SOFTWARE APPLICATION "BALBYKAN"
FOR HYDRAULIC CALCULATION, ENGINEERING DESIGN, AND
SIMULATION OF SEWERAGE SYSTEMS
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ABSTRACT

The author's work, software application "BALBYKAN", solves the problem of hydraulic calculation, engineering design and simulation of sewerage system in general. Software application "BALBYKAN" is suitable for simple and fast data input and also for simple and fast calculation.

Software application "BALBYKAN" performs the hydraulic calculation of sewerage systems according to the classical principle, but unlike the classical principle, which demands painstaking calculation, value by value, step by step, it significantly simplifies the terms of flow.

For input data the software application "BALBYKAN" demands values which are usual in sewerage system calculations based on the classical method of calculation. This software application is designed as a simple engineering tool which, according to the usual data divided into five different groups, defines the sewerage system in a settlement.

As a result of the calculation of software application "BALBYKAN", values are obtained in tabular form, and they are compatible with the demands of classical forms for the hydraulic calculation of sewerage systems.

TECHNICAL BRANCH THE AUTHOR'S WORK REFERS TO

The author's work belongs to the branch of software applications in general, that is to the branch of software applications for solving hydraulic and construction problems, and it specifically refers to hydraulic calculation, engineering design and simulation of sewerage systems.

TECHNICAL PROBLEM

The author's work, software application "BALBYKAN", solves the problem of hydraulic

calculation, engineering design and simulation of sewerage systems in general. Software application "BALBYKAN" is suitable for simple and fast data input. For input data software application "BALBYKAN" demands values which are usual for sewerage system calculation according to the classical method of calculation.

REVIEW OF THE STATE OF TECHNICS IN THE WORLD AND IN OUR COUNTRY

Software applications which exist in the world and in our country, BEMUS (Hydrotechnical Institute at the Civil Engineering Faculty, Belgrade), SWIMM U.S. EPA (Agency of environmental protection against pollution, USA), MOUSE (Danish Hydrotechnical Institute), serve primarily for the calculation of outflow and hydraulic calculation of rainwater drainage, and therefore they call for a great number of input values which are necessary for calculation. The time for data input is too long and the requested input data are frequently inaccessible so that they must be supposed, which affects the precision of calculation.

In engineering and technical practice, the existing software applications for calculation and simulation of small sewerage systems, sewerage systems in a small settlement, and for the engineering design of sewerage systems in a small settlement, are not quite practical.

The existing software applications represent theoretical complication of problems in sewerage system calculation where, during these calculations, differential equations describing the movement in the main sewers must be solved.

According to the classical engineering calculation there is a certain simplification of the flow conditions in sewerage systems, and the hydraulic calculation itself is usually solved through the calculation in a tabular form or in standard forms (which must be filled in). The essential problem with the classical calculation is that for each pipe there are about 15 values that must be calculated (this number varies depending on the number of values shown in a table). Part of the values which must be filled into the standard form for hydraulic calculation are calculated by simple mathematics, but part of them, due to the complicated formulas, must be read from graphs and tables. A sewerage system consists of a large number of pipes, so if we suppose that a system has 100 pipes, the number of values to be calculated rises to about 1500. All this is additionally complicated by the fact that an

error in the first part of the calculation causes errors in the following stages of the calculation, so that the whole calculation procedure must be repeated after noticing an error. This is the reason why classical calculation and its variations become difficult or practically impossible.

PRESENTATION OF THE ESSENCE OF THE AUTHOR'S WORK

Software application "BALBYKAN" is written in the programme language MICROSOFT FORTRAN 5.10. All the real variables are defined as DOUBLE PRECISION. The result of the calculation is presented in the output file in two forms: the form for DOS monitor review and the form suitable for the tabular presentation in the text processor Microsoft Word for Windows.

The software application is designed as a simple engineering tool which, according to the usual data divided into five different groups, defines the sewerage system in a settlement. The basic data groups necessary for the application work are:

1) Project name (defined with 80 characters maximum)

2) Number of junctions and number of pipes (number of junctions and number of pipes are entered).

3) Input data about water consumption in a settlement, the number of inhabitants, coefficient of non-uniformity (number of inhabitants, average daily water consumption in a settlement - expressed in litres per inhabitant daily, coefficient of daily non-uniformity and coefficient of hour non-uniformity.

4) Input data about junctions (number of a junction, junction level in metres above sea level, type of junctions (0- initial, 1 - transfer, 2 - inflow, 3 - pumping station, 4 - cascade; pumping station and cascade are entered as depth from the terrain to the crown of the canal after the junction exit (outlet); for 0 type of junctions the initial digging depth is entered, while for other junction types type 0 is written; if there is a special junction inflow (inlet), it may be defined as inflow (inlet) in m^3/s).

5) Input data about pipes (mark - number of an upstream junction, mark - number of a downstream junction, pipe length in metres, pipe diameter in mm, absolute roughness or working roughness of pipes in millimetres, population density coefficient).

This software application itself consists of many application blocks which perform certain function wholes.

Description of the work of software application "BALBYKAN"

The whole program "BALBYKAN" is based on the following assumptions:

- in order to formulate the mathematical model of flow in sewerage systems, a system is divided into these basic elements: 1) sections without local facilities (except on its ends); 2) junctions which are considered to be local facilities (initial manholes, cascades, pumping stations, transfer manholes where two or more pipes intersect, the last downstream manhole before a recipient or a waste-water treatment plant),

- if along the sewerage section - canal water is accumulated from the users of sewerage system or from storm water, then it is usually assumed that the inflow to the canal is equally distributed along its total length. If along a canal whose length is L, there is a regular flow of a quantity of water q, then the flow in the upstream end of the canal Q_u is equal to the total quantity of water which reaches its upstream junction. In the downstream junction of this canal the quantity water Q_n which will flow out will be equal to $Q_n = Q_u + L \times q$. The dimensions of a canal are calculated according to the flow in the downstream profile Q_n.

The program works under DOS and Microsoft Windows operative system. The minimal necessary system (hardware + software):

    *DOS and Windows Word 3.1

    *80 386 processor

    *4 megabyte,

    *10-megabyte-space on the hard disk

    RECOMMENDATION: mathematical coprocessor is recommended, but it is not essential.

    Making the input datafile is based on the matrix datefile and it will be illustrated by a concrete example. Picture 1 presents a simple sewerage system of a highway tourist centre. On location there are many facilities for guests and employees. The plan is given in proportion 1: 2 500, and sewerage network is marked in red. This is an example of the input

file in this concrete case.

LAPOVO TOURIST CENTER (ON HIGHWAY), SEWERAGE SYSTEM,
TOTAL NUMBER OF JUNCTION; TOTAL NUMBER OF PIPES
30 29
NUM INHAB.,QAVER.DAY(L/DAY),KMAXDAY,KMAXHOUR
0 0 1 1
JUNCTIONS
JUNCT. NUMB.; (Z) JUNCT. (M.A.S.); JUNC. TYPE (0-INITIAL, 1-TRANSFER, 2-INFLOW, 3-P.S.,
4-CASCADE); PS AND CASC. ARE ENTERED AS DEPTH FROM TERRAIN TO THE CROWN OF THE
CANAL AFTER THE JUNCTION EXITSE; FOR 0 TYPE ENTER INITIAL DIGGING DEPTH TO THE
CROWN OF THE CANAL, FOR TYPE 1 0; SPECIAL JUNCTION INFLOW IN (M3/S)
1 102.28 0 2.2 0.0005
2 102.45 1 0 0.0005
3 101.92 0 2.0 0.0005
4 102.10 1 0 0.0005
5 102.28 1 0 0.0005
6 101.66 0 2.16 0.0005
7 101.71 1 0 0.0005
8 102.30 1 0 0.0005
9 102.60 1 0 0.0005
10 102.26 1 0 0.0005
11 102.20 1 0 0.0005
12 102.41 1 0 0.0005
13 102.51 0 2.0 0.0005
14 102.58 1 0 0.0005
15 102.60 1 0 0.0005
16 102.24 0 2.0 0.0005
17 102.38 1 0 0.0005
18 102.47 1 0 0.0005
19 102.07 1 0 0.0005
20 102.42 1 0 0.0005
21 102.22 1 0 0.0005
22 101.26 1 0 0
23 101.26 2 0 0
24 102.52 1 0 0
25 101.20 0 2.0 0.0005
26 101.18 0 2.0 0.0005
27 101.40 1 0 0.0005
28 101.20 0 2.0 0.0005
29 101.73 1 0 0
30 102.70 1 0 0.0005
PIPES
UPST.JUN;DOWN.JUN;LEN.PIP(m);DIAMETAR(mm);SLOPE;ROUGHNESS kd(mm):POPULAT. DENSITY
1 2 60.25 300 0.004 1.5 1
2 5 58.89 300 0.004 1.5 1
3 4 34.80 300 0.004 1.5 1
4 5 45.89 300 0.004 1.5 1
5 30 41.00 300 0.004 1.5 1
30 9 32.44 300 0.004 1.5 1
6 7 61.24 300 0.004 1.5 1
7 8 75.61 300 0.004 1.5 1
8 9 77.05 300 0.004 1.5 1
9 24 50.25 300 0.004 1.5 1
24 10 60.50 300 0.004 1.5 1
10 11 81.94 300 0.01 1.5 1
11 12 41.17 300 0.004 1.5 1
12 15 31.02 300 0.004 1.5 1
13 14 35.65 300 0.004 1.5 1

14 15 24.09 300 0.004 1.5 1
15 18 40.04 300 0.004 1.5 1
16 17 39.01 300 0.004 1.5 1
17 18 39.70 300 0.004 1.5 1
28 29 49.57 300 0.004 1.5 1
29 19 57.05 300 0.004 1.5 1
18 21 10.12 300 0.004 1.5 1
19 20 56.99 300 0.004 1.5 1
20 21 59.00 300 0.004 1.5 1
21 22 54.92 300 0.004 1.5 1
22 23 30.55 300 0.004 1.5 1
25 27 56.78 300 0.004 1.5 1
27 22 55.88 300 0.004 1.5 1
26 27 61.50 300 0.004 1.5 1
INPUT END

CALCULATION

For a concrete input, the solution of hydraulic calculation for the sewerage system is reached and shown in the table in the enclosure (Table 1 and 2). The result of work estimates for sections (each section respectively) and overall work estimate (recapitulation of all works) (See Table 3 to 5).

In order to understand the procedure of solving, there is also a graphic enclosure of the iterative procedure where program "BALBYKAN" is used for solving the concrete system in Picture 1. The solution of hydraulic calculation for the whole sewerage system in the given case is performed in 14 iteration procedures (including the initial state as the first iteration) (Enclosures 6 to 8).

A description of the some function blocks is given below:

The first block serves for entering the names of input and output datafile. The program requests that the names of input datafile and output datafile be entered, while the calculation results will be written in the latter. This block covers the total number of junctions and pipes of the sewerage system for which the calculation is made. It is also checked whether the number of junctions and the number of pipes is larger than the maximum permitted number.

In the **second block** the data about the number of inhabitants, average daily consumption of water in a settlement, coefficient of daily non-uniformity and coefficient of hour non-uniformity. On the basis of the entered data the maximum flow in the sewerage system is calculated and it is expressed in (l/s).

In the **third block** the input data for junctions are entered. The data about junctions include the following information:

- number of a junction
- junction level in metres above sea level
- type of junctions (0- initial, 1 - transfer, 2 - inflow, 3 - pumping station, 4 - cascade; pumping station and cascade are entered as depth from the terrain to the crown of the canal after the junction exit (outlet); N.B. For 0 type of junctions the initial digging depth is entered, while for other junction types type 0 is written.
- special junction inflow (inlet) (if there is special junction inflow/inlet, it may be defined as inflow/inlet in m^3/s).

In the **fourth block** the input data for pipes are entered. The data about pipes include the following information:

- mark - number of an upstream junction
- mark - number of a downstream junction
- pipe length in metres, pipe diameter in millimetres
- pipe slope in ‰
- absolute roughness of pipes, that is working roughness of pipes in millimetres
- population density coefficient

In the **fifth block** the control of the entered input data is performed. It is checked if the same number marks more different junctions. It is also checked if the junctions in a pipe are marked by the same number and there is a warning if the junction in a pipe is marked by a wrong number. This block also checks if the number of pipes which enter each separate junction) is larger than the permitted one. Finally it is checked if all the pipes are marked correctly.

The **sixth block** covers the conversion of input values into the basic units of SI system. The data about pipe diameter expressed in millimetres is converted into metres and the data about absolute - working roughness expressed in millimetres is converted into metres.

From the seventh block to the fourteenth block comprises hydraulic calculation.

The **fourteenth block** is used for the correction of real calculated depth and for

calculation and transformation for oval sewerage collectors.

The **fifteenth block** is a block for calculating estimates for the work. Work estimates are calculated for each section separately and collectively in the following categories:

1)   Total length pipe for the given pipe diameters.

2)   Volumes of different categories of digging up to 2-metre depth, from 2 to 4-metre depth, from 4 to 6 metres, and over 6-metre depth.

3)   Surface of the trench supports

4)   Volume of sand used for filling under the pipe (10 cm) around the pipe (up to the trench D + 70 cm) and above the pipe (40 cm above the crown of the pipe)

5)   Surplus of earth to be taken away

The **sixteenth block** is for printing results in the form of a text file which is transformed into the tabular form after the input in Microsoft Word for Windows editor, by a simple change and command Find and Replace. All the formats are printed in such a way that between all the formats for printing variables there is form ', which is shown later in the file text as a comma between numeral values. After inserting all blank characters, the command to Convert Text to Table is given.

Page 9 brings Picture 1. Sewerage system of a highway tourist centre. Pages 13, 14, 15, 16 and 17 show the results of hydraulic calculation and estimates for the work in tables (Table 1, 2, 3, 4 and 5). In pages 10, 11 and 12 there is a graphic presentation of iterative solution to hydraulic calculation of the overall sewerage system in the given case (including the starting condition as the first iteration

The enclosed program (BALBYKAN. EXE 56052, 3/25/98 13:59:46) represents a demonstration version of program BALBYKAN for the calculation for up to 31 pipes. The enclosed program works only with the given input tile. There is a small theoretical possibility that a certain combination of input parameters allows the program to be activated for a different case. The original code of program BABLYKAN.FOR is in the author's archive.

Picture 1: Sewerage system of a highway tourist centre
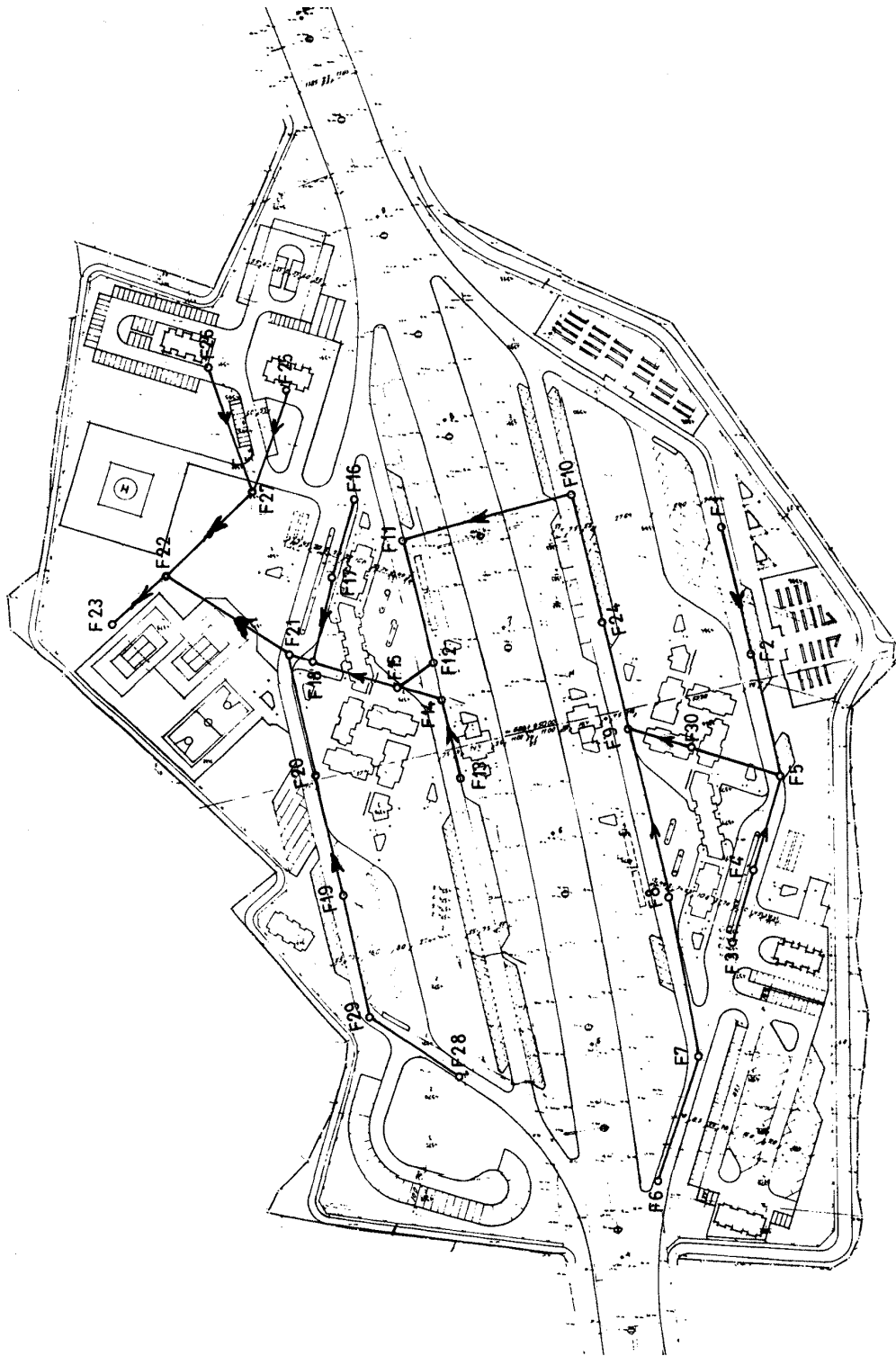
Graphic presentation of the iterative solution of program BALBYKAN
(from I to (from VII to VI iteration)

I iteration

II iteration

III iteration

IV iteration

V iteration
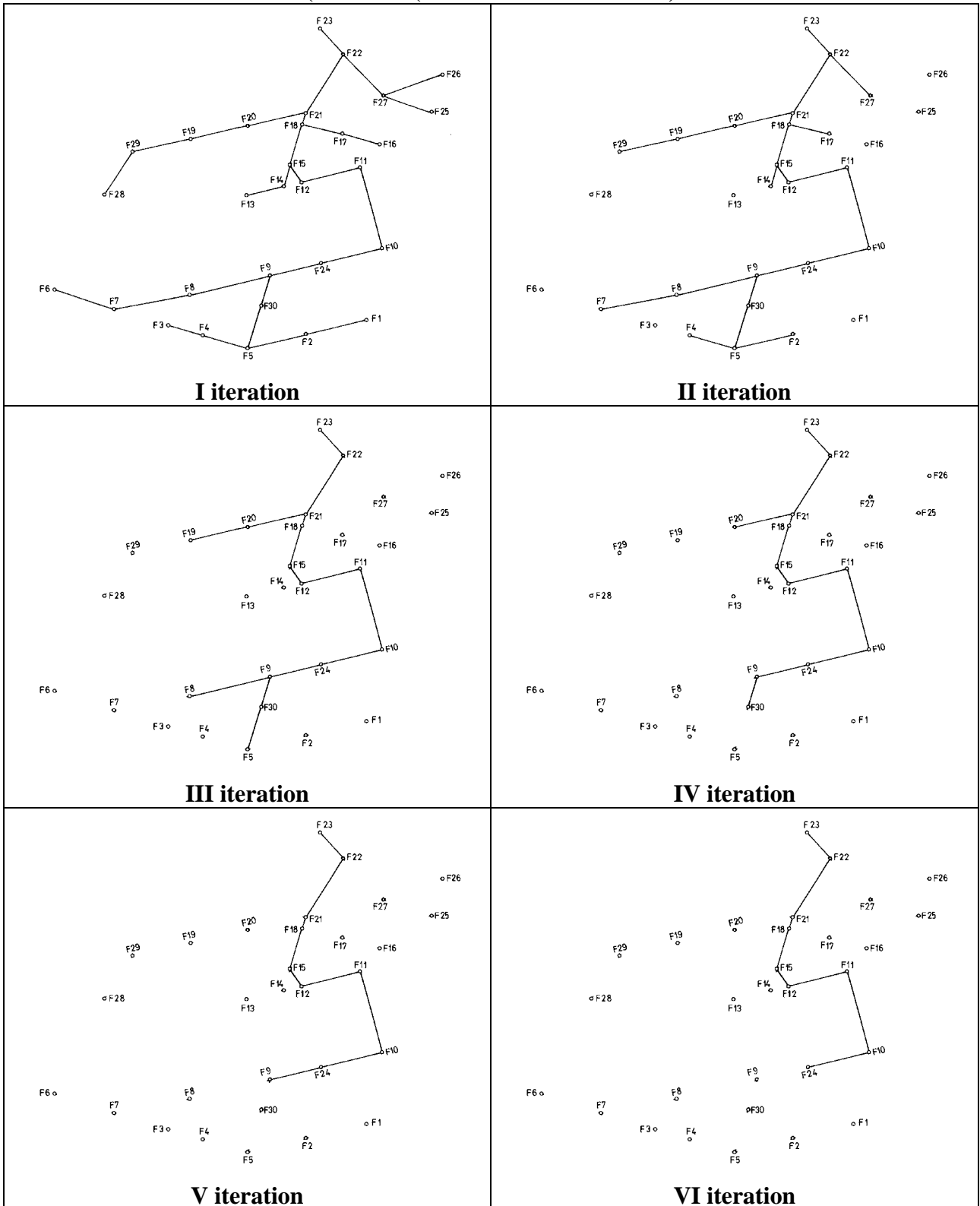
VI iteration

Graphic presentation of the iterative solution of program BALBYKAN
(from VII to XII iteration)

VII iteration

VIII iteration

IX iteration

X iteration

XI iteration
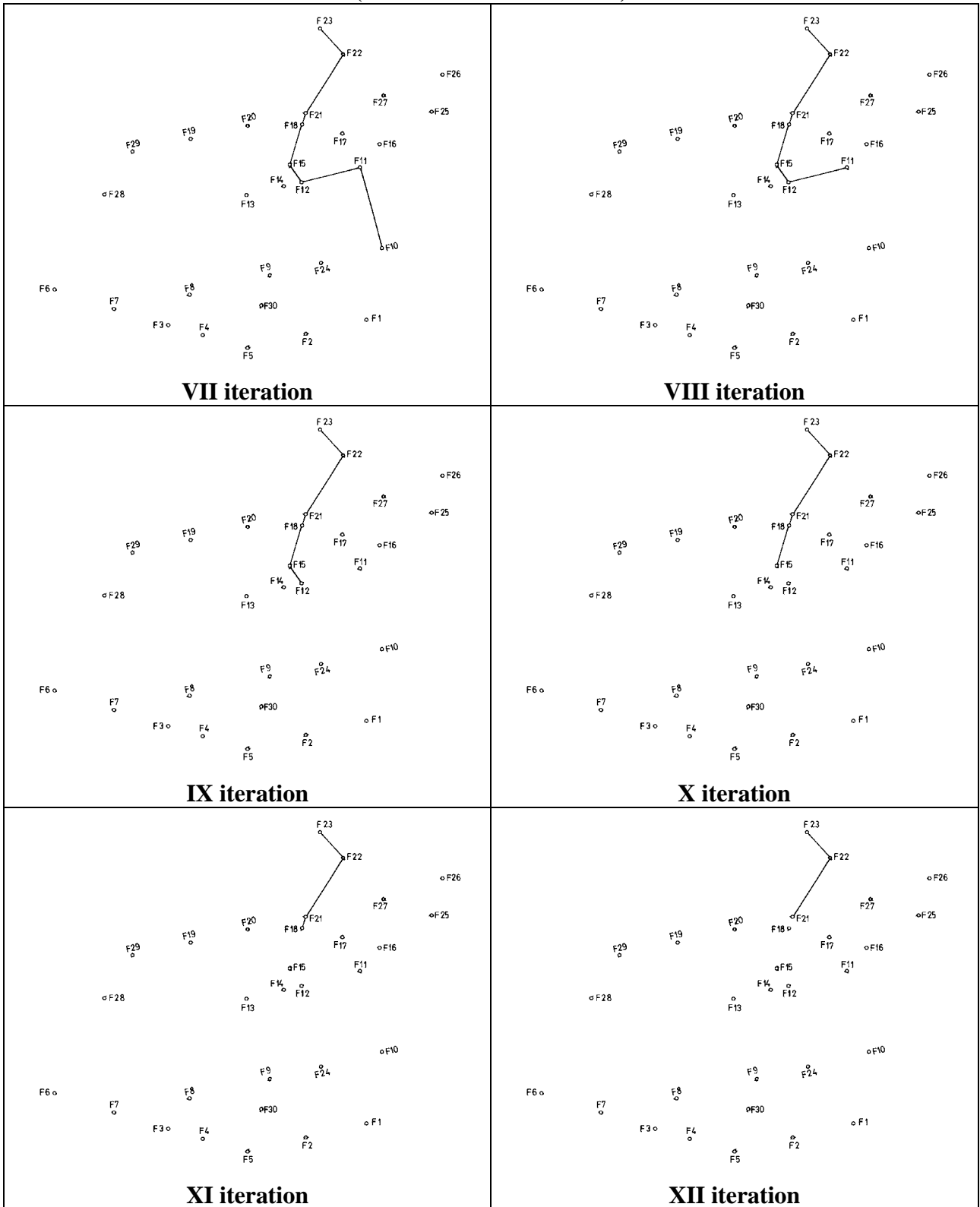
XII iteration

Graphic presentation of the iterative solution of program BALBYKAN
(from XIII to XIV iteration)
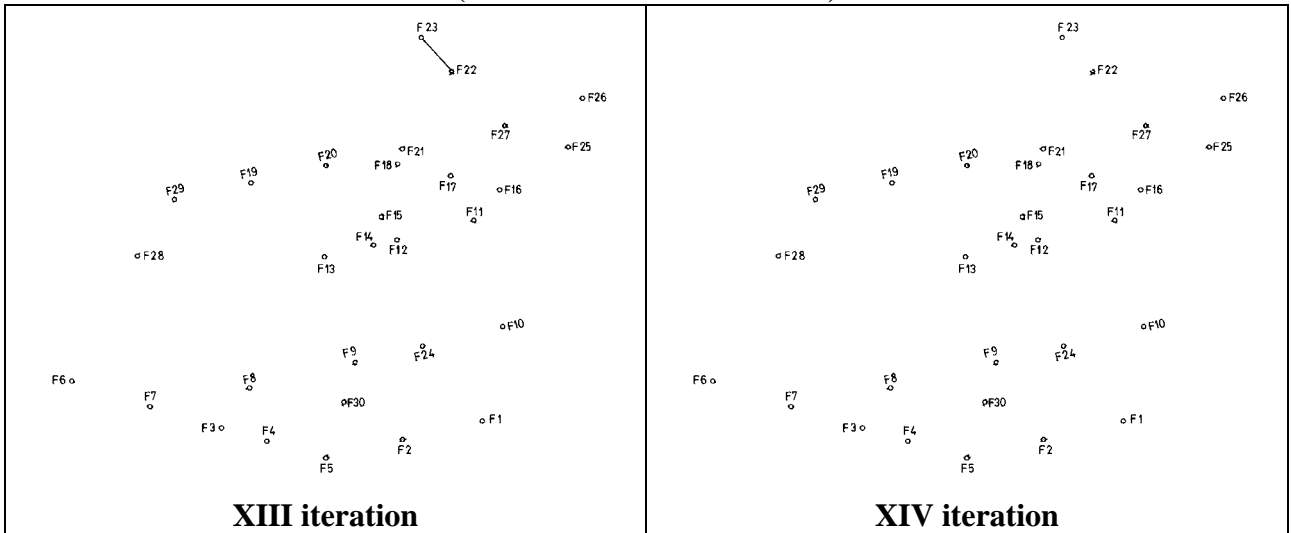
XIII iteration   **XIV iteration**

SOFTWARE APPLICATION "BALBYKAN"
FOR HYDRAULIC CALCULATION, ENGINEERING DESIGN, AND SIMULATION OF SEWERAGE SYSTEMS
(PLAPIZFK.DOC - BBYKANP9.EXE)
Max Q=14.50 (l/s); TOTAL LENGTH L= 1422.9 (m);

TABLE 1.

Nº	pipe from	pipe to	L	Qreal	i (terr.) Fall of ground	i (pipe) Fall of sewer	∅ of pipe	Q ful ∅ capacity flowing full	V ful ∅ velocity flowing full	Qreal/ Qful∅	hrael/ hful∅	Vreal/ Vful∅	h real	V real	Zterr. (upstr.) Ground elevation	Zterr. (downs.) Ground elevation	Pipe level (upstr.)	Pipe level (downst.)	H dig. dep. (upstr.)	H dig. dep. (downs.)
	from	to	(m)	(l/s)	(‰)	(‰)	(mm)	(l/s)	(m/s)				(m)	(m/s)	(m.a.s.)	(m.a.s.)	(m.a.s.)	(m.a.s.)	(m.a.s.)	(m.a.s.)
1	1	2	60.25	.50	-2.8	4.0	300.0	61.89	.88	.01	.06	.32	.02	.28	102.28	102.45	99.780	99.539	2.600	3.011
2	2	5	58.89	1.00	2.9	4.0	300.0	61.89	.88	.02	.09	.39	.03	.34	102.45	102.28	99.539	99.303	3.011	3.077
3	3	4	34.80	1.00	-5.2	4.0	300.0	61.89	.88	.02	.09	.39	.03	.34	101.92	102.10	99.620	99.481	2.400	2.719
4	4	5	45.89	1.50	-3.9	4.0	300.0	61.89	.88	.02	.10	.44	.03	.38	102.10	102.28	99.481	99.297	2.719	3.083
5	5	30	41.00	3.00	-10.2	4.0	300.0	61.89	.88	.05	.15	.53	.04	.47	102.28	102.70	99.297	99.133	3.083	3.667
6	30	9	32.44	3.50	3.1	4.0	300.0	61.89	.88	.06	.16	.56	.05	.49	102.70	102.60	99.133	99.003	3.667	3.697
7	6	7	61.24	.50	-.8	4.0	300.0	61.89	.88	.01	.06	.32	.02	.28	101.66	101.71	99.200	98.955	2.560	2.855
8	7	8	75.61	1.00	-7.8	4.0	300.0	61.89	.88	.02	.09	.39	.03	.34	101.71	102.30	98.955	98.653	2.855	3.747
9	8	9	77.05	1.50	-3.9	4.0	300.0	61.89	.88	.02	.10	.44	.03	.38	102.30	102.60	98.653	98.344	3.747	4.356
10	9	24	50.25	5.50	1.6	4.0	300.0	61.89	.88	.09	.20	.63	.06	.55	102.60	102.52	98.344	98.143	4.356	4.477
11	24	10	60.50	5.50	4.3	4.0	300.0	61.89	.88	.09	.20	.63	.06	.55	102.52	102.26	98.143	97.901	4.477	4.459
12	10	11	81.94	6.00	.7	10.0	300.0	98.07	1.39	.06	.16	.57	.05	.79	102.26	102.20	97.901	97.082	4.459	5.218
13	11	12	41.17	6.50	-5.1	4.0	300.0	61.89	.88	.11	.22	.66	.06	.58	102.20	102.41	97.082	96.917	5.218	5.593
14	12	15	31.02	7.00	-6.1	4.0	300.0	61.89	.88	.11	.22	.68	.07	.59	102.41	102.60	96.917	96.793	5.593	5.907
15	13	14	35.65	.50	-2.0	4.0	300.0	61.89	.88	.01	.06	.32	.02	.28	102.51	102.58	100.210	100.067	2.400	2.613
16	14	15	24.09	1.00	-.8	4.0	300.0	61.89	.88	.02	.09	.39	.03	.34	102.58	102.60	100.067	99.971	2.613	2.729
17	15	18	40.04	8.50	3.2	4.0	300.0	61.89	.88	.14	.25	.71	.07	.62	102.60	102.47	96.793	96.633	5.907	5.937

TABLE 2.

N°	pipe	pipe	L	Qreal	i (terr.) Fall of ground	i (pipe) Fall of sewer	∅ of pipe	Q ful ∅ capacity flowing full	V ful ∅ velocity flowing full	Qreal/ Qful∅	hrael/ hful∅	Vreal/ Vful∅	h real	V real	Zterr. (upstr.) Ground elevation	Zterr. (downs.) Ground elevation	Pipe level (upstr.)	Pipe level (downst.)	H dig. dep. (upstr.)	H dig. dep. (downs.)
	from	to	(m)	(l/s)	(‰)	(‰)	(mm)	(l/s)	(m/s)				(m)	(m/s)	(m.a.s.)	(m.a.s.)	(m.a.s.)	(m.a.s.)	(m.a.s.)	(m.a.s.)
18	16	17	39.01	.50	-3.6	4.0	300.0	61.89	.88	.01	.06	.32	.02	.28	102.24	102.38	99.940	99.784	2.400	2.696
19	17	18	39.70	1.00	-2.3	4.0	300.0	61.89	.88	.02	.09	.39	.03	.34	102.38	102.47	99.784	99.625	2.696	2.945
20	28	29	49.57	.50	-10.7	4.0	300.0	61.89	.88	.01	.06	.32	.02	.28	101.20	101.73	98.900	98.702	2.400	3.128
21	29	19	57.05	.50	-6.0	4.0	300.0	61.89	.88	.01	.06	.32	.02	.28	101.73	102.07	98.702	98.474	3.128	3.696
22	18	21	10.12	10.00	24.7	4.0	300.0	61.89	.88	.16	.27	.75	.08	.65	102.47	102.22	96.633	96.593	5.937	5.727
23	19	20	56.99	1.50	-6.1	4.0	300.0	61.89	.88	.02	.10	.44	.03	.38	102.07	102.42	98.474	98.246	3.696	4.274
24	20	21	59.00	2.00	3.4	4.0	300.0	61.89	.88	.03	.12	.47	.04	.41	102.42	102.22	98.246	98.010	4.274	4.310
25	21	22	54.92	12.50	17.5	4.0	300.0	61.89	.88	.20	.30	.79	.09	.69	102.22	101.26	96.593	96.373	5.727	4.987
26	22	23	30.55	14.50	.0	4.0	300.0	61.89	.88	.23	.33	.82	.10	.72	101.26	101.26	96.373	96.251	4.987	5.109
27	25	27	56.78	1.00	-3.5	4.0	300.0	61.89	.88	.02	.09	.39	.03	.34	101.20	101.40	98.900	98.673	2.400	2.827
28	27	22	55.88	2.00	2.5	4.0	300.0	61.89	.88	.03	.12	.47	.04	.41	101.40	101.26	98.634	98.410	2.866	2.950
29	26	27	61.50	.50	-3.6	4.0	300.0	61.89	.88	.01	.06	.32	.02	.28	101.18	101.40	98.880	98.634	2.400	2.866

ESTIMATES FOR THE WORK

TABLE 3.
(p10-1i2.doc)

N° PIPE	PIPE FROM	PIPE TO	PIPE LENGTH m	AVERAGE DEPTH m	SURFACE OF VERTICAL SHEETING m^2	DIGGING < 2m m^3	DIGGING 2-4m m^3	DIGGING 4-6m m^3	DIGGING > 6m m^3	FILLING WITH SELECT MATERI. m^3	FILLING WITH DIGGING MATERI. m^3
1	1	2	60.	2.81	338.06	120.50	48.53	.000	.000	37.917	126.856
2	2	5	59.	3.04	358.50	117.78	61.47	.000	.000	37.061	138.025
3	3	4	35.	2.56	178.15	69.60	19.47	.000	.000	21.901	64.714
4	4	5	46.	2.90	266.25	91.78	41.35	.000	.000	28.880	101.003
5	5	30	41.	3.37	276.73	82.00	56.37	.000	.000	25.802	109.665
6	30	9	32.	3.68	238.87	64.88	54.55	.000	.000	20.415	96.725
7	6	7	61.	2.71	331.61	122.48	43.33	.000	.000	38.540	122.938
8	7	8	76.	3.30	499.20	151.22	98.38	.000	.000	47.583	196.675
9	8	9	77.	4.05	624.34	154.10	154.10	3.968	.000	48.490	258.233
10	9	24	50.	4.42	443.82	100.50	100.50	20.909	.000	31.624	186.734
11	24	10	61.	4.47	540.58	121.00	121.00	28.289	.000	38.074	227.939
12	10	11	82.	4.84	792.90	163.88	163.88	68.689	.000	51.567	339.091
13	11	12	41.	5.41	445.07	82.34	82.34	57.857	.000	25.909	193.718
14	12	15	31.	5.75	356.71	62.04	62.04	54.276	.000	19.522	156.642
15	13	14	36.	2.51	178.70	71.30	18.05	.000	.000	22.436	64.395
16	14	15	24.	2.67	128.68	48.18	16.16	.000	.000	15.160	47.476
17	15	18	40.	5.92	474.22	80.08	80.08	76.950	.000	25.198	209.082
18	16	17	39.	2.55	198.80	78.02	21.38	.000	.000	24.550	72.091
19	17	18	40.	2.82	223.94	79.40	32.57	.000	.000	24.984	84.181
20	28	29	50.	2.76	274.04	99.14	37.88	.000	.000	31.196	102.319

TABLE 4.

N^o PIPE	PIPE FROM	PIPE TO	PIPE LENGTH m	AVERAGE DEPTH m	SURFACE OF VERTICAL SHEETING m^2	DIGGING < 2m m^3	DIGGING 2-4m m^3	DIGGING 4-6m m^3	DIGGING > 6m m^3	FILLING WITH SELECT MATERI. m^3	FILLING WITH DIGGING MATERI. m^3
21	29	19	57.	3.41	389.35	114.10	80.58	.000	.000	35.903	154.741
22	18	21	10.	5.83	118.04	20.24	20.24	18.541	.000	6.369	51.937
23	19	20	57.	3.99	454.26	113.98	113.15	.000	.000	35.865	187.239
24	20	21	59.	4.29	506.51	118.00	118.00	17.254	.000	37.130	211.954
25	21	22	55.	5.36	588.44	109.84	109.84	74.538	.000	34.563	255.774
26	22	23	31.	5.05	308.44	61.10	61.10	32.021	.000	19.226	132.836
27	25	27	57.	2.61	296.80	113.56	34.84	.000	.000	35.733	108.652
28	27	22	56.	2.91	324.97	111.76	50.73	.000	.000	35.167	123.370
29	26	27	62.	2.63	323.86	123.00	38.93	.000	.000	38.704	118.879

ESTIMATES OF PIPES LENGHT, SORT BY DIAMETER OF PIPES FOR SEWERAGE SYSTEM

PIPES Ø 250 mm	PIPES Ø 300 mm	PIPES Ø 350 mm
.0	1422.9	.0

ESTIMATES OF TOTAL DIGGING VOLUME FOR SEWERAGE SYSTEM

TOTAL DIGGING DEPTH < 2 m m^3	TOTAL DIGGING DEPTH 2-4 m m^3	TOTAL DIGGING DEPTH 4-6 m m^3	TOTAL DIGGING OVER 6 m m^3	GRAND TOTAL DIGGING m^3
2845.80	1940.82	453.29	.00	5239.92

TOTAL TRENCH SUPPORT 2 SIDE. m^2	TOTAL NUMBER OF MANHOLES	TOTAL DEPTH OF MANHOLES m	TOTAL FILING WITH SAND m^3	TOTAL FILING WITH EARTH m^3	EARTH TO BE TAKEN AWAY m^3
10479.83	30	106.71	895.47	4243.89	996.03