA(47)	STA(48)	STA(49)	STA(50)
	VARIABLE VALUES FOR EACH STATION									
STATION TYPE	7	3A	7	3A	6A	3A	7	6A	6A	3A
FARM CHANNEL CODE NO.		25		26		27				28
DISTANCE TO STATION (m)	2856	2950	3050	3173	3200	3337	3430	3515	3525	3526
BOTTOM ELEV AT STATION (m)	39.61	39.60	39.59	39.58	39.58	39.56	39.56	39.55	39.55	39.55
FLOW RATE IN SECTION (m†3/s)	0.494	0.494	0.378	0.378	0.287	0.286	0.217	0.217	0.217	0.217
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00002	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00004	0.00001
FLOW VARIABLES UPSTREAM										
WATER SURF ELEV (m)	41.015	41.012	41.012	41.010	41.010	41.008	41.008	41.007	41.006	41.006
FLOW DEPTH (m)	1.402	1.409	1.418	1.429	1.432	1.444	1.453	1.461	1.460	1.461
FLOW VELOCITY (m/s)	0.1037	0.1029	0.0780	0.0771	0.0583	0.0674	0.0507	0.0502	0.0991	0.0502
FLOW VARIABLES DOWNSTREAM										
WATER SURF ELEV (m)	41.015	41.013	41.012	41.010	41.010	41.008	41.008	41.006	41.006	41.006
FLOW DEPTH (m)	1.402	1.410	1.418	1.430	1.432	1.444	1.453	1.460	1.461	1.461
FLOW VELOCITY (m/s)	0.1036	0.0787	0.0779	0.0585	0.0683	0.0511	0.0506	0.0992	0.0502	0.0354
TURNOUT VARIABLES										
ACTUAL FLOW RATE (m*3/s)	-	0.105	-	0.095	-	0.067	-	-	-	0.064
TRNT HEAD LOSS (m)	-	0.233	-	0.185	-	0.233	-	-	-	0.154
PIPE TURNOUT										
PIPE DIAMETER (m)	-	0.30	-	0.35	-	0.35	-	-	-	0.30
GATE SETTING (m)	-	0.30	-	0.22	-	0.15	-	-	-	0.19
SIPHON TUBE TURNOUT										
SIPHON DIA (m)	-	-	-	-	-	-	-	-	-	-
BANKCUT TURNOUT										
BANKCUT WIDTH (m)	-	-	-	-	-	-	-	-	-	-
FLUME VARIABLES										
SUBMERGENCE RATIO	-	-	-	-	-	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-	-	-	-	-	-
CHECK VARIABLES										
CREST ELEVATION (m)	-	-	-	-	-	-	-	-	-	-

CULVERT VARIABLES

Table E42 (Cont.)

ABYUHA/JUL/ROT2

HYDRAULIC VARIABLE VALUES FOR STATIONS ON DISTRIBUTARY CANAL (CONTINUED)

VARIABLE	VARIABLE VALUES FOR EACH STATION				
	STA(51)	STA(52)	STA(53)	STA(54)	STA(55)
STATION TYPE	7	3A	7	3A	2
FARM CHANNEL CODE NO.		29		30	
DISTANCE TO STATION (m)	3625	3734	3830	3918	4081
BOTTOM ELEV AT STATION (m)	39.54	39.52	39.52	39.51	39.49
FLOW RATE IN SECTION (m3/s)	0.153	0.153	0.086	0.085	0.000
AVERAGE FRICTION SLOPE IN SECTION (m/m)	0.00000	0.00000	0.00000	0.00000	0.00000
FLOW VARIABLES UPSTREAM					
WATER SURF ELEV (m)	41.006	41.006	41.006	41.006	41.006
FLOW DEPTH (m)	1.470	1.481	1.491	1.499	1.516
FLOW VELOCITY (m/s)	0.0350	0.0346	0.0192	0.0190	0.0000
FLOW VARIABLES DOWNSTREAM					
WATER SURF ELEV (m)	41.006	41.006	41.006	41.006	41.006
FLOW DEPTH (m)	1.470	1.481	1.491	1.499	1.516
FLOW VELOCITY (m/s)	0.0350	0.0194	0.0191	0.0000	0.0000
TURNOUT VARIABLES					
ACTUAL FLOW RATE (m3/s)	-	0.073	-	0.085	-
TRNT HEAD LOSS (m)	-	0.321	-	0.304	-
PIPE TURNOUT					
PIPE DIAMETER (m)	-	0.40	-	0.30	-
GATE SETTING (m)	-	0.13	-	0.18	-
SIPHON TUBE TURNOUT					
SIPHON DIA (m)	-	-	-	-	-
BANKCUT TURNOUT					
BANKCUT WIDTH (m)	-	-	-	-	-
FLUME VARIABLES					
SUBMERGENCE RATIO	-	-	-	-	-
FLUME FLOOR ELEV (m)	-	-	-	-	-
CHECK VARIABLES					
CREST ELEVATION (m)	-	-	-	-	-
CULVERT HEAD LOSS					

APPENDIX F: COMPUTER PROGRAM OF HYDRAULIC MODEL

DATA INPUT/EDIT PROGRAM

```
LIST
10 'Program Data Input
20 '
30 '     Data is entered for the main canal and each mesqa.
40 'After entry, data is stored in the aprropriate file. A data
50 'edit program allows for change of data.
60 '
90 COLOR 7
100 DIM S(100,69),STANUM(100),TOUT(100),ST$(15),N$(30),PT(12,2,7),TT$(15),DATMAX
(12)
110 CLS : PRINT "Please wait..."
120 GOSUB 20000
200 '
210 'Main menu
220 '
230 KEY OFF
240  COLOR 7 : CLS
250 X = 20
260 LOCATE 2,X : COLOR 15
270 PRINT "Data Input/Edit Menu"
280 COLOR 7
285 A$(1) = "Input Data" : A$(2) = "Edit Data" : A$(3) = "Copy Directory" : A$(4
) = "Quit"
290 Y = 5: Q = 1
300 FOR I = 1 TO 4
310 LOCATE Y,X : PRINT A$(I)
320 Y = Y + 2
330 NEXT
340 LOCATE 15,10
350 COLOR 15
360 PRINT "Type the beginning letter to select, or"
370 LOCATE 16,10: PRINT "Press " + CHR$(24) + " to move cursor up"
380 LOCATE 17,10: PRINT "Press " + CHR$(25) + " to move cursor down"
390 LOCATE 18,10: PRINT "Press return to accept selection"
400 Y = 5 : YMIN = 5 : YMAX = 11
420 LOCATE Y,X : COLOR 0,7: PRINT A$(Q)
430 A$ = INKEY$ : IF A$ = "" THEN 430
440 IF ASC(RIGHT$(A$,1)) = 72 OR ASC(A$) = 56 THEN GOSUB 600
460 IF ASC(RIGHT$(A$,1)) = 80 OR ASC(A$) = 50 THEN GOSUB 640
465 COLOR 7
470 IF ASC(A$) = 73 OR ASC(A$) = 105 THEN Q = 1 : GOTO 520
480 IF ASC(A$) = 69 OR ASC(A$) = 101 THEN Q = 2 : GOTO 520
490 IF ASC(A$) = 67 OR ASC(A$) = 99 THEN Q = 3 : GOTO 520
500 IF ASC(A$) = 81 OR ASC(A$) = 113 THEN CLS : END
510 IF ASC(A$) <> 13 THEN BEEP : GOTO 420
520 ON Q GOSUB 10000,15000,25000,900
530 GOTO 240
600 Y = Y - 2 : IF Y < YMIN THEN Y = Y + 2 :BEEP : RETURN 420
602 COLOR 2
605 LOCATE Y+2,X : PRINT A$(Q) : Q = Q - 1
610 RETURN 420
640 Y = Y + 2 : IF Y > YMAX THEN Y = Y - 2 : BEEP : RETURN 420
645 COLOR 7
650 LOCATE Y -2,X :PRINT A$(Q) : Q = Q + 1
660 RETURN 420
```

```
900 CLS
910 END
970 '
980 '
990 '
10000 'Data input subroutine
10010 '
10020 '      Data for the distribution canal and mesqas are input.
10030 '
10040 'Menu
10050 CLS
10060 X = 20
10070 LOCATE,2,X : COLOR 15
10080 PRINT "Data Input Menu"
10090 Y = 5
10100 A$(1) = "Input Distributary Canal Data" : A$(2) = "Mesqa Data Input" : A$(
3) = "Disk Drive / Directory Specification" : A$(4) = "Quit"
10110 COLOR 7
10120 FOR I = 1 TO 4
10130 LOCATE Y,X
10140 PRINT A$(I)
10150 Y = Y + 2
10160 NEXT
10170 '
10180 COLOR 15
10190 LOCATE 15,10 : PRINT "Type the beginning letter to select, or"
10200 LOCATE 16,10 : PRINT "Press " + CHR$(24) + " to move cursor up"
10210 LOCATE 17,10 : PRINT "Press " + CHR$(25) + " to move cursor down"
10220 LOCATE 18,10 : PRINT "Press enter to accept selection."
10230 '
10240 Y = 5 : YMIN = 5 : YMAX = 11 : Q = 1
10250 LOCATE Y,X : COLOR 0,7 : PRINT A$(Q)
10260 A$ = INKEY$ : IF A$ = "" THEN 10260
10270 IF ASC(RIGHT$(A$,1)) = 72 OR ASC(A$) = 56 THEN GOSUB 10800
10280 IF ASC(RIGHT$(A$,1)) = 80 OR ASC(A$) = 50 THEN GOSUB 10900
10290 IF ASC(A$) = 73 OR ASC(A$) = 105  THEN Q = 1 : GOTO 10350
10300 IF ASC(A$) = 77 OR ASC(A$) = 109  THEN Q = 2 : GOTO 10350
10310 IF ASC(A$) = 68 OR ASC(A$) = 100  THEN Q = 3 : GOTO 10350
10330 IF ASC(A$) = 81 OR ASC(A$) = 113  THEN RETURN 240
10340 IF ASC(A$) <> 13 THEN BEEP : GOTO 10250
10350 ON Q GOSUB 11000,12000,13000,14500
10360 GOTO 10050
10800 Y = Y - 2 : IF Y < YMIN THEN Y = Y + 2 :BEEP : RETURN 10250
10810 COLOR 2
10820 LOCATE Y+2,X : PRINT A$(Q) : Q = Q - 1
10830 RETURN 10250
10900 Y = Y + 2 : IF Y > YMAX THEN Y = Y - 2 : BEEP : RETURN 10250
10910 COLOR 7
10920 LOCATE Y -2,X :PRINT A$(Q) : Q = Q + 1
10930 RETURN 10250
10940 '
10950 '
11000 'Distributary Canal Data input
11100 '
11110 IF D$ = "" THEN GOSUB 13000       'enter disk drive and dir if needed
11115 COLOR 7 : CLS : FMESQ = 0
11120 '
11130 ON ERROR GOTO 11900
11140 FILES D$ + "DIST.DAT"
11150 ON ERROR GOTO 0
11160 'Distribution canal data exists
11170 PRINT "Distributary canal data exists."
11180 PRINT "Type R to return to input menu."
11190 PRINT "Type D to delete existing distribution canal data and
11200 PRINT "input new data."
11210 [illegible]
```

```
11220 IF Q$ = "r" OR Q$ = "R" THEN RETURN
11230 IF Q$ <>"d" AND Q$ <>"D" THEN BEEP : GOTO 11210
11240 '
11250 'Input distribution canal data
11260 ON ERROR GOTO 0
11270 F$ = "DIST.DAT"
11280 GOSUB 11700                      'Enter station data
11350 DSMAX = STAMAX
11360 'Set turntout flags along distribution canal
11370 FOR I = 1 TO DSMAX
11380 IF STANUM(I) = 3 OR STANUM(I) = 4 OR STANUM(I) = 5 THEN TOUT(I) = 1 : ELSE
 TOUT(I) = 0 : GOTO 11410
11390 FF$ = "STA" + RIGHT$(STR$(I),LEN(STR$(I))-1) + ".DAT"
11400 OPEN D$ + FF$ AS #1 LEN = 128
11410 CLOSE #1
11420 NEXT
11430 S = 1
11435 S = S + 1
11440 IF S = STAMAX THEN RETURN
11450 IF TOUT(S) = 0 THEN 11435
11460 PRINT : PRINT "Enter data for mesqa at station";S;"(Y/N)?"
11470 INPUT Q$
11480 IF Q$ = "N" OR Q$ = "n" THEN RETURN
11490 IF Q$ <> "Y" AND Q$ <> "y" THEN BEEP : GOTO 11470
11500 FMESQ = 1
11505 F$ =  "STA" + RIGHT$(STR$(S),LEN(STR$(S))-1) + ".DAT"
11510 GOSUB 11700
11520 GOTO 11435
11530 '
11670 '
11680 'Enter station data
11690 '
11700 CLS
11705 IF FMESQ = 1 THEN GOSUB 24020 ELSE GOSUB 24100    'set datmax(
11710 INPUT "Input channel name ";CN$
11720 GOSUB 30050                'Enter station types
11730 GOSUB 30490                'Edit station types
11740 GOSUB 30810                'Enter data at stations
11750 GOSUB 31330                'Print data
11760 GOSUB 31560                'Store data
11770 RETURN
11780 '
11900 IF ERR = 53 THEN RESUME 11260
11910 ON ERROR GOTO 0 : RESUME  11270
11920 '
11930 '
11999 '-------------------------------------------------
12000 'Mesqa data input
12010 '
12020 COLOR 7 : CLS
12025 FMESQ = 1          'mesqa flag
12030 IF D$ = "" THEN GOSUB 13000                  'disk drive and dir
12040 '
12050 ON ERROR GOTO 12600
12060 FILES D$ + "dist.dat"
12070 ON ERROR GOTO 0
12080 '
12090 IF ERR = 53 THEN RETURN
12100 '
12110 CLS
12120 FILES D$ + "STA???.DAT"
12130 PRINT
12140 PRINT "Enter station number along distribution canal at which data is to b
e entered."
12150 PRINT "Press enter to return to the menu."
```

```
12170 IF Q = 0 THEN RETURN
12180 ON ERROR GOTO 12660
12190 F$ = "STA" + RIGHT$(STR$(Q),LEN(STR$(Q))-1) + ".DAT"
12200 FILES D$ + F$
12210 ON ERROR GOTO 0
12220 '
12230 'Chock to see if mesqa data exists
12240 OPEN D$ + F$ AS #1 LEN = 128
12250 FIELD #1,2 AS RA$,18 AS RA$(1),18 AS RA$(2), 18 AS RA$(3), 18 AS RA$(4), 1
8 AS RA$(5), 18 AS RA$(6), 18 AS RA$(7)
12260 GET #1,1
12270 CHECK = CVS(RA$(7))
12280 CLOSE #1
12290 IF CHECK = 0 THEN 12410
12300 '
12310 PRINT : PRINT "Mesqa data exists."
12320 PRINT "Type R to return to the menu,
12330 PRINT "Type D to delete existing mesqa data and enter new data."
12340 INPUT Q$
12350 IF Q$ = "R" OR Q$ = "r" THEN RETURN
12360 IF Q$ <> "D" AND Q$ <> "d" THEN 12340
12370 '
12400 'Enter mesqa data
12410 FMESQ = 1
12420 GOSUB 11700
12430 RETURN
12480 '
12600 IF ERR <> 53 THEN ON ERROR GOTO 0
12610 CLS
12620 PRINT "Enter the data for the distribution canal first."
12630 PRINT: PRINT "Press any key to continue."
12640 A$ = INKEY$ : IF A$ = "" THEN 12640
12650 RESUME NEXT
12660 IF ERR <> 53 THEN ON ERROR GOTO 0
12670 PRINT : PRINT "Turnout does not exist on station ";Q;" of distribution can
al."
12680 PRINT "Reenter station number"
12690 RESUME 12160
12700 RETURN 240                    'return to main menu
12900 '
12910 '
12920 12920 '
-----
13000 'Disk drive and directory specifications
13010 '
13020 'Drive location
13030 COLOR 7 : CLS
13040 PRINT "Input Disk Drive letter (without colon) where data is to be found."
13045 PRINT "Press enter to accept ";: COLOR 0,7 : PRINT "Drive ";DDEF$ : COLOR
7
13050 INPUT D$
13060 IF D$ <> "a" AND D$ <> "b" AND D$ <> "c" AND D$ <> "A" AND D$ <> "B" AND D
$ <> "C" AND D$ <> "" THEN PRINT "Reenter drive letter." : GOTO 13050
13065 IF D$ = "" THEN D$ = DDEF$
13070 DR$ = D$ + ":"
13075 DDEF$ = D$
13076 IF FCOPY = 1 THEN RETURN
13080 ON ERROR GOTO 13400         'trap for file not found
13085  PRINT : PRINT "Current directories: ": PRINT
13090 FILES DR$ + "*."
13100 ON ERROR GOTO 0
13110 '
13130 PRINT : INPUT "Enter directory name:";DN$
13140 ON ERROR GOTO 13450
13150 D$ = DR$ + "\" + DN$ + "\"
13160 FILES D$
```

```
13165 ON ERROR GOTO 0
13170 RETURN
13180 '
13400 IF ERR = 53 THEN PRINT "No current directories" : RESUME 13100
13410 ON ERROR GOTO 0
13450 'trap for no current directories
13460 IF ERR <> 53 THEN ON ERROR GOTO 0
13470 IF FEDIT = 1 THEN GOTO 13520
13480 INPUT "Make new directory (Y/N)";Q$
13485 IF Q$ = "n" OR Q$ = "N" THEN RESUME 13130
13490 IF Q$ <> "Y" AND Q$ <> "y" THEN 13480
13495 PRINT "Creating Directory"
13500 MKDIR DR$ + "\" + DN$ : RESUME 13165
13510 '
13520 "Directory not found, please reenter. "
13530 RESUME 13130
13540 '
14080 '
14090 '
14500 RETURN 240                    'quit to main menu
14970 '
14980 '
14990 '-
15000 'Edit data
15010 '
15020 CLS : FEDIT = 1
15030 X = 20
15040 LOCATE 2,X : COLOR 15
15050 PRINT "Edit Menu"
15055 Y = 5
15060 A$(1) = "Change Station Types" : A$(2) = "Edit Data at Station" : A$(3) =
"Disk Drive/Directory Selection":A$(6) = "Quit":A$(4) = "Rename Channel":A$(5) =
 "Print Data"
15065 COLOR 7
15070 FOR I = 1 TO 6
15080 LOCATE Y,X
15090 PRINT A$(I)
15095 Y = Y + 2
15100 NEXT
15110 COLOR 15
15120 LOCATE 17,10 : PRINT "Type the beginning letter to select, or"
15130 LOCATE 18,10 : PRINT "Press " + CHR$(24) + " to move cursor up"
15140 LOCATE 19,10 : PRINT "Press " + CHR$(25) + " to move cursor down"
15150 LOCATE 20,10 : PRINT "Press enter to accept selection" .
15160 Y = 5 : YMIN = 5 : YMAX = 15 : Q = 1
15170 LOCATE Y,X : COLOR 0,7 : PRINT A$(Q)
15180 A$ = INKEY$ : IF A$ = "" THEN 15180
15190 IF ASC(RIGHT$(A$,1)) = 72 OR ASC(A$) = 56 THEN GOSUB 15300
15200 IF ASC(RIGHT$(A$,1)) = 80 OR ASC(A$) = 50 THEN GOSUB 15340
15210 IF ASC(A$) = 67 OR ASC(A$) = 99   THEN Q = 1 : GOTO 15270
15220 IF ASC(A$) = 69 OR ASC(A$) = 101  THEN Q = 2 : GOTO 15270
15240 IF ASC(A$) = 68 OR ASC(A$) = 100  THEN Q = 3 : GOTO 15270
15245 IF ASC(A$) = 82 OR ASC(A$) = 114  THEN Q = 4 : GOTO 15270
15250 IF ASC(A$) = 80 OR ASC(A$) = 112  THEN Q = 5 : GOTO 15270
15255 IF ASC(A$) = 81 OR ASC(A$) = 113  THEN Q = 6 : GOTO 15270
15260 IF ASC(A$) <> 13 THEN BEEP : GOTO 15170
15270 ON Q GOSUB 16000,17000,13030,18000,18500,19500
15280 GOTO 15020
15300 Y = Y - 2 : IF Y < YMIN THEN Y = Y + 2 :BEEP : RETURN 15170
15310 COLOR 2
15320 LOCATE Y+2,X : PRINT A$(Q) : Q = Q - 1
15330 RETURN 15170
15340 Y = Y + 2 : IF Y > YMAX THEN Y = Y - 2 : BEEP : RETURN 15170
15350 COLOR 7
15360 LOCATE Y -2,X :PRINT A$(Q) : Q = Q + 1
15370 RETURN 15170
```

```
15970 '
15980 '
15990 '-------------------
16000 'Edit station types
16010 '
16020 IF D$ = "" THEN GOSUB 13030
16030 GOSUB 19200       'Choose file to be edited
16035 IF FDAT = 1 THEN RETURN
16040 IF STAMAX = 0 THEN RETURN
16045 STAM1 = STAMAX : FOR K = 1 TO STAMAX : TOUT(K) = STANUM(K) :NEXT
16050 GOSUB 30490                 'edit station types
16060 IF FMESQ = 1 THEN 16160
16070 'create files for additional stations or new turnouts
16080 FOR K = 1 TO STAMAX
16086 'Create new data files
16090 IF STANUM(K) < 3 OR STANUM(K) > 6 THEN 16130
16095 IF K < STAM1 AND TOUT(K) = STANUM(K) THEN 16130
16100 FF$ = "STA" + RIGHT$(STR$(K),LEN(STR$(K))-1) + ".DAT"
16110 OPEN D$ + FF$ AS #1 LEN = 128
16120 CLOSE #1
16130 NEXT
16140 '
16150 'Store new station types
16160 GOSUB 31580
16170 RETURN
16180 '
16970 '
16980 '
16990 '-------------------
17000 '
17010 'Edit data subroutine
17020 '
17030 IF D$ = "" THEN GOSUB 13030
17040 GOSUB 19200                'Select mesqa
17045 IF FDAT = 1 THEN RETURN
17050 '
17060 COLOR 7 : CLS
17070 PRINT "Enter station number along channel "
17075 PRINT "Press enter to return to menu."
17076 INPUT I
17080 IF I > STAMAX THEN PRINT "No. of stations = ";STAMAX : PRINT "Please reent
er." : GOTO 17070
17090 IF I = 0 THEN GOSUB 31580 : RETURN          'store then return
17091 CLS : COLOR 15
17092 LOCATE 1,1 : PRINT "Station "S;" along distributary canal"
17094 LOCATE 2,1 : PRINT "Station "I;" along mesqa"
17095 LOCATE 3,1 : PRINT ST$(STANUM(I))
17096 COLOR 7
17100 COLOR 7
17104 'Set datmax(
17105 IF RIGHT$(F$,1) = "D" THEN GOSUB 24100 ELSE GOSUB 24020
17106 Y = 5
17110 FOR K = 1 TO DATMAX(STANUM(I))
17120 ST = STANUM(I)
17130 LOCATE Y,40 - LEN(N$(PT(ST,1,K)))
17140 PRINT N$(PT(ST,1,K));
17150 PRINT " = ";S(I,PT(ST,2,K))
17160 Y = Y + 1
17170 NEXT
17180 GOSUB 31000
17185 GOTO 17060
17190 RETURN
17200 '
17210 '
17970 '
17980 '
```

```
17990 '-------------------------------------------------------------------------
18000 '
18010 'Change channel name
18020 '
18030 IF D$ = "" THEN GOSUB 13030
18040 GOSUB 19200                   'Select file
18045 IF FDAT = 1 THEN RETURN
18050 '
18060 COLOR 7 : CLS
18070 PRINT "Old channel name: ";CN$
18075 PRINT
18080 INPUT "Input new channel name ";CN$
18090 GOSUB 31580                   'store
18100 RETURN
18110 '
18120 '
18490 'Print Data
18500 IF D$ = "" THEN GOSUB 13030
18510 GOSUB 19200                   'Choose file
18515 IF FDAT = 1 THEN RETURN
18520 GOSUB 31370                   'Printout
18530 RETURN
18540 '
18550 '
18970 '
18980 '
18990 '-
19200 'Choose file to be edited
19210 '
19220 COLOR 7 : CLS :FDAT = 0
19230 PRINT "Choose file to be edited or printed"
19240 FILES D$ + "*.DAT"
19250 PRINT : PRINT "Type return to edit DIST (distributary canal)"
19260 PRINT "Type the station number then enter to choose stations along"
19270 PRINT "the distribution canal"
19280 INPUT Q
19290 IF Q = 0 THEN F$ = "DIST.DAT" : FMESQ = 0 ELSE F$ =  "STA" + RIGHT$(STR$(Q
),LEN(STR$(Q))-1) + ".DAT" : FMESQ = 1 :S = Q
19295 DD$ = D$ + F$
19300 OPEN DD$ AS #1 LEN = 128
19310 FIELD #1,2 AS RA$,18 AS RA$(1),18 AS RA$(2), 18 AS RA$(3), 18 AS RA$(4), 1
8 AS RA$(5), 18 AS RA$(6), 18 AS RA$(7)
19320 GET #1, 1
19330 STAMAX = CVS(RA$(7))
19340 IF STAMAX = 0 AND FCOPY = 0 THEN CLOSE #1 : GOTO 19900
19345 PRINT : PRINT "Retrieving data"
19350 CN$ = RA$(6)
19360 FOR S = 1 TO STAMAX
19365 GET #1,S
19370 STANUM(S) = CVI(RA$)
19380 FOR J = 1 TO DATMAX(STANUM(S))
19390 S(S,PT(STANUM(S),2,J)) = CVS(RA$(J))
19400 NEXT
19410 NEXT
19420 CLOSE #1
19425 S = Q
19430 RETURN
19500 FEDIT = 0 : RETURN 240             'return to main menu
19900 PRINT "There is no data in the file to be edited."
19910 PRINT "Please use data input to enter data."
19920 PRINT "Press any key to continue."
19930 A$ = INKEY$ : IF A$ = "" THEN 19930
19935 FDAT = 1
19940 RETURN
19950 '
19970 '
```

```
19980 '
19990 '-----------------------------------------------------------------------
20000 'Subroutine read string data
20010 '
20015 DDEF$ = "B"
20020 FOR J = 1 TO 12
20030 READ ST$(J)
20040 NEXT
20050 DATA "Type 1  - Head of Channel",Type 2  - End of Channel
20060 DATA "Type 3A - Pipes with adjustable gates","Type 3B - Siphon Tube",Type
3C - Bankcut
20070 DATA "Type 4A - Cutthroat Flume","Type 4B - Trapezoidal Flume","Type 4C -
Check"
20080 DATA "Type 5  - Bend","Type 6A - Enlargement or Contraction","Type 6B - Ch
ange in Roughness, Bottom Slope or Seepage Loss "
20090 DATA "Type 7  - Intermediate Station"
21010 '
21020 FOR J = 1 TO 30
21030 READ N$(J)
21040 NEXT
21050 '
21060 DATA Distance to Station (m),Bottom Elevation at Station (m)
21070 DATA Hydraulic roughness,Bottom Slope (m/m),Side Slope,Bottom Width (m)
21080 DATA Design Flow Rate (m^3/sec),Field Water Surface Elevation (m)
21090 DATA Friction Factor,Pipe Length (m),Pipe Diameter (m),Gate Setting (m)
21100 DATA Roughness Coefficient,Entrance Loss Coefficient,Siphon Length (m),Sip
hon Diameter (m)
21110 DATA Roughness Coefficient,Bankcut Length (m),Bankcut Elevation (m),Bankcu
t width (m)
21120 DATA Flume Length (m),Flume Width (m),Submergence Ratio,Flume Floor Elevat
ion (m)
21130 DATA Crest Length (m),Crest Elevation (m)
21140 DATA Bend Loss Coefficient, Enlargement Loss Coefficient, Contraction Loss
 Coefficient,Seepage Rate (m^3/s)/m
21500 'Read point array
21510 FOR ST = 1 TO 12
21520 FOR K = 1 TO 2
21530 FOR KK = 1 TO 5
21540 READ PT(ST,K,KK)
21550 NEXT: NEXT: NEXT
21560 '
21570 DATA 3,4,5,6,30
21580 DATA 3,5,4,6,27
21590 DATA 1,2,0,0,
21600 DATA 1,2,0,0,
21610 DATA 1,9,10,11,12
21620 DATA 1,10,7,8,9
21630 DATA 1,13,14,15,16
21640 DATA 1,16,15,14,17
21650 DATA 1,17,18,19,20
21660 DATA 1,20,18,19,21
21670 DATA 1,21,22,23,24
21680 DATA 1,22,23,24,25
21690 DATA 1,21,22,23,24
21700 DATA 1,22,23,24,25
21710 DATA 1,25,26,0,0
21720 DATA 1,26,28,0,0
21730 DATA 1,27,,,
21740 DATA 1,29,,,
21750 DATA 1,5,6,28,29
21760 DATA 1,4,6,61,62
21770 DATA 1,3,4,30,
21780 DATA 1,3,5,27,
21790 DATA 1,,,,
21800 DATA 1
'Read station types
[illegible]
```

```
22020 READ TT$(J)
22030 NEXT
22040 '
22050 DATA 1,2,3A,3B,3C,4A,4B,4C,5,6A,6B,7
23000 'READ DATMAX ARRAY
23010 FOR I = 1 TO 12
23020 READ DATMAX(I)
23030 NEXT
23040 '
23050 DATA 5,2,5,5,5,5,5,3,2,5,4,1
23999 RETURN
24000 'Additional mesqa data
24010 '
24020 FOR K = 3 TO 5
24030 PT(K,1,6) = 7 : PT(K,2,6) = 11
24040 PT(K,1,7) = 8 : PT(K,2,7) = 13
24045 DATMAX(K) = 7
24050 NEXT
24060 RETURN
24090 'Set datmax for distribution canal
24100 FOR K = 3 TO 5
24110 DATMAX(K) = 5
24120 NEXT
24130 RETURN
24140 '
24970 '
24980 '
24990 '
25000  'Copy directory
25010  '
25020  'Files under a directory are copied onto another directory.
25030 '
25040 FCOPY = 1
25050  GOSUB 13030                    'Drive location
25060 'Specifify directory
25070 PRINT
25080 ON ERROR GOTO 29000
25090 FILES DR$ + "*."
25100 ON ERROR GOTO 0
25110 '
25120 PRINT : PRINT "Input directory name where data is to be copied from (witho
ut \):"
25130 INPUT OD$
25140 ON ERROR GOTO 29100
25150 FILES DR$ + "\" + OD$
25160 ON ERROR GOTO 0
25170 '
25180 PRINT : PRINT "Input drive location (without :) where data is to be copied
 to."
25190 INPUT NDR$
25200 IF NDR$ <> "a" AND NDR$ <> "b" AND NDR$ <> "c" AND NDR$ <> "A" AND NDR$ <>
 "B" AND NDR$ <> "C" GOTO 25190
25210 PRINT : PRINT "Input new directory name (without \) where data is to be co
pied to"
25220 INPUT ND$
25225 ON ERROR GOTO 29200
25228 PRINT "Creating directory."
25230 MKDIR NDR$ + ":\" + ND$
25240 DO$ = DR$ + "\" + OD$ + "\"
25250 DN$ = NDR$ + ":\" + ND$ + "\"
25260 D$ = DO$ : F$ = "DIST.DAT"
25265 PRINT "DIST"
25270 GOSUB 19295                    'Restrievo Data
25280 D$ = DN$
25285 PRINT "Storing Data"
[illegible]
```

```
25300 DSMAX = STAMAX
25305 FOR S = 1 TO DSMAX : IF STANUM(S) > 2 AND STANUM(S) < 6 THEN TOUT(S) = 1 E
LSE TOUT(S) = 0
25306 NEXT
25310 FOR K = 1 TO DSMAX
25320 IF TOUT(K) = 0 GOTO 25400
25330 D$ = DO$
25340 F$ =  "STA" + RIGHT$(STR$(K),LEN(STR$(K))-1) + ".DAT" : FMESQ = 1
25345 PRINT F$
25350 GOSUB 19295                'Read data
25360 D$ = DN$
25365 PRINT "Storing Data"
25370 GOSUB 31590                'Store data
25400 NEXT
25410 FCOPY = 0 : RETURN
28990 'Error traps
29000 IF ERR <> 53 THEN ON ERROR GOTO 0
29010 PRINT "No current directories on drive ";DR$
29020 PRINT "Press any key to return to main menu."
29030 A$ = INKEY$: IF A$ = "" THEN 29030
29040 RESUME 29050
29050 RETURN
29060 '
29090 'trap no directories
29100 IF ERR <> 53 THEN ON ERROR GOTO 0
29110 "Directory not found, please reenter."
29120 RESUME 25130
29130 '
29190 'trap for existing directory
29200 IF ERR <> 75 THEN ON ERROR GOTO 0
29210 PRINT : PRINT "Directory exists, please reenter."
29220 RESUME 25220
29970 '
29980 '
29990 '--------------------------------------------------------------------------
30000 'Subroutine station types
30010 '
30020 '      Station types along the channel are chosen until the end of the
30030 'channel is encountered.
30040 '
30050 STA = 1 :STANUM(1) = 1 :STANUM1 = 1
30060 Y = 8: X = 10 : STANUM = 3
30070 CLS
30080 STA1 = 1 : Y1 = 1
30090 STA = STA + 1
30100 LOCATE 5,1
30110 CT = 1 : YMIN = 5 : YMAX = 19
30120 FOR J = 1 TO 12
30130 IF J = 3 OR J = 6 OR J = 12 THEN PRINT
30140 PRINT TAB(10) ST$(J)
30150 NEXT
30160 COLOR 15
30170 LOCATE 21,1 : PRINT "Press Enter to accept station type"
30180 LOCATE 22,1 : PRINT "Press " +CHR$(24) + " to move cursor up"
30190 LOCATE 23,1 : PRINT "Press " + CHR$(25) " to move  cursor down"
30200 COLOR 7
30210 LOCATE 2,1 :PRINT "Station ";STA1;" = ";ST$(STANUM1);"
      "
30220 IF FMESQ = 1 THEN LOCATE 1,1 : COLOR 15 :PRINT "Station " + STR$(S) + " al
ong distribution canal": COLOR 7
30230 COLOR 7
30240 LOCATE 3,1 : PRINT"Select Station Type for Station ";STA
30250 LOCATE Y,X : COLOR 0,7  : PRINT ST$(STANUM)
30260 A$ = INKEY$ : IF A$ = "" THEN 30260
30270 IF ASC(RIGHT$(A$,1)) = 72 THEN GOSUB 30300
```

```
30290 IF ASC(A$) <> 13 THEN BEEP : GOTO 30260
30300 Y1 = Y - 4
30310 STANUM(STA) = STANUM
30320 IF STANUM = 2  THEN STAMAX = STA :COLOR 7: RETURN
30330 IF FST = 1 THEN COLOR 7 : RETURN
30340 STA1 = STA
30350 STA = STA + 1
30360 STANUM1 = STANUM
30370 GOTO 30200
30380 GOSUB 30460
30390  Y = Y - 1 : IF Y < YMIN THEN Y = Y + 1 :BEEP : RETURN 30250
30400 IF Y = 7 OR Y = 11 OR Y = 18 THEN Y = Y - 1
30410 STANUM = STANUM - 1 : RETURN 30250
30420 GOSUB 30460
30430 Y = Y + 1 : IF Y > YMAX THEN Y = Y - 1 : BEEP : RETURN 30250
30440 IF Y = 7 OR Y = 11 OR Y = 18 THEN Y = Y + 1
30450 STANUM = STANUM + 1 : RETURN 30250
30460 LOCATE Y,X : COLOR 7 : PRINT ST$(STANUM) :RETURN
30470 COLOR 7
30480 RETURN
30490 'Edit station types
30500 '
30510 COLOR 7 : CLS
30520 FOR J = 1 TO STAMAX
30530 PRINT "STA ";J;" = TYPE ";TT$(STANUM(J)),
30540 CT = CT + 1
30550 IF CT > 60 THEN CT = 0 : GOSUB 30590
30560 NEXT
30570 CT = 0
30580 PRINT
30590 PRINT : PRINT "Press return to accept station types "
30600 PRINT "Type the number of the station to change the station type"
30610 INPUT STA
30620 STANUM1= STANUM(STA)
30630 STANUM = 3 : Y = 8
30640 IF STA = 0 THEN FST = 0 : RETURN
30650 IF STA < 1 OR STA > STAMAX THEN 30610
30660 CLS
30670 IF STANUM(STA) = 2 THEN FST = 0 ELSE FST = 1
30675 STA1 = STA
30680 GOSUB 30100
30690 GOTO 30510
30700 'Save distribution channel station types
30710 '
30720 FOR STA = 1 TO STAMAX
30730 DSTA(STA) = STANUM(STA)
30740 NEXT
30750 RETURN
30760 RETURN
30770 'Subroutine enter station data
30780 '
30790 '     Appropriate data for each station are entered.
30800 '
30810 FOR I = 1 TO STAMAX
30820 CLS
30830 LOCATE 1,1
30840 PRINT "Station ";I;ST$(STANUM(I))
30850 PRINT
30860 PRINT "Type the value of the parameter, then press enter."
30870 PRINT
30880 Y = 5
30890 FOR K = 1 TO DATMAX(STANUM(I))
30900 ST = STANUM(I)
30910 LOCATE Y,40 - LEN(N$(PT(ST,1,K)))
30920 PRINT N$(PT(ST,1,K));
[illegible]
```

```
30940 Y = Y + 1
30950 NEXT
30960 GOSUB 30990
30970 NEXT
30980 RETURN
30990 'Edit station data
31000 YMIN = 5 : YMAX = DATMAX(STANUM(I)) + 4
31010 X1 = 25
31020 LOCATE Y + 2,X1
31030 COLOR 15
31040 PRINT "Press enter to accept values"
31050 LOCATE Y + 3,X1
31060 PRINT "Press " +CHR$(24) + " To move cursor up"
31070 LOCATE Y + 4,X1
31080 PRINT "press " +CHR$(25) + " To move cursor down"
31090 LOCATE Y + 6,X1: PRINT "Input new value: ";:Y1 = CSRLIN
31100 COLOR 0,7 : PRINT "           " :COLOR 7
31110 Y = 5: X = 42
31120 LOCATE Y,X : COLOR 0,7 : PRINT S(I,PT(ST,2,Y-4))
31130 A$ = INKEY$ : IF A$ = "" THEN 31130
31140 IF ASC(RIGHT$(A$,1)) = 72  THEN GOSUB 31220
31150 IF ASC(RIGHT$(A$,1)) = 80  THEN GOSUB 31250
31160 IF ASC(A$) = 13 THEN COLOR 7 : RETURN
31170 IF ASC(A$) < 46 OR ASC(A$) > 57 THEN BEEP : GOTO 31120
31180 LOCATE Y1,42: PRINT A$;:INPUT "",B$
31190 S(I,PT(ST,2,Y-4)) = VAL(A$ + B$)
31200 LOCATE Y1,42 : PRINT "           "
31210 GOTO 31120
31220 GOSUB 31280
31230  Y = Y - 1 : IF Y < YMIN THEN Y = Y + 1 :BEEP
31240 RETURN  31120
31250 GOSUB 31280
31260 Y = Y + 1 : IF Y > YMAX THEN Y = Y - 1 : BEEP
31270 RETURN 31120
31280 COLOR 7
31290 LOCATE Y,X
31300 PRINT S(I,PT(ST,2,Y-4));"
31310 RETURN
31320 'Print channel data
31330 CLS
31340 INPUT "Would you like a printout of the data (Y/N) ";Q$
31350 IF Q$ = "N" OR Q$ = "n" THEN RETURN
31360 IF Q$ <> "Y" AND Q$ <> "y" THEN 31340
31370 PRINT : PRINT
31380 PRINT "Make sure printer is on and press any key to continue "
31390 A$ = INKEY$ : IF A$ = "" THEN 31390
31400 LPRINT
31410 LPRINT : LPRINT TAB(20) "Channel Name: ";CN$
31420 LPRINT
31430 IF FMESQ = 1 THEN LPRINT TAB(20) "Station #";S;" on distributary canal" :
LPRINT
31440 FOR J= 1 TO STAMAX
31450 ST = STANUM(J)
31460 LPRINT TAB(32) "STATION  ";J
31470 LPRINT TAB(32) ST$(ST)
31480 LPRINT
31490 FOR K = 1 TO DATMAX(ST)
31500 LPRINT TAB(40 - LEN(N$(PT(ST,1,K)))) N$(PT(ST,1,K))+" = "; S(J,PT(ST,2,K))
31510 NEXT
31520 LPRINT
31530 NEXT
31540 LPRINT : LPRINT : LPRINT : LPRINT
31550 RETURN
31560 'Store data
31570 '
```

```
31590 DD$ = D$ + F$
31600 OPEN DD$ AS #1 LEN = 128
31610 FIELD #1,2 AS RA$,18 AS RA$(1),18 AS RA$(2), 18 AS RA$(3), 18 AS RA$(4), 1
8 AS RA$(5), 18 AS RA$(6), 18 AS RA$(7)
31620 LSET RA$(6) = CN$
31630 LSET RA$(7) = MKS$(STAMAX)
31640 PUT #1,1
31650 FOR I = 1 TO STAMAX
31660 ST = STANUM(I)
31670 LSET RA$ = MKI$(ST)
31680 FOR J = 1 TO DATMAX(ST)
31690 LSET RA$(J) = MKS$(S(I,PT(ST,2,J)))
31700 NEXT
31710 PUT #1, I
31720 NEXT
31740 CLOSE #1
31750 RETURN
32000 '
32010 'Subroutine read data
32020 '
Ok
```

PROGRAM OF MATHEMATICAL SYSTEM MODEL

```
PLIST
1 PRINT TIME$
10 DIM S(70,69),T(20,11),T$(69),TT$(12),PT(12,7),DATMAX(12),ST(69),D(69,11),PTS(
2,12),SOLD(69),OP$(10),PTS1(15),RA$(7),STANUM(15)
50 GOSUB 30000
110 DEF FNPA(XX)=PI*XX^2/4
120 DEF FNKO(XX,YY)=.481*(YY/XX)^(-3.168)
130 DEF FNCS(DD)=S(I,15)*SQR((1000*DD)^(4/3)/(1250000!*S(I,16)^2*S(I,15)^2*S(I,1
4)+(1000*DD^(4/3))))
140 DEF FNQS(CS,D,H)=SQR(H*G/8)*CS*D^2*PI
150 DEF FNCQ(HA,HB)=1.767*S(I,26)*HA^1.5*SQR(G*HB/HA-7.55*(HB/HA)^2-2.26)
160 DEF FNAREA(SS,BW)=S(U,43)*BW+S(U,43)^2*SS
215 GOSUB 29030
217  CLS : PRINT "Program running..."
220 F$="DIST.DAT
226 CTOLD=0
230 GOSUB 22004
234 GOSUB 22530
235 U=STAMAX:DSMAX=STAMAX
240 GOSUB 20030
245 IF U<DSMAX THEN SEEP=SEEP+S(U,27)*(S(U+1,1)-S(U,1))
250 IF ST<3 OR ST>5 THEN U=U-1:GOTO 240
260 UBEG=U-1
270 GOSUB 22000
280 GOSUB 1200
285 MESQFL=S(1,31):MESQEL=S(1,33)
290 I=U:F1=0:X=U
300 GOSUB 20030
305 S(U+1,31)=SEEP
310 S(U,11)=MESQFL
315 S(U,13)=MESQEL
330 GOSUB 3050
340 GOSUB 4050
341 FOR K=1 TO 69:SOLD(K)=S(U,K):NEXT
342 GOSUB 1810
343 U=UBEG+1:FOR K=1 TO 69:S(U,K)=SOLD(K):NEXT
344 GOSUB 18500
350 F1=1
360 FOR U=UBEG TO 1 STEP-1
365 I=U
370 GOSUB 20030
380 IF ST>2 AND ST<6 THEN 500
400 S(I,31)=S(I+1,31)+S(I,27)*(S(I+1,1)-S(I,1))
410 GOSUB 5050
420 GOSUB 3050
430 GOSUB 4050
440 GOSUB 18500
450 GOTO 600
500 GOSUB 22000
510 GOSUB 1200
535 I=U:F1=1
540 GOSUB 20030
542 S(U,11)=MESQFL
543 S(U,13)=MESQEL
550 GOSUB 5050
560 GOSUB 3050
```

```
580 GOSUB 4050
590 GOSUB 18500
600 FOR K=1 TO 69:SOLD(K)=S(U,K):NEXT
610 NEXT
620 GOSUB 18720
650 END
1200 V=STAMAX:F1=0:F3=0:F4=0:F5=0:F10=0:F11=0:F12=0
1210 PRINT:PRINT:PRINT TAB(37)"Channel: ";CN$:PRINT
1220 FOR I=V-1 TO 1 STEP-1
1241 S(I,2)=S(I+1,2)+S(I,5)*(S(I+1,1)-S(I,1))
1250 IF F1=1 AND MID$(T$(I),1,1)="3"THEN 1310
1260 S(I,31)=S(I+1,31)+S(I,27)*(S(I+1,1)-S(I,1))
1310 IF F1=1 THEN 1400
1320 IF MID$(T$(I),1,1)="3"THEN X=I ELSE 1540
1340 GOSUB 3050
1350 GOSUB 4050
1355 GOSUB 1650
1360 GOTO 1540
1400 GOSUB 5050
1410 GOSUB 3050
1450 IF MID$(T$(I),1,1)<>"3"THEN 1530
1460 GOSUB 8030
1530 GOSUB 4050
1540 REM
1550 J=I:GOSUB 19020
1569 NEXT I
1590 GOSUB 18000
1592 MFSQFL=S(1,31):MESQEL=S(1,33)
1595 GOSUB 2010
1605 RETURN
1650 S(X,42)=S(X,33)
1660 S(X,43)=S(X,34)
1670 S(X,45)=S(X+1,31)/S(X,35)
1690 FOR J=V TO X+1 STEP-1
1700 S(J,33)=S(X,33):S(J,42)=S(J,33)
1710 S(J,34)=S(J,33)-S(J,2):S(J,43)=S(J,34)
1720 S(J,36)=S(J,31)/S(X,35):S(J,45)=S(J,36)
1725 GOSUB 19020
1750 NEXT J
1760 RETURN
1810 X=U:S(X,42)=S(X,33):S(X,43)=S(X,34):S(X,45)=S(X+1,31)/S(X,35)
1820 FOR U=DSMAX TO X+1 STEP-1
1830 GOSUB 20030
1840 IF U>DSMAX THEN S(U,31)=S(U,31)+S(U,27)*(S(U+1,1)-S(U,1)) ELSE S(U,31)=0
1850 S(U,33)=S(X,33):S(U,42)=S(U,33)
1860 S(U,34)=S(U,33)-S(U,2):S(U,43)=S(U,34)
1870 S(U,36)=S(U,31)/FNAREA(S(U,4),S(U,6))
1880 S(U,45)=S(U,36)
1890 GOSUB 18500
1900 NEXT
1910 RETURN
2010 FOR K=1 TO 69:FOR UU=U-1 TO U+1
2020 S(UU,K)=0:NEXT:NEXT:RETURN
3050 S(I,31)=S(I+1,31)+S(I,11)+S(I,27)*(S(I+1,1)-S(I,1))
3100 IF F1=1 THEN 3180
3120 IF MID$(T$(I),1,1)="3"THEN GOSUB 8030
3160 S(I,33)=S(I,32)+S(I,13):S(I,34)=S(I,33)-S(I,2):F1=1:RETURN
3180 ON VAL(MID$(T$(I),1,1))GOTO 3330,3330,3200,3230,3260,3290,3330
3200 GOSUB 7050
3205 S(I,32)=S(I,33)-S(I,13)
3207 RETURN
3230 IF T$(I)="4A"OR T$(I)="4B"THEN GOSUB 11030 ELSE GOSUB 6030
3240 RETURN
3260 GOSUB 14040:RETURN
3290 IF T$(I)=[illegible]THEN GOSUB [illegible]:RETURN
```

```
3300 IF T$(I)="6B"THEN GOSUB 16040:RETURN
3330 GOSUB 17030
3335 RETURN
4050 IF I<>1 THEN 4160
4060 S(I,35)=S(I,44)
4070 S(I,36)=S(I,45)
4080 S(I,37)=S(I,46)
4090 S(I,38)=S(I,47)
4100 S(I,39)=S(I,48)
4110 S(I,40)=S(I,49)
4120 S(I,41)=S(I,50)
4130 RETURN
4160 S(I,35)=S(I,34)*S(I-1,6)+S(I,34)^2*S(I-1,4)
4170 S(I,36)=S(I,31)/S(I,35)
4180 S(I,37)=S(I,36)^2/2/G
4190 S(I,38)=S(I,33)+S(I,37)
4200 S(I,39)=S(I-1,6)+2*S(I,34)*SQR(1+S(I-1,4)^2)
4210 S(I,40)=S(I,35)/S(I,39)
4220 S(I,41)=S(I,36)^2*S(I-1,3)^2/S(I,40)^(4/3)
4230 RETURN
5050 L=S(I+1,1)-S(I,1)
5055 S(I,42)=S(I+1,33)+S(I,5)*L
5530 S(I,43)=S(I,42)-S(I,2)
5540 S(I,44)=S(I,43)*S(I,6)+S(I,43)^2*S(I,4)
5550 S(I,45)=S(I+1,31)/S(I,44)
5560 S(I,46)=S(I,45)^2/2/G
5570 S(I,47)=S(I,42)+S(I,46)
5580 S(I,48)=S(I,6)+2*S(I,43)*SQR(1+S(I,4)^2)
5590 S(I,49)=S(I,44)/S(I,48)
5600 S(I,50)=S(I,45)^2*S(I,3)^2/S(I,49)^(4/3)
5610 S(I+1,51)=(S(I,50)+S(I+1,41))/2
5621 S(I+1,52)=S(I+1,51)*L
5630 R1=S(I+1,38)+S(I+1,52)
5640 R2=S(I,47)-R1
5650 IF ABS(R2)<.0001 THEN RETURN
5660 S(I,42)=S(I,42)-R2/(1-S(I,45)^2/G/S(I,49)+1.5*S(I,50)*L/S(I,49))
5670 GOTO 5530
6030 S(I,68)=S(I,42)-S(I,28)-S(I,2)
6040 S(I,67)=(S(I,31)/1.767/S(I,26))^(1/1.5)
6050 S=S(I,68)/S(I,67)
6060 IF S<.65 THEN 6290
6070 S(1,67)=S(I,68)/.65
6080 HA=S(I,67):HB=S(I,68)
6090 Q=FNCQ(HA,HB)
6095 QERR=S(I,31)-Q
6100 R80=QERR
6110 IF ABS(QERR)<.01*S(I,31)THEN 6290
6130 IF QERR<0 THEN HA1=HA-.01 ELSE HA1=HA+.01
6140 S(I,67)=HA1
6150 Q=FNCQ(HA1,HB)
6155 QERR=S(I,31)-Q
6160 R81=QERR
6170 IF ABS(QERR)<.01*S(I,31)THEN 6290
6175 IF R80*R81>0 THEN R80=R81:HA=HA1:S(I,67)=HA:GOTO 6130
6180 HA2=.5*(HA+HA1):S(I,67)=HA2
6190 Q=FNCQ(HA2,HB)
6195 QERR=S(I,31)-Q
6200 R82=QERR
6210 IF ABS(QERR)<.01*S(I,31)THEN 6290
6220 IF R82*R80<0 THEN HA1=HA2:R81=R82
6230 IF R82*R80>=0 THEN HA=HA2:R80=R82
6250 GOTO 6180
6260 RETURN
6290 S(I,34)=S(I,67)+S(I,28)
6300 S(I,33)=S(I,34)+S(I,2)
6310 RETURN
```

```
7050 S(I,34)=S(1,43)
7060 GOSUB 7300
7070 R90=R2
7080 IF ABS(R90)<=.0001 THEN 7250
7090 R50=S(I,34)
7100 IF R90>0 THEN R51=R50+.01 ELSE R51=R50-.01
7110 S(I,34)=R51
7120 GOSUB 7300
7130 R91=R2
7140 IF ABS(R91)<=.0001 THEN 7250
7150 IF R90*R91>0 THEN R90=R91:R50=R51:GOTO 7090
7160 R52=.5*(R51+R50):S(I,34)=R52
7170 GOSUB 7300
7180 R92=R2
7190 IF ABS(R92)<=.0001 THEN 7250
7200 IF R92*R90<0 THEN R51=R52:R91=R92
7210 IF R92*R90>=0 THEN R50=R52:R90=R92
7220 S(I,34)=R52
7230 GOTO 7160
7250 S(I,33)=S(I,34)+S(I,2)
7260 RETURN
7300 R6=3*S(I,6)*S(I,43)+2*S(I,43)^2*S(I,4)
7310 R7=6*(S(I,6)+S(I,43)*S(I,4))
7320 R8=S(I-1,6)*S(I,34)+S(I,34)^2*S(I-1,4)
7330 R9=3*S(I-1,6)*S(I,34)+2*S(I,34)^2*S(I-1,4)
7340 R10=6*(S(I-1,6)+S(I,34)*S(I-1,4))
7350 R11=G*(S(I,44)*R6/R7-R8*R9/R10)
7360 R12=S(I,31)^2/R8-S(1+1,31)^2/S(I,44)
7370 R2=R11-R12
7380 RETURN
8030 IF T$(I)="3B"THEN 8840
8040 IF T$(I)="3C"THEN 9530
8110 IF F1=1 THEN 8170
8130 S(I,53)=FNPA(S(I,8))
8135 S(I,64)=FNKO(S(I,8),S(I,9))
8140 S(I,12)=S(I,11)
8145 S(I,32)=S(I,12)^2*(S(I,10)*S(I,7)/S(I,8)+1+S(I,64))/(S(I,53)^2*2*G)
8150 F10=0:F11=0:F12=0
8155 RETURN
8170 IF S(I,8)<>0 AND S(I,9)<>0 THEN GOSUB 8455
8175 IF S(I,8)=0 THEN GOSUB 8400
8180 IF S(I,9)=0 THEN GOSUB 8205
8185 RETURN
8205 F11=1
8210 S(I,9)=S(I,8)
8215 S(I,53)=FNPA(S(I,8))
8220 S(I,64)=FNKO(S(I,8),S(I,9))
8230 S(I,12)=S(I,11)
8235 H=S(I,12)^2*(S(I,10)*S(I,7)/S(I,8)+1+S(I,64))/(S(I,53)^2*2*G)
8240 IF F12=0 AND H<S(I,32)THEN F12=1:GOTO 8270
8250 S(I,12)=SQR(S(I,32)*2*G*S(I,53)^2/(S(I,10)*S(I,7)/S(I,8)+1+S(I,64)))
8260 F11=0:F12=0:GOTO 10720
8270 F4=1
8275 S(I,53)=FNPA(S(I,8))
8280 S(I,9)=((2*G*S(I,32)*S(I,53)^2/S(I,11)^2-S(I,10)*S(I,7)/S(I,8)-1)/.481)^(-1
/3.68)*S(I,8)
8375 F4=0:F10=0:F11=0:F12=0:RETURN
8400 F3=1:DIAM=.05:S(I,8)=DIAM:S(I,9)=DIAM:GS=DIAM
8405 S(1,53)=FNPA(DIAM)
8410 S(I,64)=FNKO(DIAM,GS)
8415 S(I,12)=SQR(S(I,32)*2*G*S(I,53)^2/(S(I,10)*S(I,7)/DIAM+1+S(I,64)))
8420 IF S(I,12)<S(I,11)THEN DIAM=DIAM+.05:GS=DIAM:GOTO 8405
8425 S(I,8)=DIAM:S(I,9)=DIAM:GOSUB 8205
8430 F3=0:RETURN
8455 F10=1
```

```
8465 S(I,64)=FNKO(S(I,8),S(I,9))
8470 S(I,12)=SQR(S(I,32)*2*G*S(I,53)^2/(S(I,10)*S(I,7)/S(I,8)+1+S(I,64)))
8480 IF F10=1 THEN F10=0:GOTO 10720
8840 IF F1=1 THEN 8915
8880 S(I,12)=S(I,11)
8890 S(I,55)=FNCS(S(I,17))
8095 S(I,32)=8*S(I,11)^2/S(I,55)^2/PI^2/S(I,17)^4/G
8900 S(I,33)=S(I,32)+S(I,2)
8905 RETURN
8915 H=S(I,33)-S(I,13):S(I,32)=H
8920 IF S(I,17)<>0 THEN 9030
8940 QOLD=S(I,11)
8945 ROLD=1000000!
8950 D=.05
8955 IF D>.076 THEN S(I,16)=8.000001E-03 ELSE S(I,16)=.012
8957 CS=FNCS(D)
8960 QNEW=FNQS(CS,D,H)
8965 RNEW=ABS(S(I,11)-QNEW)
8970 IF RNEW<ROLD AND D<.22 THEN QOLD=QNEW:ROLD=RNEW:D=D+.025:GOTO 8955
8975 S(I,12)=QOLD
8980 S(I,55)=CS
8985 S(I,17)=D-.025
8987 PRINT"q = ";S(I,12),"d = ";S(I,17)
8990 GOTO 10720
9030 D=S(I,17)
9040 QOLD=S(I,11)
9050 CS=FNCS(D):S(I,55)=CS
9060 QNEW=FNQS(CS,D,H)
9070 IF ABS(QOLD/QNEW-1)<.05 THEN S(I,12)=QNEW:S(I,55)=CS:GOTO 10720 ELSE 9080
9077 QNEW=FNQS(CS,D,HNEW)
9080 S(I,31)=S(I+1,31)+QNEW
9085 PRINT"Qnew = ";QNEW
9087 H=8*QNEW^2/CS^2/PI^2/S(I,17)^4/G
9088 PRINT"h = ";H
9090 GOSUB 7050
9100 HNEW=S(I,33)-S(I,13)
9105 PRINT"Hnew = ";HNEW
9110 IF ABS(H/HNEW-1)>.005 THEN:GOTO 9077
9120 S(I,12)=QNEW
9130 S(I,32)=HNEW
9140 GOTO 10720
9530 P=20
9540 IF F1=1 THEN 9590
9560 IF S(I,21)=0 THEN 9600
9570 S(I,12)=S(I,11):F6=1:GOTO 9620
9590 IF S(I,21)<>0 THEN 9570
9600 S(I,21)=.18:S(I,12)=S(I,11)
9620 IF F6=0 THEN 9810
9630 GOSUB 10010
9640 R80=R23
9650 IF ABS(R80)<=TOL THEN F6=0:GOTO 10720
9660 R40=S(I,12)
9670 IF R80<0 THEN R41=R40-INC ELSE R41=R40+INC
9680 S(I,12)=R41
9690 GOSUB 10010
9700 R81=R23
9710 IF ABS(R81)<=TOL THEN F6=0:GOTO 10720
9720 IF R80*R81>0 THEN R80=R81:R40=R41:GOTO 9660
9730 R42=.5*(R41+R40):S(I,12)=R42
9740 GOSUB 10010
9750 R82=R23
9760 IF ABS(R82)<=TOL THEN F6=0:GOTO 10720
9770 IF R82*R80<0 THEN R41=R42:S(I,12)=R42:R81=R82
9780 IF R82*R80>=0 THEN R40=R42:S(I,12)=R42:R80=R82
9790 GOTO 9730
9810 [illegible]
```

```
9820 R80=R23
9830 IF ABS(R80)<=TOL THEN F6=0:GOTO 10720
9840 R40=S(I,21)
9850 IF R80<0 THEN R41=R40+INC ELSE R41=R40-INC
9860 S(I,21)=R41
9870 GOSUB 10010
9880 R81=R23
9890 IF ABS(R81)<=TOL THEN F6=0:GOTO 10720
9900 IF R80*R81>0 THEN R80=R81:R40=R41:GOTO 9840
9910 R42=.5*(R41+R40):S(I,21)=R42
9920 GOSUB 10010
9930 R82=R23
9940 IF ABS(R82)<=.002 THEN F6=0:GOTO 10720
9950 IF R82*R80<0 THEN R41=R42:S(I,21)=R42:R81=R82
9960 IF R82*R80>=0 THEN R40=R42:S(I,21)=R42:R80=R82
9970 GOTO 9910
10010 K=P:T(P,1)=S(I,13)-S(I,19):GOSUB 10340
10020 FOR K=P-1 TO 1 STEP-1
10030 T(K,1)=T(K+1,1)+T(K+1,8)*S(I,18)/(P-1)
10040 GOSUB 10340
10050 R90=R21
10060 IF ABS(R90)<=TOL THEN 10220
10070 R50=T(K,1)
10080 IF R90<0 THEN R51=R50+INC ELSE R51=R50-INC
10090 T(K,1)=R51
10100 GOSUB 10340
10120 R91=R21
10130 IF ABS(R91)<=TOL THEN 10220
10140 IF R90*R91>0 THEN R90=R91:R50=R51:GOTO 10070
10150 R52=.5*(R51+R50):T(K,1)=R52
10160 GOSUB 10340
10170 R92=R21
10180 IF ABS(R92)<=TOL THEN 10220
10190 IF R90*R92<0 THEN R91=R92:R51=R52:T(K,1)=R52
10200 IF R90*R92>=0 THEN R90=R92:R50=R52:T(K,1)=R52
10210 GOTO 10150
10220 NEXT K
10240 T(1,11)=T(1,1)+S(I,19)
10260 IF F1<>1 THEN S(I,32)=T(1,11)-S(I,13):F6=0:RETURN
10290 R23=S(I,33)-T(1,11)
10300 RETURN
10340 T(K,2)=T(K,1)*S(I,21)
10350 T(K,3)=S(I,12)/T(K,2)
10360 T(K,4)=T(K,3)^2/2/G
10370 IF K=P THEN T(K,5)=S(I,13)+T(K,4) ELSE T(K,5)=T(K,1)+S(I,19)+T(K,4)
10380 T(K,6)=2*T(K,1)+S(I,21)
10390 T(K,7)=T(K,2)/T(K,6)
10400 T(K,8)=T(K,3)^2*S(I,20)^2/T(K,7)^(4/3)
10410 IF K=P THEN RETURN
10420 T(K,9)=(T(K,8)+T(K+1,8))/2
10430 T(K,10)=T(K,9)*(S(I,18)/(P-1))
10440 R20=T(K+1,5)+T(K,10)
10450 R21=T(K,5)-R20
10460 RETURN
10510 GOTO 10720
10550 R70=S(I,11)-S(I,12)
10560 IF ABS(R70)<=.05*S(I,11)THEN RETURN
10570 IF R70>0 THEN R99=(S(I,11)-R70/2)/S(I,11) ELSE R99=(S(I,11)+R70/2)/S(I,11)
10590 R=I:U=I
10610 FOR I=1 TO M
10620 S(I,65)=S(I,11)
10630 S(I,11)=R99*S(I,11)
10640 NEXT I
10650 F13=1
10660 RETURN
```

```
10730 R5=ABS(S(I,31)-R4)
10740 RETURN
11030 IF T$(I)="4B"THEN 12380
11080 S(I,66)=.485+.1887*S(I,22)-.0269*S(I,22)^2+.0102/S(I,22)^2
11100 N1=1.418+.405/S(I,22)
11110 N2=1/(.748-.064/S(I,22))
11120 K1=2.962+1.448/S(I,22)
11130 K2=2.51-.801*LOG(S(I,22))
11135 C2=3.281^(N1-1.975)*K2*S(I,23)^1.025
11150 IF S(I,25)=0 THEN 11235 ELSE 11175
11155 RETURN
11175 S(I,56)=S(I,42)-S(I,25)
11180 R34=3.281^(N1-1.975)*K1*S(I,23)^1.025
11185 HA=(S(I,31)/R34)^(1/N1)
11187 S(I,57)=HA
11190 S(I,24)=S(I,56)/HA
11195 IF S(I,24)<=S(I,66)THEN GOSUB 11980:RETURN
11205 GOSUB 11670
11207 GOSUB 11970
11210 RETURN
11235 IF S(I,24)<=S(I,66)THEN 11250 ELSE 11360
11250 R34=3.281^(N1-1.975)*K1*S(I,23)^1.025
11255 HA=(S(I,31)/R34)^(1/N1)
11260 S(I,57)=HA
11265 S(I,56)=HA*S(I,24)
11270 S(I,25)=S(I,42)-S(I,56)
11272 GOSUB 11980
11275 RETURN
11360 S(I,56)=(S(I,31)*(-L10*LOG(S(I,24)))^N2/C2)^(1/N1)/(1/S(I,24)-1)
11370 S(I,57)=S(I,56)/S(I,24)
11380 S(I,25)=S(I,42)-S(I,56)
11390 GOSUB 11980
11400 RETURN
11670 S(I,57)=S(I,56)/S(I,66)
11680 GOSUB 11880
11690 R90=R43
11700 IF ABS(R90)<.01*S(I,31)THEN RETURN
11710 R50=S(I,57)
11720 IF R90<0 THEN R51=R50-.01 ELSE R51=R50+.01
11730 S(I,57)=R51
11740 GOSUB 11880
11750 R91=R43
11760 IF ABS(R91)<.01*S(I,31)THEN RETURN
11770 IF R90*R91>0 THEN R90=R91:R50=R51:GOTO 11710
11780 R52=.5*(R50+R51):S(I,57)=R52
11790 GOSUB 11880
11800 R92=R43
11810 IF ABS(R92)<.01*S(I,31)THEN RETURN
11820 IF R90*R92<0 THEN R51=R52:S(I,56)=R52:R91=R92
11830 IF R90*R92>=0 THEN R50=R52:S(I,56)=R52:R90=R92
11840 GOTO 11780
11880 R40=3.281^(N1-1.975)*K2*S(I,23)^1.025*(S(I,57)-S(I,56))^N1
11890 R41=(-L10*LOG(S(I,56)/S(I,57)))^N2
11900 R42=R40/R41:R43=S(I,31)-R42
11910 RETURN
11970 S(I,24)=S(I,56)/S(I,57)
11980 S(I,58)=(S(I,23)+4*S(I,22)/27)*S(I,57)
11990 S(I,59)=S(I,31)/S(I,58)
12000 S(I,34)=S(I,25)-S(I,2)+S(I,57)+1.1*(S(I,59)^2/2/G)
12015 GOSUB 13150
12020 RETURN
12380 S(I,66)=.85
12390 IF S(I,25)=0 THEN HA=(S(I,42)-S(I,2))*.8 ELSE S(I,56)=S(I,42)-S(I,25):HA=S
(I,56)/2
12410 FH=S(I,31)-(Y1*HA^2.5-Y2*HA^2+Y3*HA^1.5-Y4*HA+Y5*SQR(HA)-.002)
[illegible]
```

```
12430 HA1=HA-FH/FH1
12440 IF ABS(HA/HA1-1)>.01 THEN HA=HA1:GOTO 12410
12445 HA=HA1
12450 IF S(I,25)<>0 THEN GOSUB 12500:RETURN
12460 IF S(I,24)<=S(I,66)THEN GOSUB 12680 ELSE GOSUB 12730
12465 RETURN
12500 HAF=HA
12510 S=S(I,56)/HAF
12520 IF S<=S(I,66)THEN S(I,57)=HAF:S(I,24)=S:GOSUB 13110:RETURN
12550 HA=.8*HAF
12560 FHA=HA-HAF*(1+Q1*EXP(Q2*S(I,56)/HA))
12570 FHA1=1+HAF*Q1*Q2*S(I,56)/HA^2*EXP(Q2*S(I,56)/HA)
12580 HA1=HA-FHA/FHA1
12590 IF ABS(HA/HA1-1)>.01 THEN HA=HA1:GOTO 12560
12597 R76=S(I,31)-R75
12600 S(I,57)=HA1
12610 S(I,24)=S(I,56)/HA1
12630 GOSUB 13110
12640 RETURN
12680 S(I,57)=HA
12690 S(I,56)=HA*S(I,24)
12700 S(I,25)=S(I,24)-S(I,56)
12705 GOSUB 13100
12707 RETURN
12730 S(I,57)=HA*(1+Q1*EXP(Q2*S(I,24)))
12740 S(I,56)=S(I,57)*S(I,24)
12750 S(I,25)=S(I,42)-S(I,56)
12760 GOSUB 13100
12770 RETURN
13100 S(I,25)=S(I,42)-S(I,56):GOTO 13120
13110 S(I,24)=S(I,56)/S(I,57)
13120 S(I,58)=.61*S(I,57)+1.25*S(I,57)^2
13130 S(I,59)=S(I,31)/S(I,58)
13140 S(I,34)=S(I,25)-S(I,2)+S(I,57)+1.1*(S(I,59)^2/2/G)
13150 GOSUB 13320
13160 R90=R46-R47
13170 IF ABS(R90)<.01*R47 THEN 13390
13180 R50=S(I,56)
13190 IF R90<0 THEN R51=R50+.01 ELSE R51=R50-.01
13200 S(I,34)=R51
13205 GOSUB 13320
13210 R91=R46-R47
13220 IF ABS(R91)<.01*R47 THEN 13390
13230 IF R90*R91>0 THEN R90=R91:R50=R51:GOTO 13180
13240 R52=.5*(R50+R51):S(I,34)=R52
13250 GOSUB 13320
13260 R92=R46-R47
13270 IF ABS(R92)<.01*R47 THEN 13390
13280 IF R92*R90<0 THEN R51=R52:S(I,34)=R51:R91=R92
13290 IF R92*R90>=0 THEN R50=R52:S(I,34)=R50:R90=R92
13300 GOTO 13240
13320 R44=S(I,31)/(S(I,34)*S(I,6)+S(I,34)^2*S(I,4))
13330 R45=.1*(S(I,59)^2-R44^2)/2/G
13340 R46=S(I,25)+S(I,57)+S(I,58)^2/2/G+R45
13350 R47=S(I,2)+S(I,34)+R44^2/2/G
13360 RETURN
13390 S(I,33)=S(I,2)+S(I,34)
13400 RETURN
14040 S(I,60)=S(I,27)*S(I,46)
14060 S(I,33)=S(I,42)+S(I,60)
14080 S(I,34)=S(I,43)+S(I,60)
14090 RETURN
15030 IF S(I,61)=0 THEN COEF=S(I,62):KU=1 ELSE COEF=S(I,61):KU=-1
15070 S(I,34)=S(I,43)+2*S(I,45)^2/2/G
15080 GOSUB 15210
[illegible]
```

```
15100 IF ABS(R90)<.01*S(I,34)THEN 15470
15110 R60=S(I,34)
15120 IF R90<0 THEN R61=R60+.01 ELSE R61=R60-.01
15130 S(I,34)=R61
15140 GOSUB 15210
15150 R91=S(I,34)-R51
15160 IF ABS(R91)<.01*S(I,34)GOTO 15470
15162 IF R90*R91>0 THEN R90=R91:R60=R61:GOTO 15110
15163 S(I,34)=.5*(R60+R61):R62=S(I,34)
15164 GOSUB 15210
15165 R92=S(I,34)-R51
15166 IF ABS(R92)<.01*S(I,34)THEN 15470
15170 IF R90*R92<0 THEN R61=R62:S(I,34)=R62:R91=R92
15180 IF R92*R90>=0 THEN R60=R62:S(I,34)=R62:R90=R92
15190 GOTO 15163
15210 R50=(S(I,31)/(S(I,34)*S(I-1,6)+S(I,34)^2*S(I-1,6)))^2
15220 R51=S(I,43)+KU*(S(I,45)^2-R50)/2/G*(COEF+KU)
15470 S(I,33)=S(I,34)+S(I,2)
15480 RETURN
16040 S(I,34)=S(I,43)
16060 S(I,33)=S(I,42)
16070 RETURN
17030 S(I,34)=S(I,43)
17050 S(I,33)=S(I,42)
17060 RETURN
18000 F$="STA"+RIGHT$(STR$(U),LEN(STR$(U))-1)+".RES
18010 DD$=D$+F$
18020 OPEN DD$ AS #2 LEN = 18
18030 FIELD #2, 18 AS RA1$
18035 CT=1
18040 FOR S=1 TO STAMAX
18050 GOSUB 18200
18060 NEXT
18070 CLOSE#2
18080 RETURN
18200 LSET RA1$=MKS$(ST(S))
18210 PUT#2,CT
18220 FOR K=1 TO 9
18230 LSET RA1$=MKS$(S(S,PTS1(K)))
18240 CT=CT+1
18250 PUT#2,CT
18260 NEXT
18270 FOR K=1 TO 2
18280 LSET RA1$=MKS$(S(S,PTS(K,ST(S))))
18290 CT=CT+1:PUT#2,CT
18295 NEXT
18300 IF ST(S)<3 OR ST(S)>6 THEN 18410
18305 LSET RA1$=MKS$(S(S,11))
18307 CT=CT+1:PUT#2,CT
18310 LSET RA1$=MKS$(S(S,12))
18320 CT=CT+1:PUT#2,CT
18330 LSET RA1$=MKS$(S(S,32))
18340 CT=CT+1:PUT#2,CT
18410 RETURN
18500 F$="DIST.RES
18510 DD$=D$+F$
18520 OPEN DD$ AS #2 LEN = 18
18530 FIELD #2, 18 AS RA2$
18540 CT=CTOLD+1
18550 S=U:ST(S)=D(U,0)
18560 GOSUB 18200
18565 CTOLD=CT
18570 CLOSE#2
18580 RETURN
18720 DD$=D$+"DIST.RES
[illegible]
```

```
18740 FIELD #2, 18 AS RA2$
18750 CT=0
18755 PRINT:PRINT:PRINT TAB(32)"Distributary Canal":PRINT
18760 FOR S=DSMAX TO 1 STEP -1
18770 CT=CT+1:GET#2,CT
18780 ST=CVS(RA2$)
18785 T$(S)=TT$(ST)
18790 FOR K=1 TO 9
18795 CT=CT+1:GET#2,CT
18800 S(S,PTS1(K))=CVS(RA2$)
18810 NEXT
18820 FOR K=1 TO 2
18830 CT=CT+1:GET#2,CT
18840 S(S,PTS(K,ST))=CVS(RA2$)
18842 NEXT
18844 IF ST<3 OR ST>6 THEN 18860
18850 CT=CT+1:GET#2,CT
18852 S(S,11)=CVS(RA2$)
18854 CT=CT+1:GET#2,CT
18856 S(S,12)=CVS(RA2$)
18858 CT=CT+1:GET#2,CT
18859 S(S,32)=CVS(RA2$)
18860 J=S:GOSUB 19020:PRINT
18870 NEXT
18880 RETURN
19020 PRINT:PRINT TAB(35)"Station ";J;:PRINT
19025 PRINT TAB(36)"Type ";T$(J)
19026 A$=OP$(1):GOSUB 19400
19030 PRINT USING"###.###";S(J,2)
19040 A$=OP$(2):GOSUB 19400
19050 PRINT USING PU$;S(J,31)
19060 A$=OP$(3):GOSUB 19400
19070 PRINT USING PU$;S(J,33)
19080 ON VAL(MID$(T$(J),1,1))GOTO 19150,19150,19220,19340,19150,19150,19150
19150 RETURN
19200 A$=OP$(4):GOSUB 19400
19210 PRINT USING PU$;S(J,11)
19220 A$=OP$(4):GOSUB 19400
19230 PRINT USING PU$;S(J,12)
19240 A$=OP$(6):GOSUB 19400
19250 PRINT USING PU$;S(J,32)
19260 IF T$(J)<>"3A"THEN 19300
19270 A$="Pipe Diameter (m)":GOSUB 19400:PRINT USING PU$;S(J,8)
19280 A$="Gate Setting (m)":GOSUB 19400:PRINT USING PU$;S(J,9)
19290 RETURN
19300 IF T$(J)="3B"THEN A$="Siphon Diameter (m)":GOSUB 19400:PRINT USING PU$;S(J
,17):RETURN
19310 A$="Bankcut Width (m)":GOSUB 19400:PRINT USING PU$;S(J,21)
19320 RETURN
19340 A$="Submergence Ratio":GOSUB 19400:PRINT USING PU$;S(J,24)
19350 A$="Flume Floor Elevation (m)":GOSUB 19400:PRINT USING PU$;S(J,25)
19360 RETURN
19400 PRINT TAB(40-LEN(A$))A$;" = ";:RETURN
19520 QCOM=DISTFL/MESQFL
19530 IF ABS(QCOMP-1)<.05 THEN RETURN
19540 GOSUB 22000
19550 FOR S=1 TO STAMAX
19560 S(S,11)=QCOMP*S(S,11)
19570 NEXT
19580 GOSUB 1200
19590 I=U:F1=1
19600 GOSUB 20030
19610 S(U,8)=BDIAM:S(U,9)=DGH:S(U,17)=BSDIAM:S(U,21)=BWID
19620 RETURN 542
20030 GOSUB 31010
[illegible]
```

```
20045 ST = D(UU,0)
20050 FOR K=1 TO 4
20060 S(UU,K+2)=D(UU,K)
20070 NEXT
20080 S(UU,27)=D(UU,5)
20090 S(UU,2)=D(UU,6)
20100 FOR K=1 TO DATMAX(ST)
20110 S(UU,PT(ST,K))=D(UU,K+6)
20120 NEXT
20125 NEXT
20127 ST = D(U,0) : ST(U) = ST : T$(U) = TT$(ST)
20130 FOR K=1 TO 69
20140 S(U+1,K)=SOLD(K)
20150 NEXT
20190 GOSUB 31100
20200 RETURN
22000 F$="STA"+RIGHT$(STR$(U),LEN(STR$(U))-1)+".DAT
22004 DD$=D$+F$
22005 OPEN DD$ AS #1 LEN = 128
22010 FIELD #1,2 AS RA$,18 AS RA$(1),18 AS RA$(2), 18 AS RA$(3), 18 AS RA$(4), 1
8 AS RA$(5), 18 AS RA$(6), 18 AS RA$(7)
22020 GET#1,1
22030 STAMAX=CVS(RA$(7))
22040 FOR I=1 TO STAMAX:FOR K=1 TO 69:S(I,K)=0:NEXT:NEXT
22060 CN$=RA$(6)
22070 FOR S=1 TO STAMAX
22080 GET#1,S
22090 ST=CVI(RA$)
22091 ST(S)=ST
22095 T$(S)=TT$(ST)
22100 FOR J=1 TO DATMAX(ST)
22110 S(S,PT(ST,J))=CVS(RA$(J))
22115 NEXT
22120 IF ST=1 THEN 22210
22125 IF ST = 10 THEN 22150
22130 S(S,6)=S(S-1,6)
22140 S(S,4)=S(S-1,4)
22145 IF ST = 11 THEN 22210
22150 S(S,5)=S(S-1,5)
22160 S(S,3)=S(S-1,3)
22170 S(S,27)=S(S-1,27)
22210 NEXT
22220 CLOSE#1
22230 RETURN
22530 GOSUB 31010
22535 FOR S=1 TO STAMAX
22540 D(S,0)=ST(S)
22550 FOR K=1 TO 4
22560 D(S,K)=S(S,K+2)
22570 NEXT
22580 D(S,5)=S(S,27)
22590 FOR K=1 TO DATMAX(ST(S))
22600 D(S,K+6)=S(S,PT(ST(S),K))
22610 NEXT
22630 D(STAMAX,6)=S(STAMAX,2)
22635 D(STAMAX,6)=S(STAMAX,2)
22637 NEXT
22640 FOR K=STAMAX-1 TO 1 STEP-1
22650 D(K,6)=D(K+1,6)+S(K,5)*(S(K+1,1)-S(K,1))
22660 NEXT
22665 GOSUB 31100
22670 RETURN
23020 F$="STA"+RIGHT$(STR$(U),LEN(STR$(U))-1)+".OUT
23025 RETURN
23030 DD$=D$+F$
23040 OPEN DD$ AS #1 LEN = 128
```

```
23050 FIELD #1,2 AS RA$,18 AS RA$(1),18 AS RA$(2), 18 AS RA$(3), 18 AS RA$(4), 1
8 AS RA$(5), 18 AS RA$(6), 18 AS RA$(7)
23060 LSET RA$(6)=CN$
23070 LSET RA$(7)=MKS$(STAMAX)
23080 PUT#1,1
23090 FOR I=1 TO STAMAX
23100 ST=STANUM(I)
23110 LSET RA$=MKI$(ST)
23120 FOR J=1 TO DATMAX(ST)
23140 NEXT
23150 PUT#1,I
23160 NEXT
23170 CLOSE#1
23180 RETURN
29030 COLOR 7:CLS:DDEF$="B
29040 PRINT"Input Drive letter (without colon) where data is to be found.
29050 PRINT"Press enter to accept ";:COLOR 0,7:PRINT"Drive ";DDEF$:COLOR 7
29060 INPUT D$
29070 IF D$<>"a"AND D$<>"b"AND D$<>"c"AND D$<>"A"AND D$<>"B"AND D$<>"C"AND D$<>"
"THEN PRINT"Reenter drive letter.":GOTO 29060
29080 IF D$=""THEN D$=DDEF$
29090 DR$=D$+":
29100 ON ERROR GOTO 29300
29110 PRINT:PRINT"Current directories: ":PRINT
29120 FILES DR$+"*.
29130 ON ERROR GOTO 0
29140 PRINT:INPUT"Enter directory name:";DN$
29150 ON ERROR GOTO 29400
29160 D$=DR$+"\"+DN$+"\
29170 FILES D$
29180 ON ERROR GOTO 0
29190 CLS:PRINT"Program running
29200 RETURN
29300 IF ERR=53 THEN PRINT"No current directories. Please replace disk and press
 any key to continue.
29305 A$=INKEY$:IF A$=""THEN 29305
29306 RESUME 29110
29310 ON ERROR GOTO 0
29400 PRINT"Directory not found. Please reenter.":RESUME 29140
30000 REM
30010 FOR ST=1 TO 12
30020 FOR K=1 TO 5
30030 READ PT(ST,K)
30040 NEXT:NEXT
30060 DATA 3,5,4,6,27
30070 DATA 1,2,0,0,
30080 DATA 1,10,7,8,9
30090 DATA 1,16,15,14,17
30100 DATA 1,20,18,19,21
30110 DATA 1,22,23,24,25
30120 DATA 1,22,23,24,25
30130 DATA 1,26,28,0,0
30140 DATA 1,29,,,
30150 DATA 1,4,6,61,62
30160 DATA 1,3,5,27,
30170 DATA 1,,,,
30190 FOR J=1 TO 12
30200 READ TT$(J)
30210 NEXT
30230 DATA 1,2,3A,3B,3C,4A,4B,4C,5,6A,6B,7
30250 FOR I=1 TO 12
30260 READ DATMAX(I)
30270 NEXT
30290 DATA 5,2,5,5,5,5,5,3,2,5,4,1
30300 Y1=2.81:Y2=1.359:Y3=1.325:Y4=.244:Y5=.036
[illegible]
```

```
30320 Q1=5.083E-07:Q2=12.77
30330 G=9.810001:PI=3.141592654#
30340 L10=.434294481#
30350 TOL=.002:INC=.005
30360 PU$="###.###
30520 FOR K=3 TO 5
30530 PT(K,6)=11
30540 PT(K,7)=13
30550 DATMAX(K)=7
30560 NEXT
30660 FOR K=1 TO 6
30670 READ OP$(K)
30680 NEXT
30690 DATA Bottom Elevation (m),Flow Rate in Section (m^3/s),Upstream Water Surf
ace Elevation (m)
30700 DATA Actual Flow Rate (m^3/s),Design Flow Rate (m^3/s),Turnout Head Loss (
m)
30810 FOR K=1 TO 12
30820 FOR J=1 TO 2
30830 READ PTS(J,K)
30840 NEXT:NEXT
30850 DATA 0,0,0,0
30860 DATA 8,9,17,0,21,0
30870 DATA 24,25,24,25,28,0
30880 DATA 0,0,0,0,0,0,0,0
30900 FOR K=1 TO 9:READ PTS1(K):NEXT
30910 DATA 1,2,31,33,34,36,42,43,45
30990 RETURN
31010 FOR K=3 TO 5
31020 DATMAX(K)=5
31030 NEXT
31040 RETURN
31100 FOR K=3 TO 5
31110 DATMAX(K)=7
31120 NEXT
31130 RETURN
Ok
```

APPENDIX G: NOTATION

APPENDIX G: NOTATION

The following symbols are used in this report.

Symbol	Description	Units
A	Cross-sectional area of flow in a channel	(m^2)
A(i,j,k)	Velocity of flow (average) in a bankcut at STA(i,j,k)	(m/s)
A_a(i)	Cross-sectional area of flow at the point where H_a(i) is measured in flume at STA(i) on the distributary canal	(m^2)
A_a(i,j)	Cross-sectional area of flow at the point where H_a(i,j) is measured in flume at STA(i,j) on a farm channel	(m^2)
Ad(i)	Cross-sectional area of flow in the distributary canal just downstream of STA(i)	(m^2)
Ad(i,j)	Cross-sectional area of flow in a farm channel just downstream of STA(i,j)	(m^2)
Au(i)	Cross-sectional area of flow in the distributary canal just upstream of STA(i)	(m^2)
Au(i,j)	Cross-sectional area of flow in a farm channel just upstream of STA(i,j)	(m^2)
C_s(i,j)	Discharge coefficient of siphon tube for turnout at STA(i,j) on a farm channel	
D	Depth of flow in a channel	(m)
D_{cg}	Depth from water surface to the center of gravity of a channel section	(m)
Dd(i)	Flow depth in the distributary canal just downstream of STA(i)	(m)
Dd(i,j)	Flow depth in a farm channel just downstream of STA(i,j)	(m)

Symbol	Description	Units
Du(i)	Flow depth in the distributary canal just upstream of STA(i)	(m)
Du(i,j)	Flow depth in a farm channel just upstream of STA(i,j)	(m)
d(i,j,k)	Flow depth in a bankcut at STA(i,j,k)	(m)
$d_g(i)$	Height of the bottom of the gate above the pipe invert at STA(i) on the distributary canal	(m)
$d_g(i,j)$	Height of the bottom of the gate above the pipe invert at STA(i,j) on a farm channel	(m)
$d_p(i)$	Diameter (inside) of the pipe for turnout at STA(i) on the distributary canal	(m)
$d_p(i,j)$	Diameter (inside) at the pipe for turnout at STA(i,j) on a farm channel	(m)
$d_s(i,j)$	Diameter (inside) of siphon tube for turnout at STA(i,j) on a farm channel	(m)
E(i)	Channel bottom elevation at STA(i) on the distributary canal	(m)
E(i,j)	Channel bottom elevation at STA(i,j) on a farm channel	(m)
$E_b(i,j)$	Elevation of floor of bankcut turnout at STA(i,j) on a farm channel	(m)
$E_c(i)$	Crest elevation of check at STA(i) on the distributary canal	(m)
$E_c(i,j)$	Crest elevation of check at STA(i,j) on a farm channel	(m)
$E_f(i)$	Floor elevation of flume at STA(i) on the distributary canal	(m)

Symbol	Description	Units
$E_f(i,j)$	Floor elevation of flume at STA(i,j) on a farm channel	(m)
EL(i,j,k)	Energy line elevation in a bankcut at STA(i,j,k)	(m)
EL(i,j,k)'	New energy line elevation in a bankcut at STA(i,j,k)	(m)
ELd(i)	Energy line elevation in the distributary canal just downstream of STA(i)	(m)
ELd(i,j)	Energy line elevation in a farm channel just downstream of STA(i,j)	(m)
Eld(i)'	New energy line elevation in the distributary canal just downstream of STA(i)	(m)
ELd(i,j)'	New energy line elevation in a farm channel just downstream of STA(i,j)	(m)
ELu(i)	Energy line elevation in the distributary canal just upstream of STA(i)	(m)
ELu(i,j)	Energy line elevation in a farm channel just upstream of STA(i,j)	(m)
F	Resultant force acting in the line of flow on a channel section due to water presure	(N)
Fd(i)	Resultant force in the line of flow in the distributary canal due to the water pressure on the section just downstream of STA(i)	(N)
Fd(i,j)	Resultant force in the line of flow in a farm channel due to the water pressure on the section just downstream of STA(i,j)	(N)
Fu(i)	Resultant force in the line of flow in the distributary canal due to the water pressure on the section just upstream of STA(i)	(N)

Symbol	Description	Units
Fu(i,j)	Resultant force in the line of flow in a farm channel due to the water pressure on the section just upstream of STA(i,j)	(N)
f(i)	Friction factor of pipe for turnout at STA(i) on the distributary canal	
f(i,j)	Friction factor of pipe for turnout at STA(i,j) on a farm channel	
G_1	Absolute difference between design value of turnout flow rate and computed actual value	(m^3/s)
G_2	Absolute difference between old value of channel flow rate and new computed value	(m^3/s)
G_3	Absolute difference between old value of actual turnout flow rate and new computed value	(m^3/s)
g	Acceleration due to gravity	(m/s^2)
$H_a(i)$	Upstream flow depth in flume at STA(i) on the distributary canal	(m)
$H_a(i,j)$	Upstream flow depth in flume at STA(i,j) on a farm channel	(m)
$H_b(i)$	Downstream flow depth in flume at STA(i) on the distributary canal	(m)
$H_b(i,j)$	Downstream flow depth in flume at STA(i,j) on a farm channel	(m)
HL(i)	Head loss due to friction in the distributary canal between STA(i-1) and STA(i)	(m)
HL(i,j)	Head loss due to friction in a farm channel between STA(i,j-1) and STA(i,j)	(m)
HL(i,j,k)	Head loss due to friction in a bankcut between STA(i,j,k-1) and STA(i,j,k)	(m)

Symbol	Description	Units
$H_t(i)$	Head loss through the pipe turnout at STA(i) on the distributary canal	(m)
$H_t(i,j)$	Head loss through the turnout at STA(i,j) on a farm channel	(m)
$h_{c1}(i)$	Upstream head over crest of check structure at STA(i) on the distributary canal	(m)
$h_{c1}(i,j)$	Upstream head over crest of check structure at STA(i,j) on a farm channel	(m)
$h_{c2}(i)$	Downstream head over crest of check structure at STA(i) on the distributary canal	(m)
$h_{c2}(i,j)$	Downstream head over crest of check structure at STA(i,j) on a farm channel	(m)
$h_{\ell b}(i)$	Head loss due to bend at STA(i) on the distributary canal	(m)
$h_{\ell b}(i,j)$	Head loss due to bend at STA(i,j) on a farm channel	(m)
$h_{\ell c}$	Head loss due to sudden contraction of channel section	(m)
$h_{\ell e}$	Head loss due to sudden enlargement of channel section	(m)
$h_{\ell f}$	Energy loss due to friction between the section just upstream of flume and the section where the upstream flow depth in the flume is measured	(m)
K_1	Coefficient used in free flow equation for cutthroat flume	
K_2	Coefficient used in submerged flow equation for cutthroat flume	

Symbol	Description	Units
$K_b(i)$	Coefficient for head loss due to bend at STA(i) on the distributary canal	
$K_b(i,j)$	Coefficient for head loss due to bend at STA(i,j) on a farm channel	
$K_c(i)$	Coefficient for head loss due to channel contraction at STA(i) on the distributary canal	
$K_c(i,j)$	Coefficient for head loss due to channel contraction at STA(i,j) on a farm channel	
$K_e(i)$	Coefficient for head loss due to channel enlargement at STA(i) on the distributary canal	
$K_e(i,j)$	Coefficient for head loss due to channel enlarge- at STA(i,j) on a farm channel	
KE(i,j,k)	Kinetic energy of flow in a bankcut at STA(i,j,k)	(m)
KEd(i)	Kinetic energy of flow in the distributary canal just downstream of STA(i)	(m)
KEd(i,j)	Kinetic energy of flow in a farm channel just downstream of STA(i,j)	(m)
KEu(i)	Kinetic energy of flow in the distributary canal just upstream of STA(i)	(m)
KEu(i,j)	Kinetic energy of flow in a farm channel just upstream of STA(i,j)	(m)
$K_o(i)$	Entrance head loss coefficient for pipe with gate at STA(i) on the distributary canal	
$K_o(i,j)$	Entrance head loss coefficient for pipe with gate at STA(i,j) on a farm channel	
$K_s(i,j)$	Entrance head loss coefficient of siphon tube for turnout at STA(i,j) on a farm channel	

Symbol	Description	Units
$L(i)$	Distance of STA(i) from the head of the distributary canal	(m)
$L(i,j)$	Distance of STA(i,j) from the head of a farm channel	(m)
$L_b(i,j)$	Elevation of floor of bankcut turnout at STA(i,j) on a farm channel	(m)
$L_c(i)$	Crest length of check at STA(i) on the distributary canal	(m)
$L_c(i,j)$	Crest length of check at STA(i,j) on a farm channel	(m)
$L_f(i)$	Length of the flume located at STA(i) on the distributary canal	(m)
$L_f(i,j)$	Length of the flume located at STA(i,j) on a farm channel	(m)
$L_p(i)$	Length of pipe for turnout at STA(i) on the distributary canal	(m)
$L_p(i,j)$	Length of pipe for turnout at STA(i,j) on a farm channel	(m)
$L_s(i,j)$	Length of siphon tube for turnout at STA(i,j) on a farm channel	(m)
M	Total number of stations along the distributary canal	
$N(i)$	Total number of stations along the farm channel located at STA(i) on the distributary canal	
$n(i)$	Channel hydraulic roughness at STA(i) on the distributary canal	$(s/m^{1/3})$
$n(i,j)$	Channel hydraulic roughness at STA(i,j) on a farm channel	$(s/m^{1/3})$

Symbol	Description	Units
n_1	Exponent used in free flow equation for cutthroat flume	
n_2	Exponent used in submerged flow equation for cutthroat flume	
$n_b(i,j)$	Hydraulic roughness of bankcut turnout at STA(i,j) on a farm channel	$(s/m^{1/3})$
$n_s(i,j)$	Roughness coefficient of siphon tube for turnout at STA(i,j) on a farm channel	$(s/m^{1/3})$
P	Number of computational stations along a bankcut	
P(i,j,k)	Wetted perimeter in a bankcut at STA(i,j,k)	(m)
Pd(i)	Wetted perimeter in the distributary canal just downstream of STA(i)	(m)
Pd(i,j)	Wetted perimeter in a farm channel just downstream of STA(i,j)	(m)
Pu(i)	Wetted perimeter in the distributary canal just upstream of STA(i)	(m)
Pu(i,j)	Wetted perimeter in a farm channel just upstream of STA(i,j)	(m)
Q(i)	Flow rate in the distributary canal at STA(i)	(m^3/s)
Q(i,j)	Flow rate in a farm channel at STA(i,j)	(m^3/s)
Q(i)'	New computed value of flow rate in the distributary canal at STA(i)	(m^3/s)
Q(i,j)'	New computed value of flow rate in a farm channel at STA(i,j)	(m^3/s)
Q_d	Gross daily flow rate	(m^3/s)

Symbol	Description	Units
q(i)	Actual flow rate for turnout at STA(i) on the distributary canal	(m^3/s)
q(i,j)	Actual flow rate for turnout at STA(i,j) on a farm channel	(m^3/s)
q(i,j)'	New computed value of turnout flow rate at STA(i,j) on a farm channel	(m^3/s)
q_d(i,j)	Design flow rate for turnout at STA(i,j) on a farm channel	(m^3/s)
R(i,j,k)	Hydraulic radius in a bankcut at STA(i,j,k)	(m)
Rd(i)	Hydraulic radius in the distributary canal just downstream of STA(i)	(m)
Rd(i,j)	Hydraulic radius in the distributary canal just downstream of STA(i,j)	(m)
Ru(i)	Hydraulic radius in a farm channel just upstream of STA(i)	(m)
Ru(i,j)	Hydraulic radius in a farm channel just upstream of STA(i,j)	(m)
SF(i,j,k)	Friction slope in a bankcut at STA(i,j,k)	(m/m)
SF_a(i)	Average friction slope in the distributary canal between STA(i-1) and STA(i)	(m/m)
SF_a(i,j)	Average friction slope in a farm channel between STA(i,j-1) and STA(i,j)	(m/m)
SF_a(i,j,k)	Average friction slope in a bankcut between STA(i,j,k-1) and STA(i,j,k)	(m/m)
SFd(i)	Friction slope in the distributary canal just downstream of STA(i)	(m/m)
SFd(i,j)	Friction slope in a farm channel just downstream of STA(i,j)	(m/m)

Symbol	Description	Units
SFu(i)	Friction slope in the distributary canal just upstream of STA(i)	(m/m)
SFu(i,j)	Friction slope in a farm channel just upstream of STA(i,j)	(m/m)
S_o(i)	Channel bottom slope at STA(i) on the distributary canal	(m/m)
S_o(i,j)	Channel bottom slope at STA(i,j) on a farm channel	(m/m)
SR(i)	Submergence ratio of flume at STA(i) on the distributary canal	
SR(i,j)	Submergence ratio of flume at STA(i,j) on a farm channel	
SR_c(i)	Submergence ratio for check structure at STA(i) on the distributary canal	
SR_c(i,j)	Submergence ratio for check structure at STA(i,j) on a farm channel	
SR_t(i)	Transition submergence of flume at STA(i) on the distributary canal	
SR_t(i,j)	Transition submergence of flume at STA(i,j) on a farm channel	
STA(i)	Station (i) on the distributary canal	
STA(i,j)	Station (j) on the farm channel located at station (i) on the distributary canal	
STA(i,j,k)	Station (k) on the bankcut channel located at station (j) on the farm channel located at station (i) on the distributary canal	
s	Seepage rate per unit length of the distributary canal	[(m^3/s)/m]

Symbol	Description	Units
$s(i)$	Seepage rate per unit length of the farm channel located at STA(i) on the distributary canal	[(m^3/s)/m]
$V(i,j,k)$	Velocity of flow (average) in a bankcut at STA(i,j,k)	(m/s)
$V_a(i)$	Velocity of flow (average) at point where $H_a(i)$ is measured in flume at STA(i) on the distributary canal	(m/s)
$V_a(i,j)$	Velocity of flow (average) at point where $H_a(i,j)$ is measured in flume at STA(i,j) on a farm channel	(m/s)
$Vd(i)$	Velocity of flow (average) in the distributary canal just downstream of STA(i)	(m/s)
$Vd(i,j)$	Velocity of flow (average) in a farm channel just downstream of STA(i,j)	(m/s)
$Vu(i)$	Velocity of flow (average) in the distributary canal just upstream of STA(i)	(m/s)
$Vu(i,j)$	Velocity of flow (average) in a farm channel just upstream of STA(i,j)	(m/s)
W	Channel bottom width	(m)
$W(i)$	Channel bottom width at STA(i) on the distributary canal	(m)
$W(i,j)$	Channel bottom width at STA(i,j) on a farm channel	(m)
$W_b(i,j)$	Width of bankcut turnout at STA(i,j) on a farm channel	(m)
$W_f(i)$	Throat width of flume at STA(i) on the distributary canal	(m)

Symbol	Description	Units
$W_f(i,j)$	Throat width of the flume at STA(i,j) on a farm channel	(m)
$WS(i,j,k)$	Water surface elevation in a bankcut at STA(i,j,k)	(m)
$WSd(i)$	Water surface elevation in the distributary canal just downstream of STA(i)	(m)
$WSd(i,j)$	Water surface elevation in a farm channel just downstream of STA(i,j)	(m)
$WS_t(i)$	Tailwater surface elevation on pipe outlet to farm channel at STA(i) on the distributary canal	(m)
$WS_t(i,j)$	Elevation of water surface on field at the outlet of turnout at STA(i,j) on a farm channel	(m)
$WSu(i)$	Water surface elevation in the distributary canal just upstream of STA(i)	(m)
$WSu(i,j)$	Water surface elevation in a farm channel just upstream of STA(i,j)	(m)
Z	Channel side slope	
$Z(i)$	Channel side slope at STA(i) on the distributary canal	
$Z(i,j)$	Channel side slope at STA(i,j) on a farm channel	
ΔL	Length of short channel section at location of turnout	(m)
ρ	Mass density of water	(kg/m^3)