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USER'S MANUAL FOR A TWO-DIMENSIONAL, GROUND-WATER FLOW CODE ON THE
OCTOPUS COMPUTER NETWORK

Thomas G. Naymik

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MASTER

FOREWORD

A computer code developed by Taylor and Brown (1967) was adapted to the Lawrence Livermore Laboratory computer network to study the important geohydrological factors associated with a nuclear waste repository in geologic media. The study was executed under contract to the Nuclear Regulatory Commission. To date, the author has applied the code to the simulation of generic geohydrological situations, but other potential applications of the code are apparent.

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ABSTRACT

A ground-water hydrology computer code, programmed by R. L. Taylor (in Proc. American Society of Civil Engineers, Journal of Hydraulics Division, 93(HY2), pp. 25-33 (1967)), has been adapted to the Octopus computer system at Lawrence Livermore Laboratory. Using an example problem, this manual details the input, output, and execution options of the code.

INTRODUCTION AND SUMMARY

A computer code written by R.L. Taylor (Taylor and Brown, 1967) was adapted to study important geohydrological parameters associated with underground nuclear waste repositories. To explore the code's capabilities, the author of this manual developed an example problem that simulates conditions in the vicinity of a geologic repository.

Basically, the code calculates pressures, equipotentials, and flow vectors in two-dimensional flow problems. Flow is governed by a generalized Darcy equation:

$$q_i = \frac{K_{ij}}{\mu} \left\{ p_{,j} + F_j \right\} , \quad (1)$$

where

q_i = the flow rate in the i direction

K_{ij} = a symmetric, second-rank tensor that describes the local permeability of the medium

μ = the liquid viscosity

p = the liquid pressure

F = the body force term

The finite element approach is used to formulate the equations of ground-water flow and the solution is obtained by the Rayleigh-Ritz procedure (Taylor and Brown, 1967). Both planar and axisymmetric problems with zoned heterogeneity and with isotropic or anisotropic materials (under conditions of saturated steady-state flow) can be solved; both flux and pressure boundary conditions may be considered. The code also can solve certain unconfined flow problems with the use of free surface boundaries.

PREPARATION OF THE DATA FILE

The finite element mesh must be built before the data deck is prepared. But, because of the flexibility in this procedure and because of the large number of available references on the subject (for example, Pinder and Gray, 1977), we will not discuss mesh construction in this paper. The reader should also note that this code can handle triangular elements. Below we present a list of the necessary input data, formats, and an example problem to clarify the procedure for running this code.

Identification card (20A4)

Control card (6I5, 3F10.0, I5)

Number of nodes (I5)

Number of elements (I5)

Number of materials (I5)

Number of free surface correction nodes (I5)

Type of problem (I5)

0 = Axisymmetric flow

1 = Plane flow

Number of flow cards (I5)

Height for equipotential reference (F10.0)

Total available head (F10.0)

Free surface correction factor (F10.0)

Number of iterations for free surface (I5)

Material identification cards: one material per card (5X, 3F10.0)

Item:

Material number (5X) for user bookkeeping

Principal hydraulic conductivity 1 (F10.0)

Principal hydraulic conductivity 2 (F10.0)

Fluid weight (F10.0)

The 1 axis is measured with respect to X (or R)

Nodal cards (I5, I2, I3, 3F10.0)

Item:

Node number (I5)
Control for mesh generation (I2)*
Boundary condition (I3)*
X ordinate of node (F10.0)
Z ordinate of node (F10.0)
F (F10.0)

If the boundary condition is

Negative: F is the amount of fluid added at the node.

Zero: No fluid is lost or gained.

Positive: F is the pressure at the node.

Element cards (6I5, F10.0)

Item:

Element Number (I5)*
Node I (I5)
Node J (I5)
Node K (I5)
Node L (I5)
Material identification number (I5)
Angle in degrees between the X-axis (or R) and the 1 direction

*Consult Taylor and Brown (1967)

Distributed flow cards: one boundary per card (2I5, F10.0)

Item:

Node I (I5)

Node J (I5)

Flow rate along boundary (F10.0)

Free surface description: one card per free surface node (I5, F10.0)

Item:

Node number (I5)

Correction direction in degrees with respect to the X-axis (F10.0)

EXAMPLE PROBLEM EXECUTED FROM A REMOTE TERMINAL

To complete this run of the code on the LLL system, four files are needed:

- GWFLOW, the executable code
- UXRJ
- UXTV
- A data input file.

An example problem, taken from an earlier study by Naymik (1978), is presented to demonstrate the creation of the data input file.

Figure 1 illustrates the finite element mesh of the example problem. Node numbering proceeds along vertical mesh lines from bottom left to top right; element numbering proceeds in the same manner. The problem (illustrated by Fig. 1) is divided into 346 elements whose shapes are prescribed by the coordinates of 372 nodes forming the corners.

The complete data input file for the example problem is found in Appendix A. The first line is the problem identification. The second line is the control line. It indicates 372 nodes, 346 elements, 14 different materials, the lack of free surface correction nodes, a planar solution, the lack of distributed flow conditions, a zero reference for equipotentials, the total available head of 1204.7lm (greatest head assigned to a node as a boundary condition), a zero free surface correction factor, and two iterations. Only one iteration is required for a steady-rate solution that does not involve a free surface; two iterations were used as a check.

Lines 3 through 16 are the 14 material identification lines. Each material having different principal hydraulic conductivities is assigned an integer (starting with 1 and ending with the total number of materials). The nodal information is presented on lines 17 through 388 in the format described earlier. The hydraulic head is determined with reference to $z = 0$, where z is the vertical coordinate. The horizontal coordinate is x . The lowest nodes in the mesh have z -values = 0. The nodes farthest to the left have x -values = 0. The element information is in lines 389 through 734. Element corners are defined by node numbers starting in the lower left corner and proceed counterclockwise around the element (for example, in Fig. 1, element 1 is defined by nodes 1, 7, 8, and 2).

The following TTY interactions are used to execute the controller:

```
User:    GWFLOW/ t v
TTY:     ENTER-INPUT DATA DISK FILE NAME
User:    Name of input file
TTY:     ENTER - # OF LEVELS, MAP GRID OPT, XMIN, XMAX, ZMAX
User*:   a, b, c, d, e
TTY:     ALL DONE
```

The output files are HSP0, JATV80DD80, and VELCJT. The HSP0 from the example problem is presented in Appendix B. In HSP0, the input is printed out (in Appendix B the node and element information was omitted), followed by pressures, and potential values at each node. The final printed data are the

*The number of levels (a) refers to the number of equipotential and equipressure lines desired in the plot file that are generated by the UX80LVB graphics package. The map grid options (b) are: 1 (which plots the full problem as in Fig. 1) or 0 (which plots only the part of the problem between XMIN (c) and XMAX (d)). The ZMAX (e) is the largest z -value used in the mesh; ZMAX = 1000 in Fig. 1. The example problem required 0.2 minutes of computer time.

flow rates per unit area, calculated at each element center. The horizontal flow rate (Q1) and the vertical flow rate (Q2) are components of the vector, total Q and direction. The file VELOUT contains flow rates interpolated from the element centers to the nodes.

The UATV80DD80 file can be used with UXTV and UXRJ (Blair, 1977). The file contains plots of

- equal potential contours with nodes
- equal potential contours without nodes
- pressure contours with nodes
- pressure contours without nodes
- the finite element mesh.

The graphics from the example problem are presented in Appendix C. In the example problem

- Number (#) of levels = 25
- Map grid option (OPT) = 1
- XMTN = 0
- XMAX = 28942.5
- ZMAX = 1000.

For further information, contact T. G. Naymik or G. D. Mendez at Lawrence Livermore Laboratory.

ACKNOWLEDGMENTS

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G. F. Pinder and W. G. Gray, Finite Element Simulation in Surface and Subsurface Hydrology (Academic Press, New York, San Francisco, London, 1977).

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APPENDIX A:

INPUT FOR EXAMPLE PROBLEM

This appendix contains all input data for the example problem discussed in the preceding text. The problem demonstrates the utility of a ground-water hydrology code that was originally programmed by R. L. Taylor (1967).

EXAMPLE PROBLEM FOR USER'S MANUAL

```

372.346,14,0,1,0,0,1204.71,0,2,
131.5,3,15,1,
2,315,0315,1,
3,00315,000315,1,
4,00315,000315,1,
5,0000063,0000063,1,
6,134,1,134,1,
7,0000063,0000063,1,
831500,31500,1,
9,00315,000315,1,
102,299,2,299,1,
11,00315,000315,1,
12,00315,000315,1,
131890,1890,1,
14,0000151,0000151,1,
1,0,1,0,0,1204.71
2,0,1,0,200,1004.71
3,0,1,0,400,804.057
4,0,1,0,600,545.326
5,0,1,0,800,344.71
6,0,1,0,1000,144.71
7,0,1,8200,0,1153.71
8,0,1,8200,200,963.71
9,0,0,8200,400,0
10,0,0,8200,600,0
11,0,1,8200,800,303.71
12,0,1,8200,1000,103.71
13,0,1,9000,0,1159.71
14,0,1,9000,200,959.71
15,0,0,9000,400,0
16,0,0,9000,600,0
17,0,0,9000,800,0
18,0,1,9000,800,299.71
19,0,1,9000,1000,99.71
20,0,1,9500,0,1157.21
21,0,1,9500,200,957.21
22,0,0,9500,400,0
23,0,0,9500,450,0
24,0,0,9500,500,0
25,0,0,9500,550,0
26,0,0,9500,600,0
27,0,1,9500,800,297.21
28,0,1,9500,1000,97.21
29,0,1,9800,0,1155.71
30,0,1,9800,200,955.71
31,0,0,9800,400,0
32,0,0,9800,440,0
33,0,0,9800,475,0
34,0,0,9800,500,0
35,0,0,9800,525,0
36,0,0,9800,560,0
37,0,0,9800,600,0
38,0,1,9800,800,295.71
39,0,1,9800,1000,95.71
40,0,1,10000,0,1154.7
41,0,1,10000,200,954.71
42,0,0,10000,400,0
43,0,0,10000,450,0
44,0,0,10000,475,0

```


45	0	0	10000	491	75	0
46	0	0	10000	497	5	0
47	0	0	10000	502	5	0
48	0	0	10000	508	25	0
49	0	0	10000	525	0	
50	0	0	10000	550	0	
51	0	0	10000	600	0	
52	0	1	10000	800	294	71
53	0	1	10000	1000	94	71
54	0	1	10100	0	1154	21
55	0	1	10100	200	954	21
56	0	0	10100	400	0	
57	0	0	10100	450	0	
58	0	0	10100	475	0	
59	0	0	10100	491	75	0
60	0	0	10100	497	5	0
61	0	0	10100	502	5	0
62	0	0	10100	508	25	0
63	0	0	10100	525	0	
64	0	0	10100	550	0	
65	0	0	10100	600	0	
66	0	1	10100	800	294	21
67	0	1	10100	1000	94	21
68	0	1	10200	0	1153	71
69	0	1	10200	200	953	71
70	0	0	10200	400	0	
71	0	0	10200	450	0	
72	0	0	10200	475	0	
73	0	0	10200	491	75	0
74	0	0	10200	497	5	0
75	0	0	10200	502	5	0
76	0	0	10200	508	25	0
77	0	0	10200	525	0	
78	0	0	10200	550	0	
79	0	0	10200	600	0	
80	0	1	10200	800	293	71
81	0	1	10200	1000	93	71
82	0	1	10300	0	1153	21
83	0	1	10300	200	953	21
84	0	0	10300	400	0	
85	0	0	10300	450	0	
86	0	0	10300	475	0	
87	0	0	10300	491	75	0
88	0	0	10300	497	5	0
89	0	0	10300	502	5	0
90	0	0	10300	508	25	0
91	0	0	10300	525	0	
92	0	0	10300	550	0	
93	0	0	10300	600	0	
94	0	1	10300	800	293	21
95	0	1	10300	1000	93	21
96	0	1	10400	0	1152	71
97	0	1	10400	200	952	71
98	0	0	10400	400	0	
99	0	0	10400	450	0	
100	0	0	10400	475	0	
101	0	0	10400	491	75	0
102	0	0	10400	497	5	0
103	0	0	10400	502	5	0
104	0	0	10400	508	25	0

105	0	0	10400	525	0
106	0	0	10400	550	0
107	0	0	10400	600	0
108	0	1	10400	800	292.71
109	0	1	10400	1000	92.71
110	0	1	10700	0	1151.21
111	0	1	10700	200	951.21
112	0	0	10700	400	0
113	0	0	10700	450	0
114	0	0	10700	475	0
115	0	0	10700	491	75.0
116	0	0	10700	497	5.0
117	0	0	10700	502	5.0
118	0	0	10700	508	25.0
119	0	0	10700	525	0
120	0	0	10700	550	0
121	0	0	10700	600	0
122	0	1	10700	800	291.21
123	0	1	10700	1000	91.21
124	0	1	11000	0	1149.71
125	0	1	11000	200	949.71
126	0	0	11000	400	0
127	0	0	11000	450	0
128	0	0	11000	475	0
129	0	0	11000	491	75.0
130	0	0	11000	497	5.0
131	0	0	11000	502	5.0
132	0	0	11000	508	25.0
133	0	0	11000	525	0
134	0	0	11000	550	0
135	0	0	11000	600	0
136	0	1	11000	800	289.71
137	0	1	11000	1000	89.71
138	0	1	11298	0	1148.22
139	0	1	11298	200	948.22
140	0	0	11298	400	0
141	0	0	11298	450	0
142	0	0	11298	475	0
143	0	0	11298	491	75.0
144	0	0	11298	497	5.0
145	0	0	11298	502	5.0
146	0	0	11298	508	25.0
147	0	0	11298	525	0
148	0	0	11298	550	0
149	0	0	11298	600	0
150	0	1	11298	800	288.22
151	0	1	11298	1000	68.22
152	0	1	11300	0	1148.21
153	0	1	11300	200	948.21
154	0	0	11300	400	0
155	0	0	11300	450	0
156	0	0	11300	475	0
157	0	0	11300	491	75.0
158	0	0	11300	497	5.0
159	0	0	11300	502	5.0
160	0	0	11300	508	25.0
161	0	0	11300	525	0
162	0	0	11300	550	0
163	0	0	11300	600	0
164	0	1	11300	800	288.21

165	0	1	11300	1000	88.21
166	0	1	11600	0	1146.71
167	0	1	11600	200	946.71
168	0	0	11600	400	0
169	0	0	11600	490	0
170	0	0	11600	497	0
171	0	0	11600	491.75	0
172	0	0	11600	497.5	0
173	0	0	11600	502.5	0
174	0	0	11600	508.25	0
175	0	0	11600	525	0
176	0	0	11600	550	0
177	0	0	11600	600	0
178	0	1	11600	800	286.71
179	0	1	11600	1000	86.71
180	0	1	11900	0	1145.21
181	0	1	11900	200	945.21
182	0	0	11900	400	0
183	0	0	11900	450	0
184	0	0	11900	475	0
185	0	0	11900	491.75	0
186	0	0	11900	497.5	0
187	0	0	11900	502.5	0
188	0	0	11900	508.25	0
189	0	0	11900	525	0
190	0	0	11900	550	0
191	0	0	11900	600	0
192	0	1	11900	800	285.21
193	0	1	11900	1000	85.21
194	0	1	12200	0	1143.71
195	0	1	12200	200	943.71
196	0	0	12200	400	0
197	0	0	12200	450	0
198	0	0	12200	475	0
199	0	0	12200	491.75	0
200	0	0	12200	497.5	0
201	0	0	12200	502.5	0
202	0	0	12200	508.25	0
203	0	0	12200	525	0
204	0	0	12200	550	0
205	0	0	12200	600	0
206	0	1	12200	800	283.71
207	0	1	12200	1000	83.71
208	0	1	12500	0	1142.21
209	0	1	12500	200	942.21
210	0	0	12500	400	0
211	0	0	12500	450	0
212	0	0	12500	475	0
213	0	0	12500	491.75	0
214	0	0	12500	497.5	0
215	0	0	12500	502.5	0
216	0	0	12500	508.25	0
217	0	0	12500	525	0
218	0	0	12500	550	0
219	0	0	12500	600	0
220	0	1	12500	800	282.21
221	0	1	12500	1000	82.21
222	0	1	12540	0	1142.01
223	0	1	12540	200	942.01
224	0	0	12540	400	0

225	0	0	12540	450	0
226	0	0	12540	475	0
227	0	0	12540	491	75
228	0	0	12540	497	5
229	0	0	12540	502	5
230	0	0	12540	508	25
231	0	0	12540	525	0
232	0	0	12540	550	0
233	0	0	12540	600	0
234	0	1	12540	800	282.01
235	0	1	12540	1000	82.01
236	0	1	12740	0	1141.01
237	0	1	12740	200	941.01
238	0	0	12740	400	0
239	0	0	12740	450	0
240	0	0	12740	475	0
241	0	0	12740	491	75
242	0	0	12740	497	5
243	0	0	12740	502	5
244	0	0	12740	508	25
245	0	0	12740	525	0
246	0	0	12740	550	0
247	0	0	12740	600	0
248	0	1	12740	800	281.01
249	0	1	12740	1000	81.01
250	0	1	12840	0	1140.51
251	0	1	12840	200	940.51
252	0	0	12840	400	0
253	0	0	12840	450	0
254	0	0	12840	475	0
255	0	0	12840	491	75
256	0	0	12840	497	5
257	0	0	12840	502	5
258	0	0	12840	508	25
259	0	0	12840	525	0
260	0	0	12840	550	0
261	0	0	12840	600	0
262	0	1	12840	800	280.51
263	0	1	12840	1000	80.51
264	0	1	12935	0	1140.0325
265	0	1	12935	200	940.0325
266	0	0	12935	400	0
267	0	0	12935	450	0
268	0	0	12935	475	0
269	0	0	12935	491	75
270	0	0	12935	497	5
271	0	0	12935	502	5
272	0	0	12935	508	25
273	0	0	12935	525	0
274	0	0	12935	550	0
275	0	0	12935	600	0
276	0	1	12935	800	280.0325
277	0	1	12935	1000	80.0325
278	0	1	12937	0	1140.0225
279	0	1	12937	200	940.0225
280	0	0	12937	400	0
281	0	0	12937	450	0
282	0	0	12937	475	0
283	0	0	12937	491	75
284	0	0	12937	497	5

285	0.0	12937	5,502.5	0.
286	0.0	12937	5,508.25	0.
287	0.0	12937	5,525.	0.
288	0.0	12937	5,550.	0.
289	0.0	12937	5,600.	0.
290	0.1	12937	5,800.	280.0225
291	0.1	12937	5,1000.	80.0225
292	0.1	12942	5,0.	1139.9975
293	0.1	12942	5,200.	939.9975
294	0.0	12942	3,400.	0.
295	0.0	12942	3,450.	0.
296	0.0	12942	3,475.	0.
297	0.0	12942	3,491.75	0.
298	0.0	12942	3,497.5	0.
299	0.0	12942	3,502.5	0.
300	0.0	12942	3,508.25	0.
301	0.0	12942	3,525.	0.
302	0.0	12942	3,550.	0.
303	0.0	12942	3,600.	0.
304	0.1	12942	5,800.	279.9975
305	0.1	12942	5,1000.	79.9975
306	0.1	12944	5,0.	1139.9875
307	0.1	12944	5,200.	939.9875
308	0.0	12944	3,400.	0.
309	0.0	12944	3,450.	0.
310	0.0	12944	3,475.	0.
311	0.0	12944	3,491.75	0.
312	0.0	12944	3,497.5	0.
313	0.0	12944	3,502.5	0.
314	0.0	12944	3,508.25	0.
315	0.0	12944	3,525.	0.
316	0.0	12944	3,550.	0.
317	0.0	12944	3,600.	0.
318	0.1	12944	5,800.	279.9875
319	0.1	12944	5,1000.	79.9875
320	0.1	13040	0.	1139.51
321	0.1	13040	200.	939.51
322	0.0	13040	400.	0.
323	0.0	13040	450.	0.
324	0.0	13040	475.	0.
325	0.0	13040	491.75	0.
326	0.0	13040	497.5	0.
327	0.0	13040	502.5	0.
328	0.0	13040	508.25	0.
329	0.0	13040	525.	0.
330	0.0	13040	550.	0.
331	0.0	13040	600.	0.
332	0.1	13040	800.	279.51
333	0.1	13040	1000.	79.51
334	0.1	15040	0.	1129.51
335	0.1	15040	200.	929.51
336	0.0	15040	400.	0.
337	0.0	15040	440.	0.
338	0.0	15040	475.	0.
339	0.0	15040	500.	0.
340	0.0	15040	525.	0.
341	0.0	15040	560.	0.
342	0.0	15040	600.	0.
343	0.1	15040	800.	269.51
344	0.1	15040	1000.	69.51

345	0	1	18040	0	1114.51
346	0	1	18040	200	914.51
347	0	0	18040	400	0
348	0	0	18040	450	0
349	0	0	18040	500	0
350	0	0	18040	550	0
351	0	0	18040	600	0
352	0	1	18040	800	254.51
353	0	1	18040	1000	54.51
354	0	1	22040	0	1094.51
355	0	1	22040	200	894.51
356	0	0	22040	400	0
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358	0	0	22040	600	0
359	0	1	22040	800	234.51
360	0	1	22040	1000	34.51
361	0	1	24040	0	1084.51
362	0	1	24040	200	884.51
363	0	0	24040	400	0
364	0	0	24040	500	0
365	0	1	24040	800	224.51
366	0	1	24040	1000	24.51
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368	0	1	28942.5	200	860
369	0	1	28942.5	400	659.347
370	0	1	28942.5	600	400.616
371	0	1	28942.5	800	200
372	0	1	28942.5	1000	0
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18	17	25	26	26	3
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APPENDIX B:

PRINTED OUTPUT FROM THE EXAMPLE PROBLEM (HIGH SPEED FILE)

This appendix contains computer generated output from an example problem in ground-water hydrology. The problem was solved with a computer code originally prepared by R. L. Taylor (1967) and later modified for use at Lawrence Livermore Laboratory.

1EXAMPLE PROBLEM FOR USER'S MANUAL

0 NUMBER OF NODAL POINTS----- 372
 0 NUMBER OF ELEMENTS----- 346
 0 NUMBER OF DIFF. MATERIALS--- 14
 0 REFERENCE FOR EQUI. LINES--- 0.
 0 AVAILABLE HEAD----- 1.2047E+03
 0 CORRECTION FACTOR----- 0.
 0 PLANE FLOW PROBLEM

0MATERIAL : PERMEABILITIES

MATERIAL:	K1	K2	R0
1	31.50000000	3.15000000	1.00000000
2	0.31500000	0.03150000	1.00000000
3	0.00315000	0.00031500	1.00000000
4	0.00315000	0.00031500	1.00000000
5	0.00000630	0.00000630	1.00000000
6	1.13400000	1.13400000	1.00000000
7	0.00000630	0.00000630	1.00000000
8	31500.00000000	31500.00000000	1.00000000
9	0.00315000	0.00031500	1.00000000
10	2.29900000	2.29900000	1.00000000
11	0.00315000	0.00031500	1.00000000
12	0.00315000	0.00031500	1.00000000
13	1890.00000000	1890.00000000	1.00000000
14	0.00001510	0.00001510	1.00000000

11 ITERATION NO. 1

ONODAL PRESSURES

ONODE	PRESSURE	EQUIPOT LINE
1	1.20471E+03	1.00000E+00
2	1.00471E+03	1.00000E+00
3	8.04057E+02	9.99458E-01
4	5.45326E+02	9.50707E-01
5	3.44710E+02	9.50195E-01
6	1.44710E+02	9.50195E-01
7	1.16371E+03	9.65967E-01
8	9.63710E+02	9.65967E-01
9	7.53138E+02	9.65492E-01
10	5.04286E+02	9.16640E-01
11	3.03710E+02	9.16162E-01
12	1.03710E+02	9.16162E-01
13	1.15971E+03	9.62647E-01
14	9.59710E+02	9.62647E-01
15	7.59043E+02	9.62093E-01
16	6.29125E+02	9.37259E-01
17	5.00125E+02	9.13187E-01
18	2.99710E+02	9.12842E-01
19	9.97100E+01	9.12842E-01
20	1.15721E+03	9.60571E-01
21	9.57210E+02	9.60571E-01
22	7.56342E+02	9.59851E-01
23	6.88026E+02	9.44647E-01
24	6.21828E+02	9.31202E-01
25	5.58271E+02	9.19948E-01
26	4.97140E+02	9.10709E-01
27	2.97210E+02	9.10767E-01
28	9.72100E+01	9.10767E-01
29	1.15571E+03	9.59326E-01
30	9.55710E+02	9.59326E-01
31	7.54653E+02	9.56449E-01
32	6.92213E+02	9.39822E-01
33	6.35901E+02	9.22132E-01
34	5.83016E+02	9.07285E-01
35	5.67934E+02	9.07218E-01
36	5.33419E+02	9.07620E-01
37	4.94978E+02	9.08914E-01
38	2.95710E+02	9.09522E-01
39	9.57100E+01	9.09522E-01
40	1.15471E+03	9.56496E-01
41	9.54710E+02	9.56496E-01
42	7.53557E+02	9.57539E-01
43	6.71299E+02	9.30763E-01
44	6.28944E+02	9.16357E-01
45	5.99712E+02	9.05996E-01
46	5.93962E+02	9.05996E-01
47	5.88187E+02	9.05352E-01
48	5.82437E+02	9.05352E-01
49	5.66468E+02	9.06002E-01
50	5.41942E+02	9.08384E-01
51	4.84253E+02	9.08936E-01
52	2.94710E+02	9.08692E-01
53	9.47100E+01	9.08692E-01

54	1.15421E+03	9.58081E-01
55	9.54210E+02	9.58081E-01
56	7.53023E+02	9.57097E-01
57	6.70000E+02	9.29685E-01
58	6.27990E+02	9.15565E-01
59	5.99712E+02	9.05996E-01
60	5.93962E+02	9.05996E-01
61	5.88187E+02	9.05352E-01
62	5.82437E+02	9.05352E-01
63	5.66217E+02	9.05792E-01
64	5.42039E+02	9.06475E-01
65	4.93850E+02	9.07978E-01
66	2.94210E+02	9.08277E-01
67	9.42100E+01	9.08277E-01
68	1.15371E+03	9.57666E-01
69	9.53710E+02	9.57666E-01
70	7.52501E+02	9.56662E-01
71	6.69403E+02	9.29189E-01
72	6.27697E+02	9.15321E-01
73	5.99712E+02	9.05996E-01
74	5.93962E+02	9.05996E-01
75	5.88187E+02	9.05352E-01
76	5.82437E+02	9.05352E-01
77	5.66170E+02	9.05753E-01
78	5.41903E+02	9.06362E-01
79	4.93429E+02	9.07628E-01
80	2.93710E+02	9.07862E-01
81	9.37100E+01	9.07862E-01
82	1.15321E+03	9.57251E-01
83	9.53210E+02	9.57251E-01
84	7.51984E+02	9.56234E-01
85	6.69055E+02	9.28900E-01
86	6.27540E+02	9.15191E-01
87	5.99712E+02	9.05996E-01
88	5.93962E+02	9.05996E-01
89	5.88186E+02	9.05352E-01
90	5.82436E+02	9.05352E-01
91	5.66100E+02	9.05696E-01
92	5.41722E+02	9.06212E-01
93	4.92992E+02	9.07266E-01
94	2.93210E+02	9.07447E-01
95	9.32100E+01	9.07447E-01
96	1.15271E+03	9.56836E-01
97	9.52710E+02	9.56836E-01
98	7.51473E+02	9.55810E-01
99	6.68785E+02	9.28676E-01
100	6.27426E+02	9.15097E-01
101	5.99712E+02	9.05996E-01
102	5.93962E+02	9.05996E-01
103	5.88186E+02	9.05352E-01
104	5.82436E+02	9.05352E-01
105	5.66022E+02	9.05631E-01
106	5.41526E+02	9.06048E-01
107	4.92544E+02	9.06894E-01
108	2.92710E+02	9.07032E-01
109	9.27100E+01	9.07032E-01
110	1.15121E+03	9.55591E-01
111	9.51210E+02	9.55591E-01
112	7.49968E+02	9.54560E-01
113	6.68085E+02	9.26095E-01

114	6.27143E+02	9.14862E-01
115	5.99712E+02	9.05996E-01
116	5.93962E+02	9.05996E-01
117	5.88185E+02	9.05351E-01
118	5.82436E+02	9.05351E-01
119	5.65771E+02	9.05422E-01
120	5.40898E+02	9.05528E-01
121	4.91156E+02	9.05742E-01
122	2.91210E+02	9.05786E-01
123	9.12100E+01	9.05786E-01
124	1.14971E+03	9.54346E-01
125	9.49710E+02	9.54346E-01
126	7.48483E+02	9.53327E-01
127	6.67409E+02	9.27534E-01
128	6.26872E+02	9.14637E-01
129	5.99712E+02	9.05996E-01
130	5.93962E+02	9.05996E-01
131	5.88185E+02	9.05351E-01
132	5.82436E+02	9.05351E-01
133	5.65513E+02	9.05208E-01
134	5.40255E+02	9.04994E-01
135	4.89739E+02	9.04566E-01
136	2.89710E+02	9.04541E-01
137	8.97100E+01	9.04541E-01
138	1.14822E+03	9.53109E-01
139	9.48220E+02	9.53109E-01
140	7.47018E+02	9.52112E-01
141	6.66742E+02	9.26980E-01
142	6.26604E+02	9.14414E-01
143	5.99712E+02	9.05995E-01
144	5.93962E+02	9.05995E-01
145	5.88185E+02	9.05351E-01
146	5.82435E+02	9.05351E-01
147	5.65258E+02	9.04996E-01
148	5.39619E+02	9.04466E-01
149	4.88338E+02	9.03402E-01
150	2.88220E+02	9.03305E-01
151	8.82200E+01	9.03305E-01
152	1.14821E+03	9.53101E-01
153	9.48210E+02	9.53101E-01
154	7.47008E+02	9.52103E-01
155	6.66738E+02	9.26977E-01
156	6.26602E+02	9.14413E-01
157	5.99712E+02	9.05995E-01
158	5.93962E+02	9.05995E-01
159	5.88185E+02	9.05351E-01
160	5.82435E+02	9.05351E-01
161	5.65256E+02	9.04995E-01
162	5.39615E+02	9.04463E-01
163	4.88329E+02	9.03395E-01
164	2.88210E+02	9.03296E-01
165	8.82100E+01	9.03296E-01
166	1.14671E+03	9.51856E-01
167	9.46710E+02	9.51856E-01
168	7.45540E+02	9.50885E-01
169	6.66070E+02	9.26422E-01
170	6.26334E+02	9.14150E-01
171	5.99711E+02	9.05995E-01
172	5.93961E+02	9.05995E-01
173	5.88185E+02	9.05350E-01

174	5.82435E+02	9.05350E-01
175	5.65008E+02	9.04789E-01
176	5.38996E+02	9.03949E-01
177	4.86961E+02	9.02260E-01
178	2.86710E+02	9.02051E-01
179	8.67100E+01	9.02051E-01
180	1.14521E+03	9.50611E-01
181	9.45210E+02	9.50611E-01
182	7.44078E+02	9.49570E-01
183	6.85404E+02	9.25669E-01
184	6.25067E+02	9.13968E-01
185	5.99711E+02	9.05995E-01
186	5.93961E+02	9.05995E-01
187	5.88184E+02	9.05350E-01
188	5.82434E+02	9.05350E-01
189	5.64782E+02	9.04601E-01
190	5.38431E+02	9.03480E-01
191	4.85704E+02	9.01216E-01
192	2.85210E+02	9.00806E-01
193	8.52100E+01	9.00806E-01
194	1.14371E+03	9.49365E-01
195	9.43710E+02	9.49365E-01
196	7.42624E+02	9.48464E-01
197	6.64742E+02	9.25320E-01
198	6.25801E+02	9.13748E-01
199	5.99710E+02	9.05994E-01
200	5.93960E+02	9.05994E-01
201	5.88184E+02	9.05350E-01
202	5.82434E+02	9.05350E-01
203	5.64605E+02	9.04454E-01
204	5.37988E+02	9.03112E-01
205	4.84696E+02	9.00380E-01
206	2.83710E+02	8.99561E-01
207	8.37100E+01	8.99561E-01
208	1.14221E+03	9.48120E-01
209	9.42210E+02	9.48120E-01
210	7.41190E+02	9.47274E-01
211	6.64104E+02	9.24790E-01
212	6.25546E+02	9.13536E-01
213	5.99710E+02	9.05994E-01
214	5.93960E+02	9.05994E-01
215	5.88183E+02	9.05349E-01
216	5.82433E+02	9.05349E-01
217	5.64540E+02	9.04400E-01
218	5.37818E+02	9.02971E-01
219	4.84242E+02	9.00003E-01
220	2.82210E+02	8.98316E-01
221	8.22100E+01	8.98316E-01
222	1.14201E+03	9.47954E-01
223	9.42010E+02	9.47954E-01
224	7.41002E+02	9.47117E-01
225	6.64029E+02	9.24729E-01
226	6.25518E+02	9.13512E-01
227	5.99708E+02	9.05992E-01
228	5.93958E+02	9.05992E-01
229	5.88182E+02	9.05348E-01
230	5.82432E+02	9.05348E-01
231	5.64546E+02	9.04405E-01
232	5.37833E+02	9.02983E-01
233	4.84257E+02	9.00015E-01

234	2.82010E+02	8.98150E-01
235	8.20100E+01	8.98150E-01
236	1.14101E+03	9.47124E-01
237	9.41010E+02	9.47124E-01
238	7.40070E+02	9.46344E-01
239	6.63968E+02	9.24677E-01
240	6.25543E+02	9.13534E-01
241	5.99701E+02	9.05986E-01
242	5.93931E+02	9.05986E-01
243	5.88177E+02	9.05344E-01
244	5.82427E+02	9.05344E-01
245	5.64675E+02	9.04513E-01
246	5.38134E+02	9.03233E-01
247	4.84714E+02	9.00394E-01
248	2.81010E+02	8.97320E-01
249	8.10100E+01	8.97320E-01
250	1.14051E+03	9.46709E-01
251	9.40510E+02	9.46709E-01
252	7.39614E+02	9.45965E-01
253	6.64719E+02	9.25301E-01
254	6.26000E+02	9.13913E-01
255	5.99697E+02	9.05983E-01
256	5.93947E+02	9.05983E-01
257	5.88175E+02	9.05342E-01
258	5.82425E+02	9.05342E-01
259	5.64867E+02	9.04672E-01
260	5.38548E+02	9.03577E-01
261	4.85282E+02	9.00866E-01
262	2.80510E+02	8.96905E-01
263	8.05100E+01	8.96905E-01
264	1.14003E+03	9.46313E-01
265	9.40033E+02	9.46313E-01
266	7.39182E+02	9.45607E-01
267	6.66953E+02	9.27155E-01
268	6.28365E+02	9.15876E-01
269	5.99693E+02	9.05980E-01
270	5.93943E+02	9.05980E-01
271	5.88172E+02	9.05340E-01
272	5.82422E+02	9.05340E-01
273	5.65671E+02	9.05339E-01
274	5.39150E+02	9.04076E-01
275	4.86115E+02	9.01557E-01
276	2.80032E+02	8.96506E-01
277	8.00325E+01	8.96508E-01
278	1.14002E+03	9.46305E-01
279	9.40023E+02	9.46305E-01
280	7.39173E+02	9.45600E-01
281	6.67021E+02	9.27212E-01
282	6.28493E+02	9.15982E-01
283	5.99693E+02	9.05980E-01
284	5.93943E+02	9.05980E-01
285	5.88172E+02	9.05340E-01
286	5.82422E+02	9.05340E-01
287	5.65671E+02	9.05339E-01
288	5.39149E+02	9.04076E-01
289	4.86119E+02	9.01560E-01
290	2.80023E+02	8.96500E-01
291	8.00225E+01	8.96500E-01
292	1.14000E+03	9.46284E-01
293	9.39998E+02	9.46284E-01

294	7.39151E+02	9.45581E-01
295	6.67195E+02	9.27357E-01
296	6.28835E+02	9.16263E-01
297	5.99693E+02	9.05980E-01
298	5.93943E+02	9.05979E-01
299	5.88942E+02	9.05979E-01
300	5.83191E+02	9.05978E-01
301	5.66439E+02	9.05977E-01
302	5.38807E+02	9.03791E-01
303	4.83491E+02	8.99379E-01
304	2.79997E+02	8.96479E-01
305	7.99975E+01	8.96479E-01
306	1.13999E+03	9.46279E-01
307	9.39988E+02	9.46279E-01
308	7.39142E+02	9.45573E-01
309	6.67267E+02	9.27416E-01
310	6.28976E+02	9.16383E-01
311	5.99693E+02	9.05980E-01
312	5.93942E+02	9.05979E-01
313	5.88942E+02	9.05979E-01
314	5.83191E+02	9.05978E-01
315	5.66439E+02	9.05977E-01
316	5.38807E+02	9.03792E-01
317	4.83489E+02	8.99379E-01
318	2.79987E+02	8.96471E-01
319	7.98875E+01	8.96471E-01
320	1.13951E+03	9.45879E-01
321	9.39510E+02	9.45879E-01
322	7.38710E+02	9.45215E-01
323	6.71568E+02	9.31002E-01
324	6.38100E+02	9.23957E-01
325	6.16203E+02	9.19684E-01
326	6.08763E+02	9.18281E-01
327	6.02334E+02	9.17095E-01
328	5.95045E+02	9.15819E-01
329	5.74112E+02	9.12345E-01
330	5.43471E+02	9.07664E-01
331	4.81921E+02	8.98076E-01
332	2.79510E+02	8.96075E-01
333	7.95100E+01	8.96075E-01
334	1.12951E+03	9.37578E-01
335	9.29510E+02	9.37578E-01
336	7.28940E+02	9.37105E-01
337	6.77307E+02	9.27449E-01
338	6.32042E+02	9.18928E-01
339	5.95690E+02	9.12825E-01
340	5.67311E+02	9.06700E-01
341	5.21903E+02	8.98051E-01
342	4.69934E+02	8.88126E-01
343	2.69510E+02	8.87774E-01
344	6.95100E+01	8.87774E-01
345	1.11451E+03	9.25127E-01
346	9.14510E+02	9.25127E-01
347	7.13920E+02	9.24637E-01
348	6.49212E+02	9.12428E-01
349	5.84507E+02	9.00220E-01
350	5.19808E+02	8.88021E-01
351	4.55118E+02	8.75828E-01
352	2.54510E+02	8.75327E-01
353	5.45100E+01	8.75323E-01

354	1.09451E+03	9.08526E-01
355	8.94510E+02	9.08526E-01
356	6.93921E+01	9.00037E-01
357	5.64509E+02	8.83622E-01
358	4.35095E+02	8.59207E-01
359	2.34510E+02	8.58721E-01
360	3.45100E+01	8.58721E-01
361	1.08451E+03	9.00225E-01
362	8.84510E+02	9.00225E-01
363	6.83936E+02	8.99748E-01
364	4.25092E+02	8.50904E-01
365	2.24510E+02	8.50420E-01
366	2.45100E+01	8.50420E-01
367	1.06000E+03	8.79880E-01
368	8.60000E+02	8.79880E-01
369	6.59347E+02	8.79338E-01
370	4.00616E+02	8.30587E-01
371	2.00000E+02	8.30075E-01
372	0.	8.30075E-01

1EXAMPLE PROBLEM FOR USER'S MANUAL

CELEMENT FLOWS

OELMT	Q1	Q2	ANG	TOTAL Q	DIRECTION
1	1.57500E-01	-2.08980E-14	0.	1.57500E-01	-0.0000
2	1.57345E-03	9.64657E-06	0.	1.57640E-03	3.5030
3	1.57422E-05	9.25985E-05	0.	9.39231E-05	80.3815
4	1.57577E-03	9.38656E-05	0.	1.57856E-03	3.4090
5	1.57800E-01	1.43105E-14	0.	1.57800E-01	0.0000
6	1.57500E-01	3.25963E-14	0.	1.57500E-01	0.0000
7	1.59375E-03	9.76257E-06	0.	1.59874E-03	3.5053
8	1.61251E-05	9.42405E-05	0.	9.56101E-05	80.2904
9	1.80612E-05	9.25915E-05	0.	9.44349E-05	78.9739
10	1.63823E-05	9.13485E-05	0.	9.28038E-05	79.8327
11	1.60661E-03	7.80671E-05	0.	1.60851E-03	2.7819
12	1.57500E-01	0.	0.	1.57500E-01	0.0000
13	1.57500E-01	0.	0.	1.57500E-01	0.0000
14	1.62411E-03	1.20904E-04	0.	1.64256E-03	4.2212
15	1.70121E-05	1.15390E-04	0.	1.16507E-04	81.6132
16	4.07646E-05	9.69434E-05	0.	1.05079E-04	67.1722
17	4.20119E-05	8.93683E-05	0.	9.87918E-05	64.8251
18	1.88100E-05	7.01258E-05	0.	7.26047E-05	74.9849
19	1.72800E-03	2.71714E-05	0.	1.72821E-03	0.9009
20	1.57500E-01	-8.71718E-13	0.	1.57500E-01	-0.0000
21	1.57500E-01	-3.12924E-12	0.	1.57500E-01	-0.0000
22	1.67406E-03	1.51540E-04	0.	1.68090E-03	5.1725
23	1.77312E-05	1.78719E-04	0.	1.77607E-04	84.2704
24	1.09992E-04	1.46955E-04	0.	1.83480E-04	53.1876
25	2.34025E-04	1.43151E-04	0.	2.74335E-04	31.4537
26	2.55649E-04	5.72835E-05	0.	2.61988E-04	12.6297
27	1.42798E-04	3.94553E-05	0.	1.48148E-04	15.4499
28	2.25993E-04	1.22790E-05	0.	2.58078E-04	82.4103
29	1.92247E-03	-6.31984E-05	0.	1.92351E-03	-1.8828
30	1.57500E-01	3.72529E-14	0.	1.57500E-01	0.0000
31	1.57500E-01	1.55963E-14	0.	1.57500E-01	0.0000
32	1.65095E-03	1.73994E-04	0.	1.65010E-03	0.0182
33	1.72690E-05	2.03225E-04	0.	2.03997E-04	85.1430
34	7.54648E-05	1.92856E-04	0.	2.07095E-04	69.6235
35	1.05975E-04	2.05599E-04	0.	2.30064E-04	51.9561
36	1.00043E-04	1.83215E-04	0.	1.08749E-04	68.9838
37	3.05752E-05	4.88555E-05	0.	5.76427E-05	57.3658
38	3.63364E-03	8.36180E-05	0.	3.63481E-03	1.3182
39	2.30734E-03	-7.11295E-04	0.	2.43278E-03	-18.5800
40	1.83232E-03	-9.84928E-04	0.	2.08044E-03	-28.2568
41	1.14103E-05	-1.49590E-05	0.	1.84976E-05	-51.8131
42	1.35802E-03	-5.36201E-05	0.	1.36124E-03	-3.9437
43	1.57500E-01	-3.72625E-14	0.	1.57500E-01	0.0000
44	1.57500E-01	1.86255E-14	0.	1.57500E-01	0.0000
45	1.62588E-03	1.84134E-04	0.	1.63628E-03	6.4813
46	2.88414E-05	2.05640E-04	0.	2.07652E-04	82.0182
47	1.84870E-05	1.95901E-04	0.	1.93300E-04	80.5928
48	1.50247E-05	2.25759E-04	0.	2.26288E-04	86.1925
49	1.88101E-05	2.02465E-04	0.	4.88520E-05	2.3753
50	1.84481E-03	4.88662E-05	0.	4.88692E-05	89.9978
51	3.20837E-03	-8.32233E-04	0.	3.20971E-03	-82.8515
52	3.97556E-06	-1.23441E-05	0.	1.29885E-05	-72.1482
53	2.44494E-06	-8.16292E-06	0.	8.52121E-06	-73.3261

174	1.57500E-01	-6.20882E-15	0.	1.57500E-01	-0.0000
175	1.55043E-03	1.74579E-04	0.	1.56024E-03	6.4281
176	1.1028E-05	1.78150E-04	0.	1.78495E-04	86.4338
177	4.66657E-06	1.78156E-04	0.	1.70223E-04	89.4346
178	1.39803E-06	1.78157E-04	0.	1.78163E-04	89.5504
179	5.56816E-02	1.13214E-04	0.	5.56817E-02	0.1161
180	5.17935E-03	4.89053E-05	0.	4.89053E-05	89.9939
181	4.17156E-02	4.26858E-05	0.	4.17156E-02	0.0392
182	9.29568E-07	1.86320E-05	0.	1.86552E-05	87.1457
183	3.25183E-08	1.86328E-05	0.	1.89734E-05	80.1314
184	7.61823E-06	1.89802E-05	0.	2.04327E-05	69.1145
185	3.1660E-03	1.18590E-04	0.	1.32175E-03	5.0505
186	1.57500E-01	3.72529E-14	0.	1.57500E-01	0.0000
187	1.87500E-01	2.0882E-15	0.	1.87500E-01	0.0000
188	1.84040E-03	8.8048E-05	0.	1.84930E-03	8.1495
189	1.08796E-05	1.73149E-04	0.	1.78495E-04	86.4046
190	4.66661E-06	1.73245E-04	0.	1.73308E-04	88.4504
191	1.39913E-06	1.73278E-04	0.	1.73281E-04	89.5572
192	6.24946E-02	1.15391E-04	0.	6.24947E-02	0.1058
193	5.58383E-09	4.88885E-05	0.	4.88988E-05	89.9935
194	4.92218E-02	3.58244E-05	0.	4.92218E-02	0.0418
195	3.46087E-07	1.0329E-05	0.	3.05012E-05	89.0513
196	1.23876E-06	1.16335E-05	0.	2.10693E-05	86.6294
197	3.28001E-06	2.37703E-04	0.	2.18807E-05	81.3786
198	1.02598E-03	3.72529E-14	0.	1.05316E-03	13.0443
199	1.87500E-01	2.72529E-14	0.	1.87500E-01	0.0000
200	1.57500E-01	4.89418E-11	0.	1.57500E-01	0.0000
201	1.59040E-03	1.59722E-04	0.	1.59871E-03	5.5582
202	1.03714E-05	1.70283E-04	0.	1.70599E-04	86.5146
203	4.08104E-06	1.70539E-04	0.	1.70587E-04	88.6292
204	1.19388E-06	1.70530E-04	0.	1.70534E-04	89.5991
205	6.62938E-02	4.94691E-05	0.	6.62938E-02	0.0428
206	4.64105E-10	3.4332E-06	0.	2.34332E-06	89.9887
207	4.98758E-07	3.3785E-06	0.	4.98755E-07	0.0034
208	-2.12780E-07	1.4386E-08	0.	1.43847E-08	9.0586
209	-6.49964E-07	1.16402E-05	0.	2.16569E-05	92.2493
210	-1.17811E-06	2.25263E-05	0.	2.25591E-05	92.9935
211	7.23938E-04	3.6970E-04	0.	8.09342E-04	24.8005
212	1.57500E-01	7.7420E-12	0.	1.57500E-01	-0.0000
213	1.57500E-01	1.38698E-14	0.	1.57500E-01	0.0000
214	1.52090E-03	1.53420E-04	0.	1.52862E-03	5.7602
215	7.91691E-03	1.87184E-04	0.	1.87368E-04	87.3230
216	2.70938E-09	1.87700E-04	0.	1.89701E-04	89.0068
217	-1.45822E-07	1.70684E-04	0.	1.70684E-04	90.0490
218	6.98046E-02	8.89456E-05	0.	6.98047E-02	0.0730
219	4.76557E-10	3.38955E-06	0.	2.33955E-06	89.9883
220	4.94937E-07	7.133E-05	0.	4.94937E-07	0.0438
221	-9.76394E-07	-0.01036E-05	0.	2.01273E-05	92.7806
222	-3.38944E-06	-0.05022E-05	0.	2.07805E-05	99.8873
223	-5.35986E-06	-0.20393E-04	0.	2.26332E-05	105.1538
224	4.27784E-04	8.8606E-04	0.	6.34907E-04	47.6068
225	1.57500E-01	3.72529E-14	0.	1.57500E-01	-0.0000
226	1.57500E-01	2.79397E-14	0.	1.57500E-01	0.0000
227	1.50648E-04	4.4848E-04	0.	1.51340E-04	5.4821
228	-4.64254E-06	1.60699E-04	0.	1.50708E-04	91.6554
229	-1.90168E-05	1.71010E-04	0.	1.72064E-04	96.3464
230	-7.12262E-06	1.75324E-04	0.	1.75468E-04	92.3264
231	7.42257E-05	1.89400E-05	0.	7.42258E-05	0.0532
232	4.92575E-06	3.3430E-06	0.	2.33530E-06	89.9879
233	4.90615E-02	6.25229E-04	0.	4.90622E-02	-0.3066

[illegible][illegible]

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 104

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APPENDIX C:

EXAMPLE PROBLEM GRAPHICS

This appendix contains computer-generated graphic displays of output from an example problem in ground-water hydrology described in the preceding text. The problem was solved with a computer code originally prepared by R.L. Taylor (1967) and later modified for use at Lawrence Livermore Laboratory.

FIG. C-1. Equal potential contour with nodes.

FIG. C-2. Equal potential contour without nodes.

FIG. C-3. Pressure contour with nodes.

FIG. C-4. Pressure contour without nodes.

FIG. C-5. Finite-element mesh