ATTACHMENT B

ANNOTATED BIBLIOGRAPHY OF SEDIMENTATION PROCESSES IN GLACIAL LAKES AND RIVERS

INTRODUCTION

A literature search was conducted to obtain information on glacial lake trap efficiency of suspended sediments, with emphasis on materials smaller than 50 microns. Relevant information will provide a basis for predicting the fate of suspended sediments entering the reservoirs of the proposed Susitna Hydroelectric Project.

The bibliography contains annotations for 36 references with relevant information and a listing of 31 additional references with no specific information. There is information on depositional processes when proglacial rivers enter standing water bodies (Church and Gilbert 1975; Carmack, Gray, Pharo, and Daley 1979; Embleton and King 1975; Gilbert 1973, 1975; Gilbert and Shaw 1981; Hamlin and Carmack 1978; Pharo and Carmack 1979; Smith 1978; Sturm and Matter 1978), with details on particle size distribution for two ancient lake environments (Ashley 1975; Shaw 1975). However, research reveals that reconstructing modern depositional environments from analyses of ancient environments may be misleading, as distance from source and shore and depth of lake are not as significant as density, wind-induced currents, and stratification (Bryan 1974a, b). Furthermore, misinterpretation of depositional events can lead to overestimation of the time involved in deposition (Shaw, Gilbert, and Archer 1978). A method is presented for determining sedimentation rates by radioactive fallout (Ashley 1979). One study on a modern lake shows that suspended sediment concentrations affect density stratification (Gustavson 1975b). Two studies (Ostrem 1975; Theakstone 1976) address lake trap efficiency and distance of deposition from the source.

The literature search included a review of University of Alaska theses and publications of the University of Alaska's Institute of Water Resources and Geophysical Institute, the U.S. Geological Survey, and the U.S. Army Corps of Engineers' Cold Regions Research and Engineering Laboratory (CRREL). A computer search was conducted on the CRREL Bibliography and on Selected Water Resources Abstracts.

PART I - RELEVANT INFORMATION

1. Arnborg, L., H.J. Walker, and J. Peippo. 1967. Suspended load in the Colville River, Alaska, 1962. Geografiska Annaler. 49A (2-4):131-144.

   Discussion of suspended sediment data collected during one year (1962) for hydrologic-morphologic study of the Colville River delta. Three aspects of suspended load considered were: quantity transported in water; size of particles in suspension; and total quantity transported in a given period of time. As unit volume increases, median grain size and total load carried increases. Grain size analyses for samples representative of selected locations, depths, and times are presented. The amount and size of suspended material increased with depth at one location.

2. Ashley, G.M. 1975. Rhythmic sedimentation in glacial Lake Hitchcock, Massachusetts-Connecticut. Pages 304-320 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glacio-lacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

   Discussion of seasonal silt and clay deposition (varves) in an ancient environment. Suspended sediment concentration affects water density far more than temperature in glacial lakes. The settling velocity of a 60 silt grain in 4°C water undisturbed by currents is 0.05 cm/second. Therefore, such a grain would settle 50 m in 1.15 days. However, silt was found in all winter clay layers, and could indicate that lake currents were present, preventing settling, or sediment was introduced year-round. Mean grain size of silt layers depends on location in the lake whereas grain size distribution of clay layers is uniform. Grain size analyses are presented, but there is no specific information on the distance traveled across the lake prior to deposition.

3. Ashley, G.M. 1979. Sedimentology of a tidal lake, Pitt Lake, British Columbia, Canada. Pages 327-345 in Ch. Schluchter, ed. Moraines and Varves. Proceedings of an INQUA Symposium of Genesis and Lithology of Quaternary Deposits, Zurich, September 10-20, 1978. A.A. Balkema, Rotterdam.

   Sedimentation rates were determined by ^{137}Cs dating techniques. Grain size analyses were determined for 190 samples and mean grain size distribution was mapped. Annual sediment accumulation equalled $150 \pm 20 \times 10^3$ tons, of which 50% was coarser than 50.

4. Ashley, G.M., and L.E. Moritz. 1979. Determination of lacustrine sedimentation rates by radioactive fallout (^{137}Cs), Pitt Lake, British Columbia. Canadian Journal of Earth Sciences. 16(4):965-970.

Discussion of techniques for determining modern lacustrine sedimentation rates.

5. Borland, W.M. 1961. Sediment transport of glacier-fed streams in Alaska. Journal of Geophysical Research. 66(10):3347-3350.

Developed empirical formula for sediment yield rates for glacial drainage basins based on glacier area, total drainage area, and length of watercourse. No differentiation by particle size. Used five years of U.S. Geological Survey suspended sediment data from Denali and Gold Creek stations to test formula.

6. Bryan, M.L. 1974a. Sedimentation in Kluane Lake. Pages 151-154 in V.C. Bushnell and M.G. Marcus, eds. Ice Field Ranges Research Project Scientific Results, Vol 4. American Geographical Society, New York, NY, and Arctic Institute of North America, Montreal, Canada.

Study of bathymetry, thermal structure, and sediment distribution in Kluane Lake, 1968. A weak thermocline developed in July and August, which was occasionally destroyed by storm-induced mixing. The lake is ice-covered for eight months, and receives sediment from the Slims River for four months. Statistical parameters of grain size analyses are presented.. Sedimentation is affected by density, by wind-induced lake currents, and by stratification as well as by bathymetry, distance from shore and input, point and sediment composition. Highly turbid, cold glacial waters may be sufficiently dense to flow across the lake bottom regardless of thermal stratification. When the Slims River warms, it flows over the lake.

7. Bryan, M.L. 1974b. Sublacustrine morphology and deposition, Kluane Lake, Yukon Territory. Pages 171-187 in V.C. Bushnell and M.B. Marcus, eds. Icefield Ranges Research Project Scientific Results, Vol 4. American Geographical Society, New York, NY, and Arctic Institute of North American, Montreal, Canada.

Discussion of processes affecting sedimentation in lakes from glacial streams. Bathymetric mapping of Kluane Lake in 1968 and 1970 revealed growth of the Slims River delta. Cartographic and statistical analyses of bottom sediments are presented. Finest sediments farthest from the Slims River

were not in the deepest portion of the lake. Distance from source, depth of lake, and distance from shore are not significant in controlling deposition. Reconstructing depositional environments based on sediment size analysis may be misleading.

8. Carmack, E.C., C.B.J. Gray, C.H. Pharo, and R.J. Daley. 1979. Importance of lakeriver interaction on the physical limnology of the Kamloops Lake/Thompson River system Limnology and Oceangraphy. 24(4):634-644.

   Discussion of physical effects of large river entering a deep, intermontane lake. No information of particle size analysis.

9. Church, M., and R. Gilbert. 1975. Proglacial fluvial and lacustrine environments. Pages 22-100 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists. Tulsa, OK. Special Publication 23.

   Discussion of deposition when proglacial rivers enter standing water bodies. Significant events are: aggradation on the bed due to deposition of bed load extends upstream from the lake, along with reduced flow velocities; development of a high angle delta, with transport of sediment to the delta lip; movement of coarse material over the lip and down into the lake in turbidity flows (bottom flow); movement of river water down the delta front to lake water of equal density (interflow); movement of river water onto the surface of the lake if density is less than the lake (surface flow); deposition of fine-grained material and formation of varves, of which the silt (summer) portion is deposited by turbidity currents, and the clay (winter) portion by the turbidity current after stagnation, and then by slow, continuous settling from suspension. Turbidity underflow is not a continuous event in the melt season. Varve formation cannot be directly correlated to mean annual discharge, because a single large flood can create a turbidity flow. Turbidity flows resulting in more rapid deposition depend on discharge, river and lake water temperature, thermal structure of the lake, quantity of sediment suspended in the lake from previous events, and river and lake dissolved sediment concentrations. No specific information on particle size is presented.

10. Embleton, C., and C.A.M. King. 1975. Glacial geomorphology. John Wiley and Sons, New York, NY. pp. 532-558.

   Review of general principles affecting sediment deposition in lacustrine environments with examples. Lake floor deposits become increasingly fine toward center or deepest parts of lakes, requiring quiet water and long settling periods. Turbidity currents formed by cold, silt-laden stream water are important in distributing sediment across the lake floor. Rhythmites (laminated deposits) develop in cold freshwater lakes receiving intermittent streamflow, and in some cases form on an annual basis (varves). They can also form from sudden fluctuations in discharge (bursting of an ice-dammed lake upstream), unseasonal warm or cold spells, or periodic storms.

11. Everts, C.H. 1976. Sediment discharge by glacier-fed rivers in Alaska. Pages 907-923 in Rivers '76. Vol. 2. Symposium on Inland Waterways for Navigation, Flood Control and Water Diversions. 3rd Annual Symposium, Colorado State University, Fort Collins, CO. Waterways, Harbors and Coastal Engineering Div., American Society of Civil Engineers, New York, NY.

Investigation of glacial sediments discharged into the coastal zone (Knik, Matanuska). Size distribution, composition, and settling characteristics of glacial sediment are important characteristics in determining where the sediment will be transported and deposited when it reaches the marine environment. Based on particle size distribution analyses, it appears that fine-grained particles pass completely through the river system. Ice margin lakes fringing glaciers are depositories for coarse sediments. Clay minerals were absent, which is significant because clay particles form aggregates with other fine-grained particles and settle more rapidly. This absence may be common in other glacial areas because of negligible chemical weathering in the source areas.

12. Fahnestock, R.K. 1963. Morphology and hydrology of a glacial stream: White River, Mount Rainier, Washington. U.S. Geological Survey. Professional Paper 422A. 70 pp.

Investigation of formation of a valley train by a proglacial stream. Particle size analyses of deposited material showed silts and clays were washed out of stream deposits. Analysis of suspended load indicated that silt and clay stay in suspension and are carried out of the study area into Puget Sound.

13. Fahnestock, R.K. 1969. Morphology of the Slims River. Pages 161-172 in V.C. Bushnell and R.H. Ragle, eds. Ice Field Ranges Research Project Scientific Results, Vol. 1. American Geographical Society, New York, NY, and Arctic Institute of North America, Montreal, Canada.

Investigation of the Slims River, a proglacial stream flowing 14 miles from Kaslawulsh Glacier to Kluane Lake. The river is modifying a valley train deposited when the glacier was up against a terminal moraine. It is regrading, ie, adjusting to a decrease in load at the source by cutting in the upper reaches and depositing in the lower reaches. The Slims River is also affected by downstream changes in the base level, which is controlled by the extension of the delta into Kluane Lake and the variation in lake level. As the volume growth rate of the delta is not known, the sediment transport rate cannot be estimated. Suspended sediment is predominantly silt and clay. No data on particle size distribution.

14. Gaddis, B. 1974. Suspended-sediment transport relationships for four Alaskan glacier streams. M.S. Thesis. University of Alaska, Fairbanks, AK. 102 pp.

    Investigation of suspended sediment transport relationships in glacial streams at Gulkana, Maclaren, Eklutna, and Wolverine glaciers. Data on mean particle size is presented for four glacial streams for one season at sites near the terminus. Sediment availability depends on amount of sediment, distance travelled downstream, and mechanical nature of sediment entrainment (no specific information on entrainment).

15. Gilbert, R. 1973. Processes of underflow and sediment transport in a British Columbia mountain lake. Pages 493-507 in Fluvial Processes and Sedimentation. Proceedings of the 9th Hydrology Sympasuim, University of Alberta, Edmanton. Canada, May 8-9. Subcommittee on Hydrology, Associate Committee on Geodesy and Geophysics, National Research Council of Canada.

    Description of processes involved in formation of varved sediment deposits in proglacial lakes, primarily underflow and interflow. Underflow increases with increase of water and suspended sediment inflow. Cores obtained to determine thickness and comparision of varves. No information on particle size distribution.

16. Gilbert, R. 1975. Sedimentation in Lillooet Lake, British Columbia. Canadian Journal of Earth Sciences. 12(10):1697-1711.

    Lillooet Lake receives sediment from a 3,580 sq km drainage basin, of which 7% is glacier-covered. Interflow and underflow distribute sediment through the lake in summer when the lake is stratified. Factors affecting distribution are: density characteristics of the lake and inflowing water, as determined by temperature and suspended sediment concentrations; currents induced by wind and inflow; thermal structure of the lake water, which determines the nature of circulation patterns and allows interflow along the thermocline; diurnal and seasonal fluctuations in inflowing waters and sediment;

and the large annual volume of inflow (4.5 times greater than the lake volume on the average). Interflow carries sediment at the base of the epilimnion to the distal end of the lake in one to two days. No specific information on particle size.

17. Gilbert, R., and J. Shaw. 1981. Sedimentation in proglacial Sunwapta Lake, Alberta. Canadian Journal of Earth Sciences. 18(1):81-93.

    Examination of hydrologic and limnologic conditions of Sunwapta Lake, a small, proglacial lake in the Canadian Rockies. Sediment input was measured and sedimentation rates were calculated. Sediments of small, shallow lakes with large and highly variable inflows are expected to demonstrate lateral and vertical variability, whereas those in large proglacial lakes are more predictable due to modification by large, stable water masses.

18. Gustavson, T.C. 1975a. Bathymetry and sediment distribution in proglacial Malaspina Lake, Alaska. Journal of Sedimentary Petrology. 45:450-461.

See next abstract

19. Gustavson, T.C. 1975b. Sedimentation and physical limnology in proglacial Malaspina Lake, southeastern Alaska. Pages 249-263 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

    Underflow, interflow, and overflow water entered Malaspina Lake, and the type of flow is dependent on the relative suspended sediment content of the lake water and the inflowing melt water. The 18-km long lake is density stratified (increasing suspended sediment concentration with depth) but not thermally stratified. No specific information on particle size or trap efficiency is presented.

20. Guymon, G.L. 1974. Regional sediment yield analysis of Alaska streams. Journal of the Hydraulics Div. of the American Society of Civil Engineers. 100(HY1):41-51.

    Analyzed Borland's (1961) formula. Considered particle size, but used an average particle size in the formula. However, concluded that particle size affects application of the formula.

21. Hamblin, P.F., and E.C. Carmack. 1978. River-induced currents in a fjord lake. Journal of Geophysical Research. 83(C2):885-889.

Discussion of dynamics of strong flowing river entering a long, narrow lake (Kamloops Lake, B.C.). River-induced currents influence circulation patterns in a fjord lake. No specific information on sedimentation rates or particle size analysis.

22. Hobbie, J.E. 1973. Arctic limnology: a review. Pages 127-168 in M.E. Britton, ed. Alaskan arctic tundra. Arctic Institute of North America. Technical Paper 25.

Review of properties of lake in northern tundra regions. Thermal cycle of deep arctic lakes is highly variable, and stratification is uncommon, occurring only in warm, calm weather after lake waters rise to 4°C. Deep lakes maintain circulation even when ice covered. Deeper lakes are relatively turbid as a result of glacial flour from streams draining active glaciers. Lake Peters is fed by glacial streams and drains via a 1-km long, 15-m deep channel into Lake Schrader in the Brooks Range. Both are 50-60 m deep. Lake Peters acts as a settling basin. When dense glacial water enters Lake Peters in June, it sinks to the bottom, and the lake fills upward with turbid water.

23. Mathews, W.H. 1956. Physical limnology and sedimentation in a glacial lake. Bulletin of the Geological Society of America. 67:537-552.

Garibaldi Lake, British Columbia, receives sediment from two glacial streams with relatively low sediment content. Particle size and composition of bottom deposit analyses revealed slow transport to site of deposition and slow rate of deposition for clays. No information on amount of sediment passing through system.

24. Ostrem, G. 1975. Sediment transport in glacial meltwater streams. Pages 101-122 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

Recognized problems of utilizing glacial waters for hydroelectric projects, specifically in reservoirs and turbines. Grain size analyses of cores of varved sediments showed that summer layers consisted of coarser material than winter layers (based on 20 micron grain size variation). X-ray diffraction analyses showed that summer deposits contained more quartz (rapid sedimentation), and winter deposits, more mica (slower sedimentation). For one 1,800-m long proglacial lake over 29 years, about 70 percent of the total suspended sediment input was deposited.

Discussion of dynamics of strong flowing river entering a long, narrow lake (Kamloops Lake, B.C.). River-induced currents influence circulation patterns in a fjord lake. No specific information on sedimentation rates or particle size analysis.

22. Hobbie, J.E. 1973. Arctic limnology: a review. Pages 127-168 in M.E. Britton, ed. Alaskan arctic tundra. Arctic Institute of North America. Technical Paper 25.

Review of properties of lake in northern tundra regions. Thermal cycle of deep arctic lakes is highly variable, and stratification is uncommon, occurring only in warm, calm weather after lake waters rise to 4°C. Deep lakes maintain circulation even when ice covered. Deeper lakes are relatively turbid as a result of glacial flour from streams draining active glaciers. Lake Peters is fed by glacial streams and drains via a 1-km long, 15-m deep channel into Lake Schrader in the Brooks Range. Both are 50-60 m deep. Lake Peters acts as a settling basin. When dense glacial water enters Lake Peters in June, it sinks to the bottom, and the lake fills upward with turbid water.

23. Mathews, W.H. 1956. Physical limnology and sedimentation in a glacial lake. Bulletin of the Geological Society of America. 67:537-552.

Garibaldi Lake, British Columbia, receives sediment from two glacial streams with relatively low sediment content. Particle size and composition of bottom deposit analyses revealed slow transport to site of deposition and slow rate of deposition for clays. No information on amount of sediment passing through system.

24. Ostrem, G. 1975. Sediment transport in glacial meltwater streams. Pages 101-122 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

Recognized problems of utilizing glacial waters for hydroelectric projects, specifically in reservoirs and turbines. Grain size analyses of cores of varved sediments showed that summer layers consisted of coarser material than winter layers (based on 20 micron grain size variation). X-ray diffraction analyses showed that summer deposits contained more quartz (rapid sedimentation), and winter deposits, more mica (slower sedimentation). For one 1,800-m long proglacial lake over 29 years, about 70 percent of the total suspended sediment input was deposited.

25. Ostrem, G., T. Ziegler, and S.R. Ekman. 1970. A study of sediment transport in Norwegian glacial rivers, 1969. Institute of Water Resources, Dept. of Hydrology, Oslo, Norway. Report 6/70. Report for Norwegian Water Resources and Electricity Board. Translated from Norwegian by H. Carstens. 1973. Institute of Water Resources, University of Alaska, Fairbanks, AK. Report 35. 1 vol.

Investigations were conducted on water discharge and sediment volume measurements in glacial rivers above and at the outlet of glacial lakes to calculate the sedimentation of fine material on the bottom of the lakes. Volume of material available for transport is probably largest at the beginning of the season. No data on particle size.

26. Pharo, C.H., and E.D. Carmack. 1979. Sedimentation processes in a short residence-time intermontane lake, Kamloops Lake, British Columbia. Sedimentology. 26:523-541.

Sediment transport and deposition in the lake is controlled by three interdependent processes: delta progradation at the lake-river confluence; sediment density surges originating along the delta face, which result in turbidite sequences lakeward from the base of the delta; and dispersal by the interflowing river plume, which, due to Coriolis effects, results in a higher sedimentation rate and greater fraction of coarser material along the right-hand of the lake in the direction of flow. Suspended sediment concentrations are high above the thermocline where higher turbulence, maintained by wind mixing and river inter interflow, reduces settling velocities. Particles settle rapidly once they enter the hypolimnion.

27. Ritchie, J.C., J.R. McHenry, and A.C. Gill. 1973. Dating recent reservoir sediments. Limnology and Oceanography. 18:254-283.

Discussion of radioactive ^{137}Cs dating. Method could be used to date sediment in reserviors that have not been surveyed.

28. Shaw, J. 1975. Sedimentary successions in Pleistocene ice-marginal lakes. Pages 281-302 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

Discussion of sedimentation in proximal portion of a glacial lake based on interpretation on the ancient environment. Mean grain size values were determined for sections of each facies from o to 80. No information on transport of fine materials.

29. Shaw, J. 1977. Sedimentation in an alpine lake during deglaciation, Okanagan Valley, British Columbia, Canada. Geografiska Annaler. 59(A):221-240.

Ancient lake sediments were examined to develop a model of alpine lake sedimentation based on changing depositional processes with time and distance from the ice margin.

30. Shaw, J., R. Gilbert, and J.J.J. Archer. 1978. Proglacial lacustrine sedimentation during winter. Arctic and Alpine Research. 10(4):689-699.

Discussion of deposition of coarse-grained sediments during winter in Lillooet Lake. Misinterpretation can lead to overestimation of time seqences of deposition.

31. Slatt, R.M. 1970. Sedimentological and geochemical aspects of sediment and water from ten Alaskan valley glaciers. Ph.D. Thesis. University of Alaska, Fairbanks, AK. 125 pp. Studied five groups of glaciers with different bedrock lithologies; Worthington and Matanuska; Castner and Fels; Gulkana and College; Rendu and Reed; and Carroll and Norris. Particle size analyses and mineralogy of superglacial and suspended stream sediments are presented. The environment of transport has a much greater effect on grain size than the nature of the starting material.

32. Slatt, R.M. 1971. Texture of ice-cored deposits from ten Alaskan valley glaciers. Journal of Sedimentary Petrology. 41(3):828-834.

Revised and condensed portions of Ph.D. thesis (see above).

33. Smith, N.D. 1978. Sedimentation processes and patterns in a glacier-fed lake with low sediment input. Canadian Journal of Earth Sciences. 15(5):714-756. Snow melt and glacial melt waters carrying relatively low suspended sediment concentrations enter Hector Lake in the eastern Rocky Mountains, Alberta. When stratified, water and fine sediments enter the lake as interflow and overflow. Grain size analyses were conducted on 42 cores. Deposition varies left to right as well as distally due to katabatic winds generating downlake currents in the epilimnion that are deflected southward (rightward) by the Coriolis force.

34. Sturm, M., and A. Matter. 1978. Turbidites and varves in Lake Brienz (Switzerland): deposition of clastic detritus by density currents. Pages 147-168 in A. Matter and M.E. Tucker, eds. Modern and ancient lake sediments. International Association of Sedimentologists. Special Publication 2.

Discussion of sediment transport and deposition by overflow, interflow, and underflow in a long, narrow, deep basin with rivers entering at each end. Fine-grained sediments supplied by overflows and interflows settle continuously during summer thermal stratification. Most of the fine-grained particles remain in suspension at the thermocline because the vertical density gradient is more dependent on temperature than on an increase in density due to suspended particles. During fall turnover, the remaining sediment trapped at the thermocline settles.

35. Theakstone, W.H. 1976. Glacial lake sedimentation, Austerdalsisen, Norway. Sedimentology. 23(5):671-688.

A lake completely filled with glacial sediments, over which braided stream deposits formed. A new proglacial lake then formed. Discussion of bedding and composition of ancient lake sediments. Initially, deposition was very slow in deep (80 m) water. In another lake 300 m from a glacier, about 75 percent of the sediment transported in suspension is retained in the basin, but the amount retained in one day is highly variable. The daily summer values exceeded the minimum by 200 times (data not presented).

36. Tice, A.R., L.W. Gatto, and D.M. Anderson. 1972. The mineralogy of suspended sediment in some Alaskan glacial streams and lakes. Cold Regions Research and Engineering Laboratory Corps of Engineers, U.S. Army, Hanover, NH. Research Report 305. 10 pp.

Investigation of the role of chemical weathering of bedrock in cold regions determined that no chemical changes occurred in fine suspended material. Suspended sediment samples were obtained for X-ray diffraction analyses from galcial outwash streams and lakes in seven areas (Chackachamna, Palmer-Matanuska, Moose Pass-Portage, Valdez, Juneau, Mt. McKinley National Park, and Black Rapids).

PART II- NO SPECIFIC INFORMATION

1. Agterberg. F.P., and I. Banerjee. 1969. Stochastic model for the deposition of varves in glacial Lake Barlow-Ojibway, Ontario, Canada. Canadian Journal of Earth Sciences. 6:625-652

2. Banerjee, I., and B.C. McDonald. 1975. Nature of esker sedimentation. Pages 132-154 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

3. Boothroyd, J.C. and G.M Ashley. 1975. Processes, bar morphology, and sedimentary structures on braided outwash fans, northeastern Gulf of Alaska. Pages 193-222 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

4. Bradley, W.H. 1965. Vertical density currents. Science. 150(3702):1423-1428.

5. Clague, J.J. 1975. Sedimentology and paleohydrology of late Wisconsinan outwash, Rocky Mountain trench, southeastern British Columbia. Pages 223-237 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

6. Everts, C.H. and H.E. Moore. 1976. Shoaling rates and related data from Knik Arm near Anchorage, Alaska. Coastal Engineering Research Center, Corps of Engineers, U.S. Army, Fort Belvoir, VA. Technical Paper 76-1. 84 pp.

7. Gilbert, R. 1971. Observations on ice-dammed Summit Lake, British Columbia, Canada. Journal of Glaciology. 10(60):351-356.

8. Gustavason, T.C., G.M. Ashley, and J.C. Boothroyd. 1975. Depositional sequences in glaciolacustrine deltas. Pages 264-280 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

9. Guymon, G.L. 1974. Sediment relations of selected Alaskan glacier-fed streams. Institute of Water Resources, University of Alaska, Fairbanks, AK. Report 51. 17 pp.

10. Hobbie, J.E., ed. 1980. Limnology of tundra ponds: Barrow, Alaska. Dowden, Hutchinson and Ross, Inc., Stroudsburg, PA. US/IBP Synthesis Series 13. 514 pp.

11. Howarth, P.J., and R.J. Price. 1969. The proglacial lakes of Breidamerdurjokull and Fjallsjokull, Iceland. Geographical Journal. 135:573-581.

12. Jopling, A.V. 1975. Early studies on stratified drift. Pages 4-21 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

13. Kindle, E.M. 1930. Sedimentation in a glacial lake. Journal of Geology. 38(1):81-87.

14. Lawson, D.E. 1977. Sedimentation in the terminus region of the Matanuska Glacier, Alaska. Ph.D. Thesis. University of Illinois, Urbana-Champaign, IL. 287 pp.

15. Long, W.E. 1972. Glacial processes and their relationship to streamflow; Flute Glacier, Alaska. Institute of Water Resources, University of Alaska, Fairbanks, AK. Report 18. 1 vol.

16. Ludlam, S.D. 1967. Sedimentation in Cayuga Lake, New York. Limnology and Oceanography. 12(4):618-632.

17. McDonald, B.C., and W.W. Shilts. 1975. Interpretation of faults in glaciofluvial sediments. Pages 123-131 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

18. Moores, E.A. 1962. Configuration of the surface velocity profile of Gulkana Glacier, central Alaska Range, Alaska. M.S. Thesis. University of Alaska, Fairbanks, AK. 47pp.

19. Moravek, J.R. 1973. Some further observations on the behavior of an ice-dammed self-draining lake, Glacier Bay, Alaska, USA. Journal of Glaciology. 12(66):505-507.

20. Reger, R.D. 1964. Recent glacial history of Gulkana and College Glaciers, central Alaska Range, Alaska. M.S. Thesis. University of Alaska, Fairbanks, AK. 75 pp.

21. Rust, B.R. 1975. Fabric and structure in glaciofluvial gravels. Pages 238-248 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

22. Rust, B.R., and R. Romanelli. 1975. Late quaternary subaqueous outwash deposits near Ottawa, Canada. Pages 177-192 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

23. Ryder, J.M., and M. Church. 1972. Paraglacial sedimentation: consideration of fluvial processes conditioned by glaciation. Bulletion of the Geological Society of America. 83:3059-3072.

24. Saunderson, H.C. 1975. Sedimentology of the Brampton esker and its associated deposits: an empirical test of theory. Pages 155-176 in A.V. Jopling and B.C. McDonald, eds. Glaciofluvial and glaciolacustrine sedimentation. Society of Economic Paleontologists and Mineralogists, Tulsa, OK. Special Publication 23.

25. Sellmann, P.V. 1962. Flow and ablation of Gulkana Glacier, central Alaska Range, Alaska. M.S. Thesis University of Alaska, Fairbanks, AK. 36 pp.

26. Shira, D.L. 1978. Hydroelectric powerplant siting in glacial areas of Alaska. Pages 59-76 in Applied Techniques for Cold Environments, Vol. 1. Proceedings of the Cold Regions Specialty Conference, Anchorage, AK, May 17-19. American Society of Civil Engineers, New York, NY.

27. Slatt, R.M., and C.M. Hoskin. 1968. Water and sediment in the Norris Glacier outwash area, upper Taku Inlet, southeastern Alaska. Journal of Sedimentary Petrology. 38(2):434-456.

28. Stone, K.H. 1963. Alaskan ice-dammed lakes. Association of American Geographers: Annals. 52:332-349.

29. St. Onge, D.A. 1980. Glacial Lake Coppermine, north-central District of MacKenzie, Northwest Territories. Canadian Journal of Earth Sciences. 17(9):1310-1315.

30. Williams, P.F., and B.R. Rust. 1972. The sedimentology of a braided river. Pages 183-210 in V.C. Bushnell and R.H. Ragle, eds. Icefield Ranges Research Project Scientific Results, Vol. 3. American Geographic Society, New York, NY, and Arctic Institute of North America, Montreal, Canada.

31. Yould, E.P., and T. Osterkamp. 1978. Cold regions considerations relative to development of the Susitna hydroelectric project. Pages 887-895 in Applied Techniques for

Cold Environments, Vol 2. Proceedings of the Cold Regions Specialty Conference, Anchorage, AK, May 17-19. American Society of Civil Engineers, New York, NY.

2. Water Use and Quality

Comment 33 (p. E-2-96, para. 2)

Provide quantitative estimates of nutrient adsorption on suspended sediments (e.g., glacial flour) that will be transported into Watana Reservoirs. Provide data on levels of exchangeable phosphorus in soils in the Watana and Devil Canyon impoundment zones.

Response

Quantitative estimates of nutrient adsorption on suspended sediments (e.g., glacial flour) that will be transported into Watana Reservoir are not available at the present time. Data on levels of exchangeable phosphorus in soils in the Watana and Devil Canyon impoundment zones do not presently exist.

Additionally, to our knowledge at the present time, approved and standardized methods do not exist for quantitatively estimating exchangeable phosphorus in soil samples. In fact, the definition of the term "exchangeable phosphorus" is not standardized in state-of-the-art limnological literature.

The present level of knowledge about the Susitna River drainage basin and the limnology of the two proposed reservoirs indicates that the project reservoirs will maintain a low productivity (oligotrophic) trophic status due to phosphorus limitation (Peratrovich, Nottingham and Drage, Inc. and Hutchison, 1982; Peterson and Nichols, 1982; Rast and Lee, 1978; Stuart, 1983; Vollenweider and Kerekes, 1980).

Data about nutrients attached to turbidity particles which are potentially exchangeable with juxtapositioned microbial biomass are difficult, time consuming, and expensive to acquire. We hope that the FERC staff will agree with our position and withdraw or temper this request.

References

Peratrovich, Nottingham and Drage, Inc. and Ian P.G. Hutchinson, 1982. Susitna Reservoir Sedimentation and Water Clarity Study. Prepared for Acres American Inc., Anchorage, Alaska, 35 pp.

Peterson, L.A. and G. Nichols, 1982. Water Quality Effects Resulting from Impoundment of the Susitna River. Prepared with R & M Consultants, Inc. for Acres American Inc., Buffalo, New York, 18 pp.

Rast, W. and G.F. Lee, 1978. Summary analysis of the North American (U.S. portion) OECD entrophication project: nutrient loading - lake response relationships and trophic state indices. EPA-600/3-78-008. 455 pp.

Stuart, T.J., 1983. The effects of freshet turbidity on selected aspects of the biogeochemistry and the trophic status of Flathead Lake, Montana, U.S.A., Ph.D. dissertation, North Texas State University, Denton, Texas, 229 pp.

Vollenweider, R.A. and J. Kerekes, 1980. The loading concept as a basis for controlling eutrophication philosophy and preliminary results of the OECD Programme on eutrophication. Prog. Wat. Tech., Vol. 12, Norway, pp. 5-18. IAWPR/Pergamon Press Ltd.

2. Water Use and Quality

Comment 35 (p. E-2-100, para. 4)

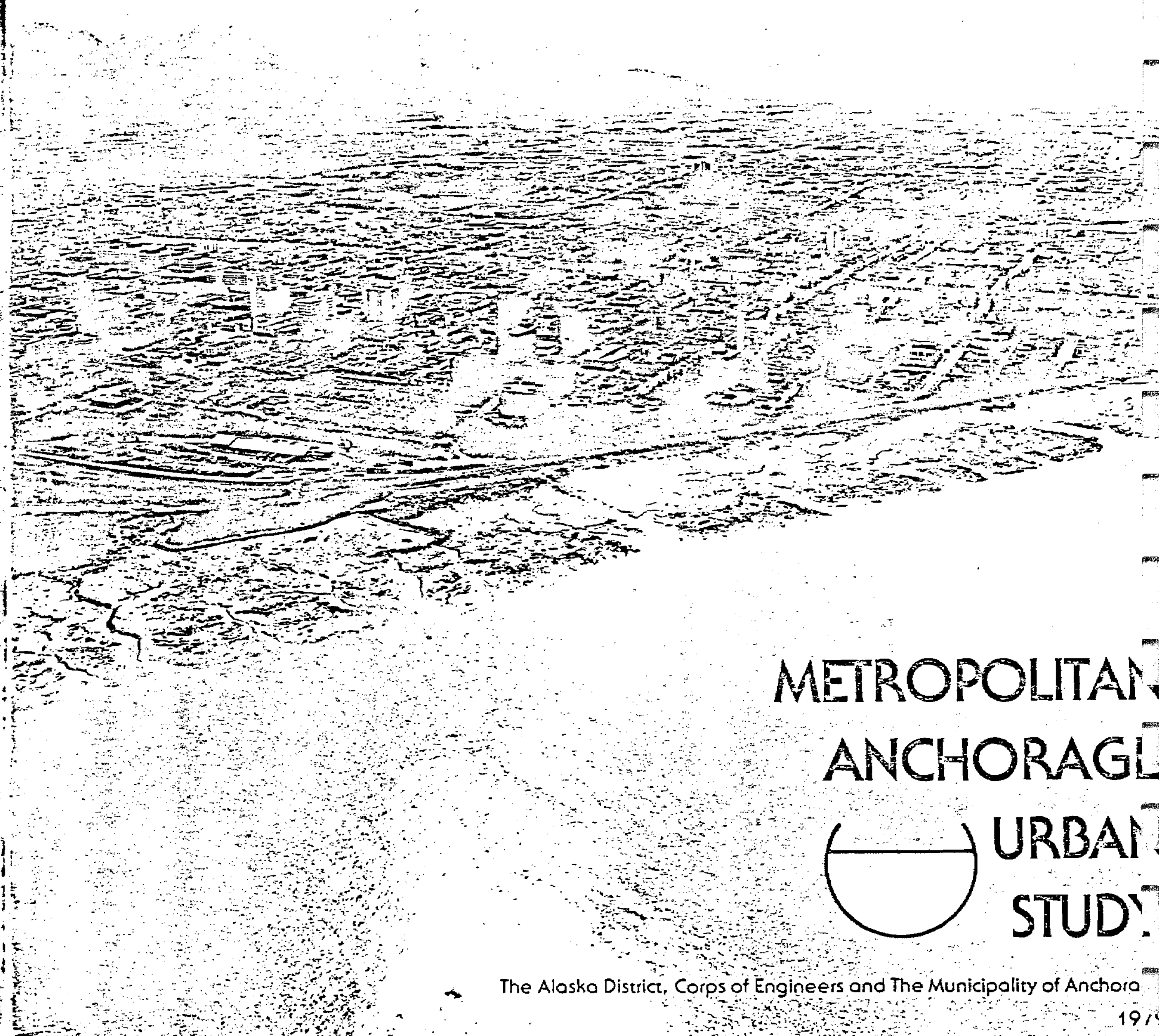
Provide real and simulated salinity data which show the accuracy of the Corps of Engineers salinity model for predicting salinity in Cook Inlet at different locations (e.g., Node 27) under different flow conditions. Also, provide parameter values used in these simulations and document the source of the values used.

Response

Real and simulated salinity data for Node 27 near the Susitna River mouth are provided in pp. 2-35-2 to 2-35-35.

Also provided is a user's guide (pp. 2-35-36 to 2-35-171) for the computer modeling effort conducted by the Corps of Engineers on the estuary hydrodynamics and water quality of Cook Inlet. The user's guide documents parameter values and their source for use in the Cook Inlet water quality modeling effort. An example problem data set and simulation results are presented on pp. 2-35-92 to 2-35-131.

Volume 3
WATER QUALITY, KNIK ARM - UPPER COOK INLET



METROPOLITAN
ANCHORAGE
URBAN
STUDY

The Alaska District, Corps of Engineers and The Municipality of Anchorage

1979

2-35-2

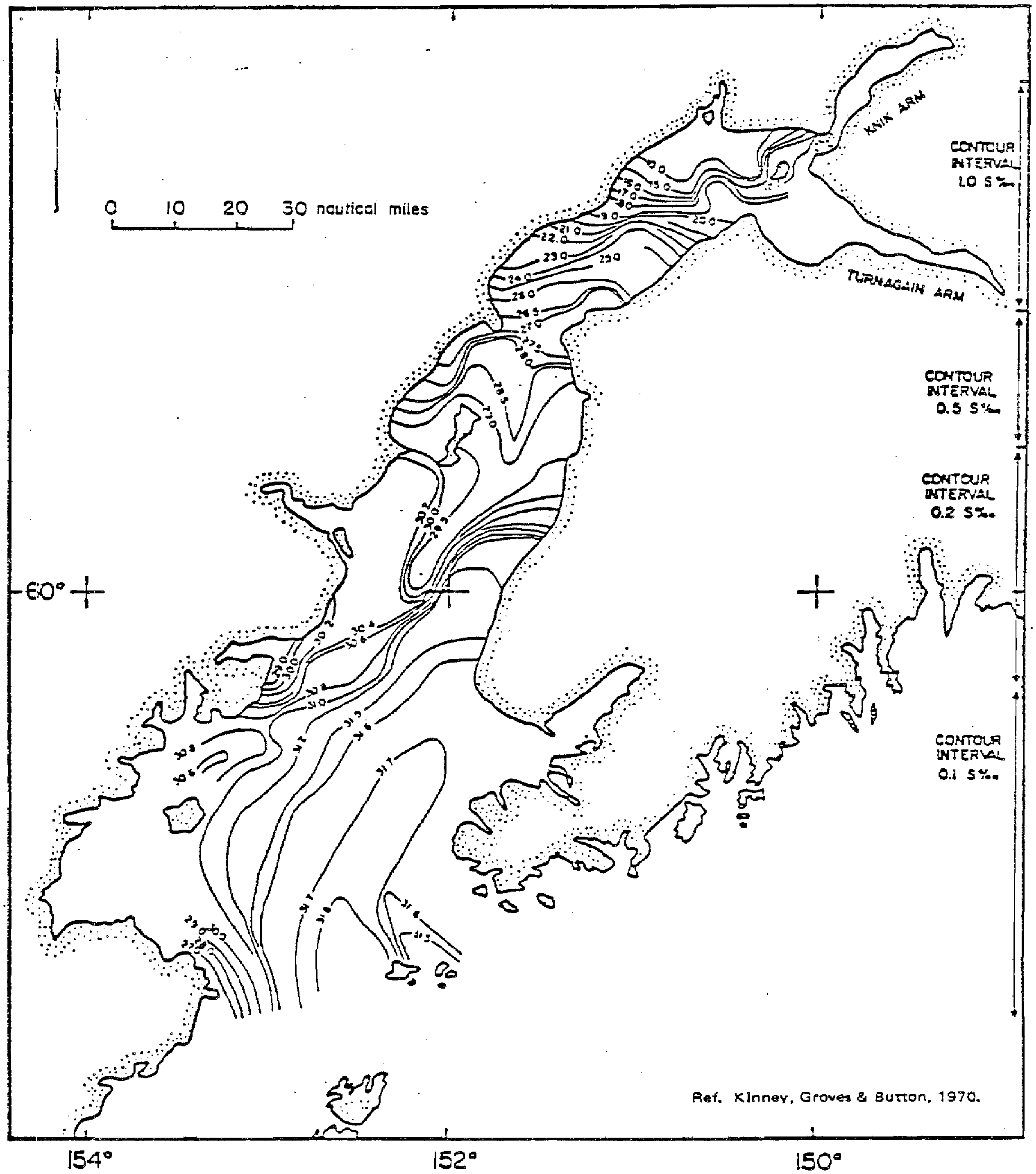


FIGURE 2.5 Surface Salinity Distribution in Cook Inlet

2-35-3

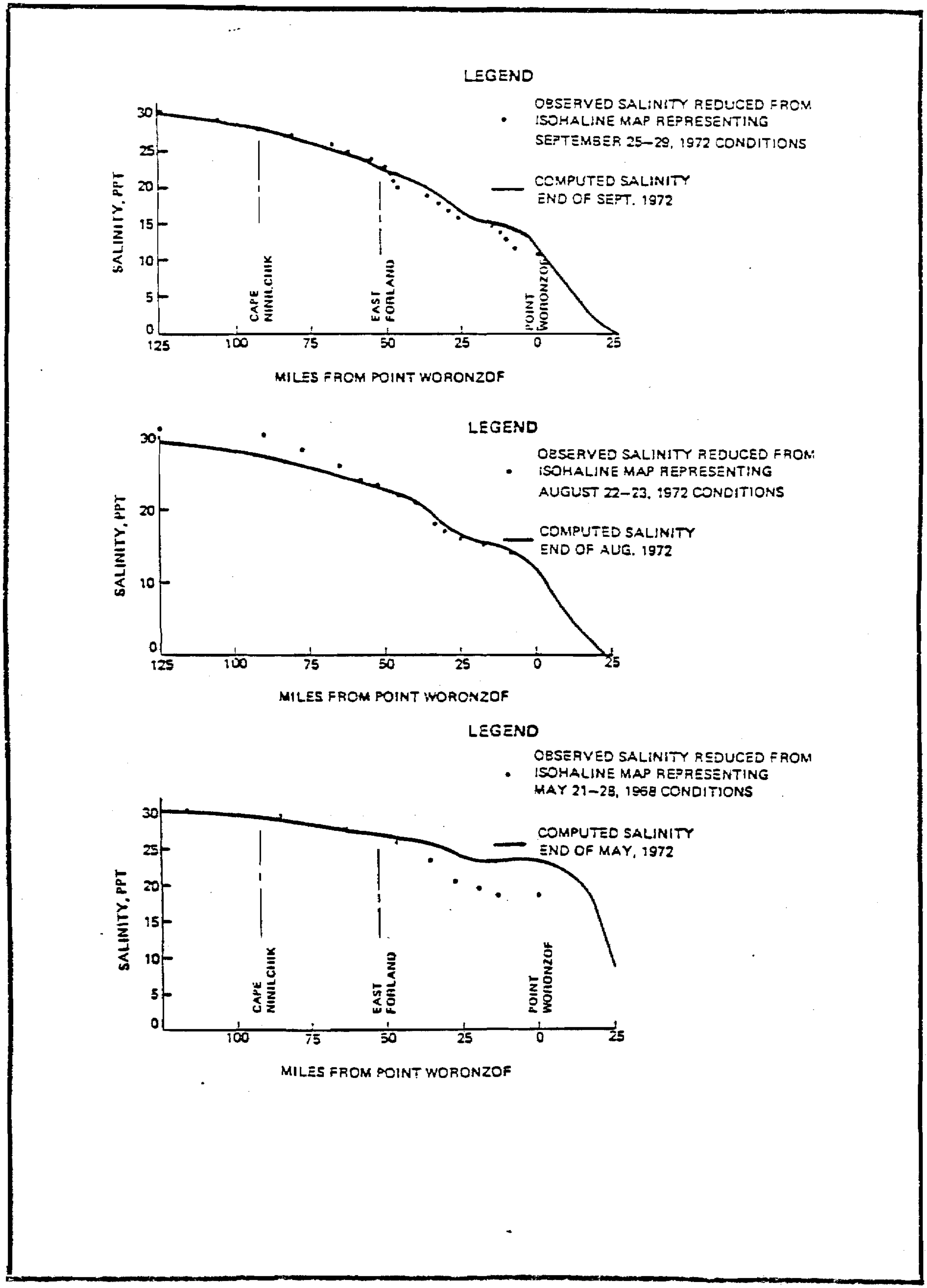


FIGURE 7.4 Computed and Observed Salinity between Anchor Point and Knik Arm

2-35-4

RESOURCE MANAGEMENT ASSOCIATES
Research • Development • Applications

11 October 1982

HARZA-EBASCO
Susitna Joint Venture
Document Number

525

Please Return To
DOCUMENT CONTROL

Mr. Wayne M. Dyok
Acres American Inc.
Suite 305
1577 C Street
Anchorage, Alaska 99501

Dear Mr. Dyok:

As authorized by your letter to Dr. Robert Carlson, dated September 23a 1982, I have performed a numerical modeling study to determine the effects of altered Susitna River flows on the salinity of Cook Inlet. The following describes the results of this study.

Background

The construction and operation of the proposed Susitna River Hydroelectric Project will alter the amount of freshwater which enters Cook Inlet from the Big Susitna River. With this project, inflows during the high runoff summer months will be reduced and increased during the low runoff winter months. To assess the effects of this change in freshwater inflow on the salinity distribution within Cook Inlet, a numerical model previously applied to Cook Inlet during a Corps of Engineers sponsored study was used (1,2).

Model Application

The numerical model used in this application represents the estuary as a series on nodes (discrete volume elements) and interconnecting channels. In the aggregate this node-channel representation provides a 2-dimensional (i.e., 2-dimensional in the horizontal plane and uniform vertically) description of the estuary including flow rates and velocities and water quality parameter concentrations over time and space.

The model representation of Cook Inlet shown in Figure 1 was developed in the beforementioned study. This model representation is adequate for this study, therefore no modification or further calibration was performed. To provide a more detailed description of the model concepts and its application to Cook Inlet, excerpts from the report to the Corps of Engineers (1) have been included as Exhibit A.

Typical hydraulic conditions were used for the study. Monthly average inflows from the various streams tributary to Cook Inlet were provided by Dr. Robert Carlson. These tributary flows, including the

2-25-5

pre and post Susitna Hydroelectric Project flows along with the model inflow locations are shown in Table 1.

Study Results

To assess the effects of the proposed project on the salinity of Cook Inlet, the following hydrodynamic and dynamic water quality simulations were performed.

[redacted]

Cases 3 and 4 had very similar Susitna River flow and therefore the effects on Cook Inlet salinity were quite similar.

D[redacted] (i.e., Node 27). [redacted]. The pre and post project salinities distribution at six locations within the inlet are shown in Figures 2 through 7. The end of month salinities at selected nodal locations are presented in Exhibit B.

I hope that this brief summary of our modeling approach and results meets the requirements of your project. It has been a pleasure providing this service to Acres American and I hope we are able to assist you in future studies.

Sincerely,

Donald J. Smith

DJS/ch
cc: Dr. Robert Carlson
Enclosures

REFERENCES

1. Tetra Tech Inc., "Water Quality Study, Knik Arm and Upper Cook Inlet, Alaska," report to the Corps of Engineers, September, 1977.

2. Smith, D. J., "User's Guide for the Estuary Hydrodynamic and Water Quality Models," Tetra Tech report to the Corps of Engineers, September, 1977.

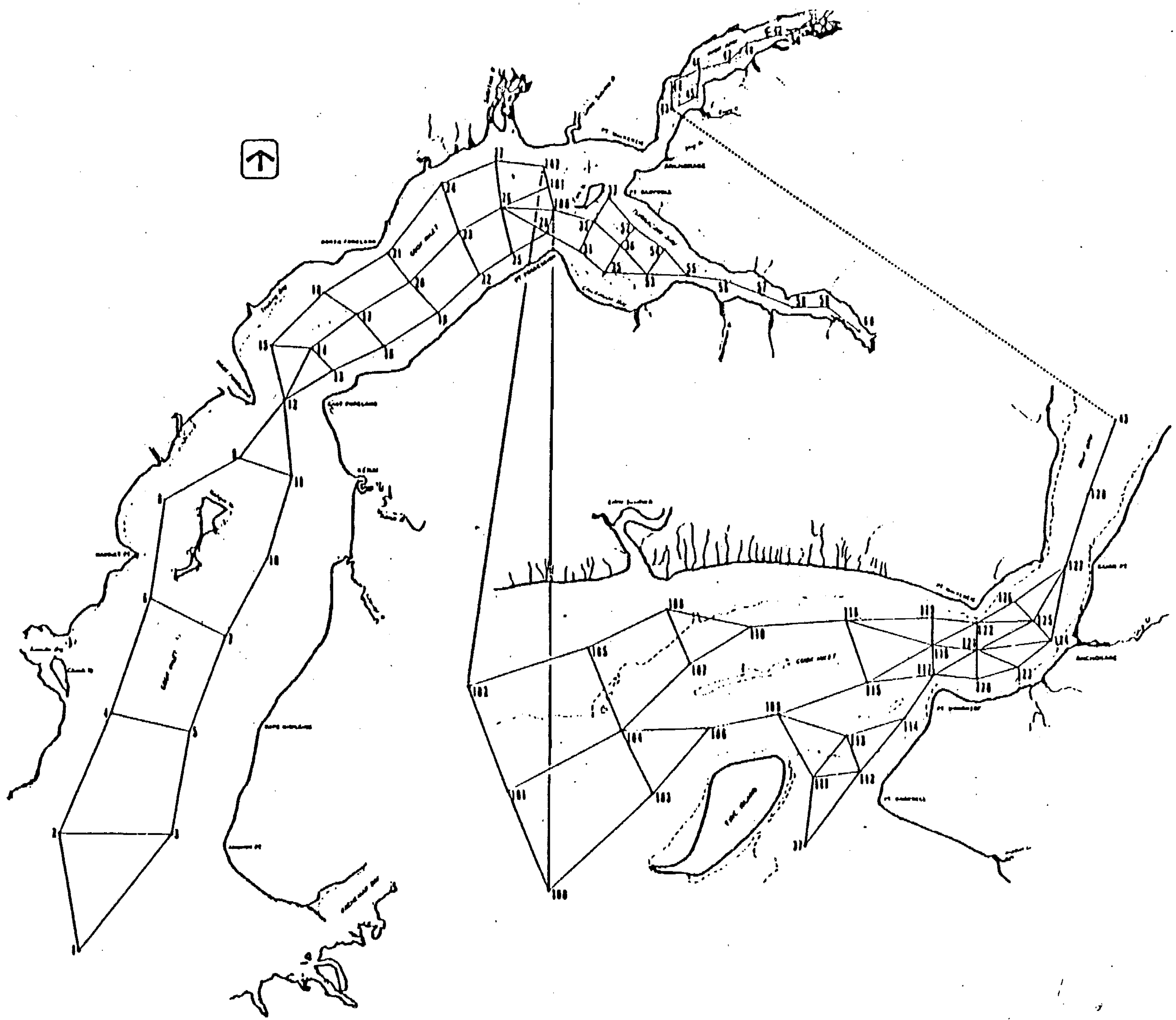


FIGURE 1

NODE-CHANNEL NETWORK REPRESENTATION OF COOK INLET

TABLE 1

TYPICAL RIVER INFLOWS (cfs) TO COOK INLET

RIVER LOCATION	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
NODE 27+ .. CASE 1	30055	12658	8215	7906	7037	6320	6979	60463	123698	131932	110841	65963
NODE 27++ .. CASE 3	32392	19191	17033	16108	14705	13500	13319	57611	107381	117004	102348	62629
NODE 27++ .. CASE 4	32184	19772	17620	16973	15922	14415	13640	55930	105702	116333	101733	63254
NODE 11	6262	2768	1787	1616	1330	1200	1218	2862	7246	11955	13895	12010
NODE 10	4441	2266	1267	794	631	571	573	737	1519	4293	7434	7079
NODE 7	394	309	185	160	173	205	518	723	401	280	286	387
NODE 8	4590	2243	1521	1140	939	828	820	1938	10669	22353	22461	11279
NODE 24	9329	4459	3073	2317	1909	1682	1667	3939	12682	45428	45647	22922
NODE 50	7695	3457	2068	1646	1399	1225	1707	7483	28070	47454	38654	20983
NODE 125	761	288	193	145	119	121	155	561	2363	4048	3815	2060
NODE 55	1083	400	209	91	45	45	100	1028	3485	2721	2120	1556
NODE 116	3700	2082	1511	1130	904	869	880	3427	7354	6319	4200	2856

+ .. PRE PROJECT SUSITNA RIVER FLOWS

++ .. POST PROJECT SUSITNA RIVER FLOWS

2-35-9

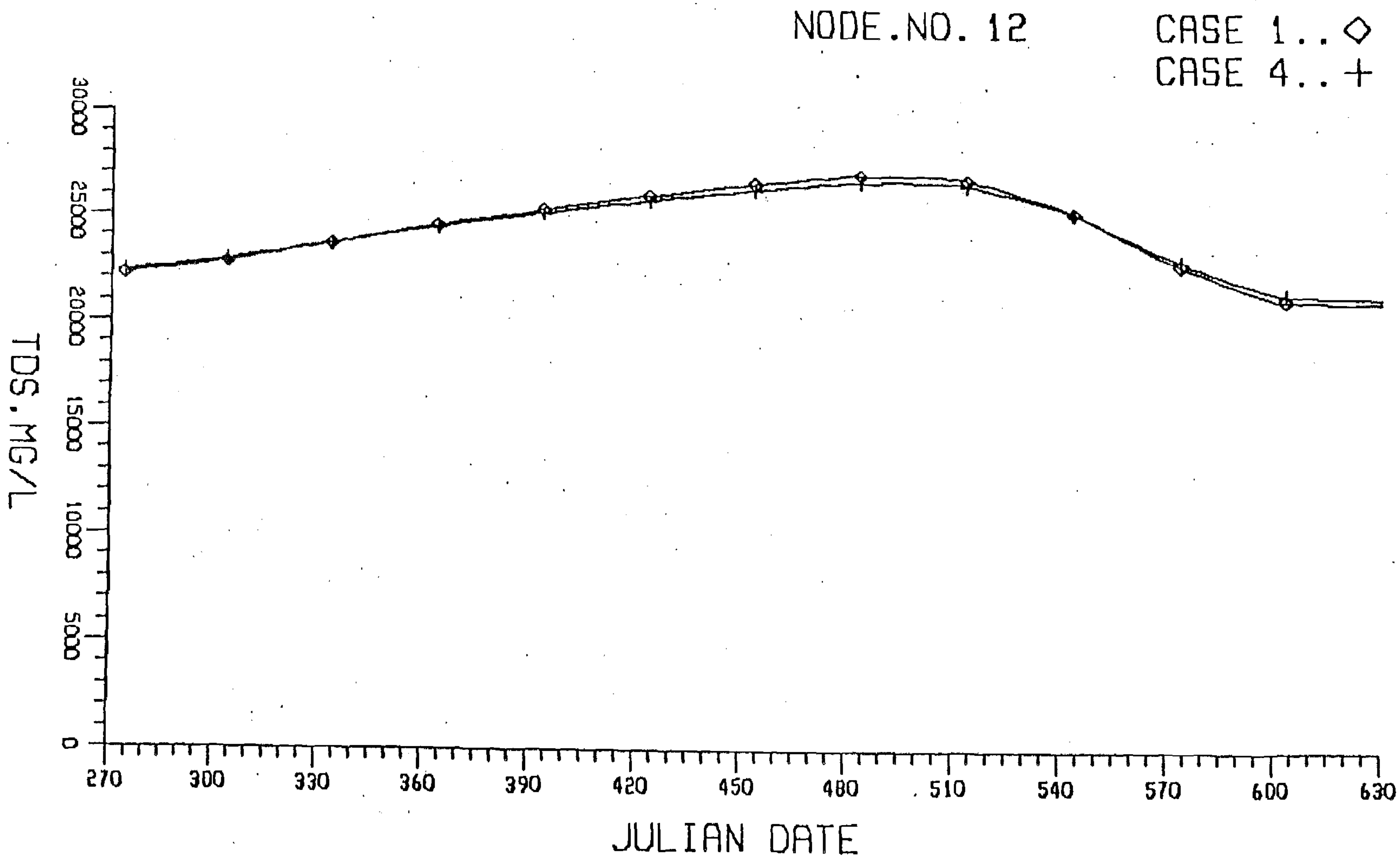


FIGURE 2

TEMPORAL VARIATION IN SALINITY WITHIN COOK INLET NEAR
EAST FORLAND UNDER PRE AND POST
SUSITNA HYDROELECTRIC PROJECT CONDITIONS

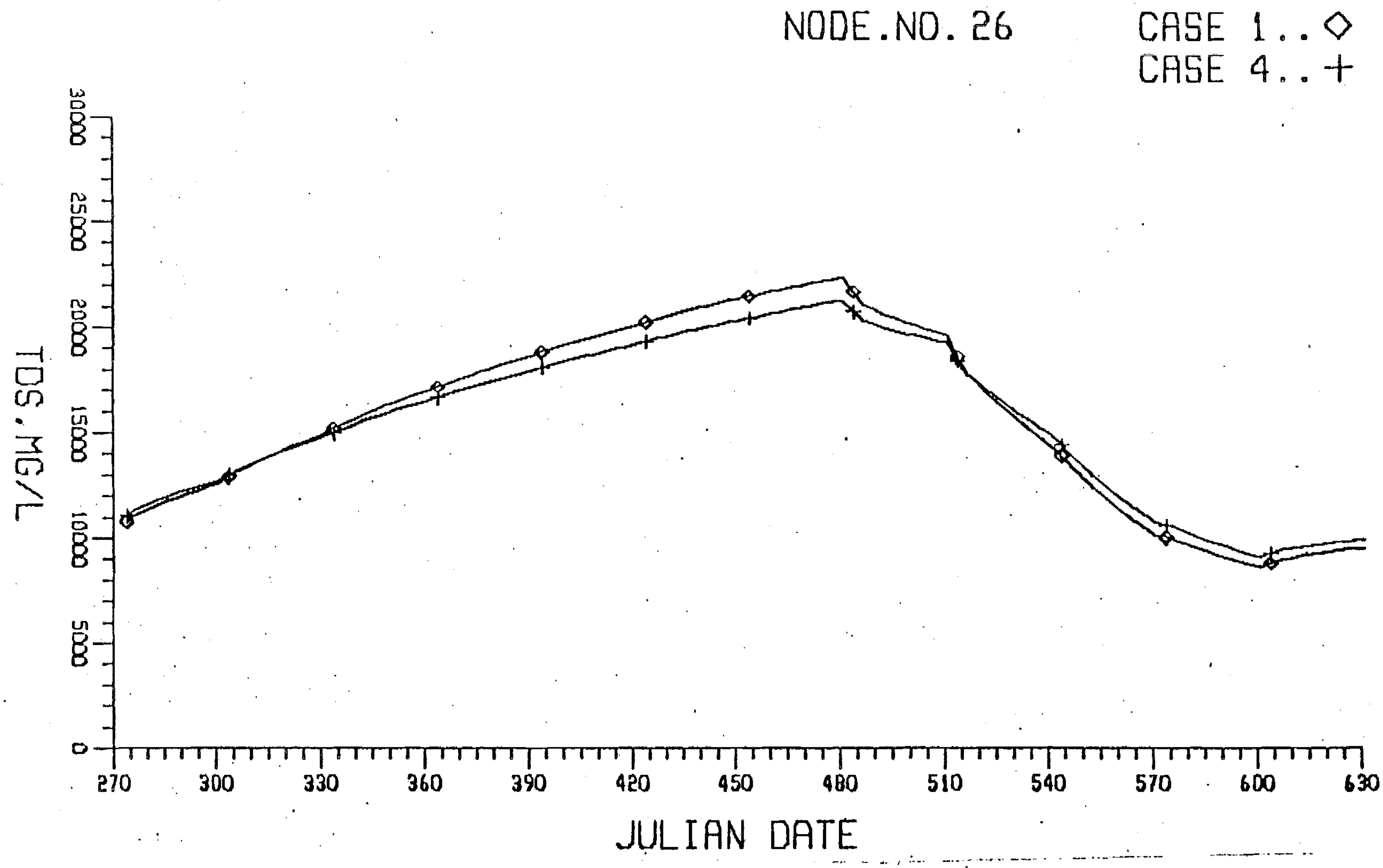


FIGURE 3

TEMPORAL VARIATION IN SALINITY WITHIN CENTRAL COOK INLET SOUTH OF THE SUSITNA RIVER UNDER PRE AND POST SUSITNA HYDROELECTRIC PROJECT CONDITIONS

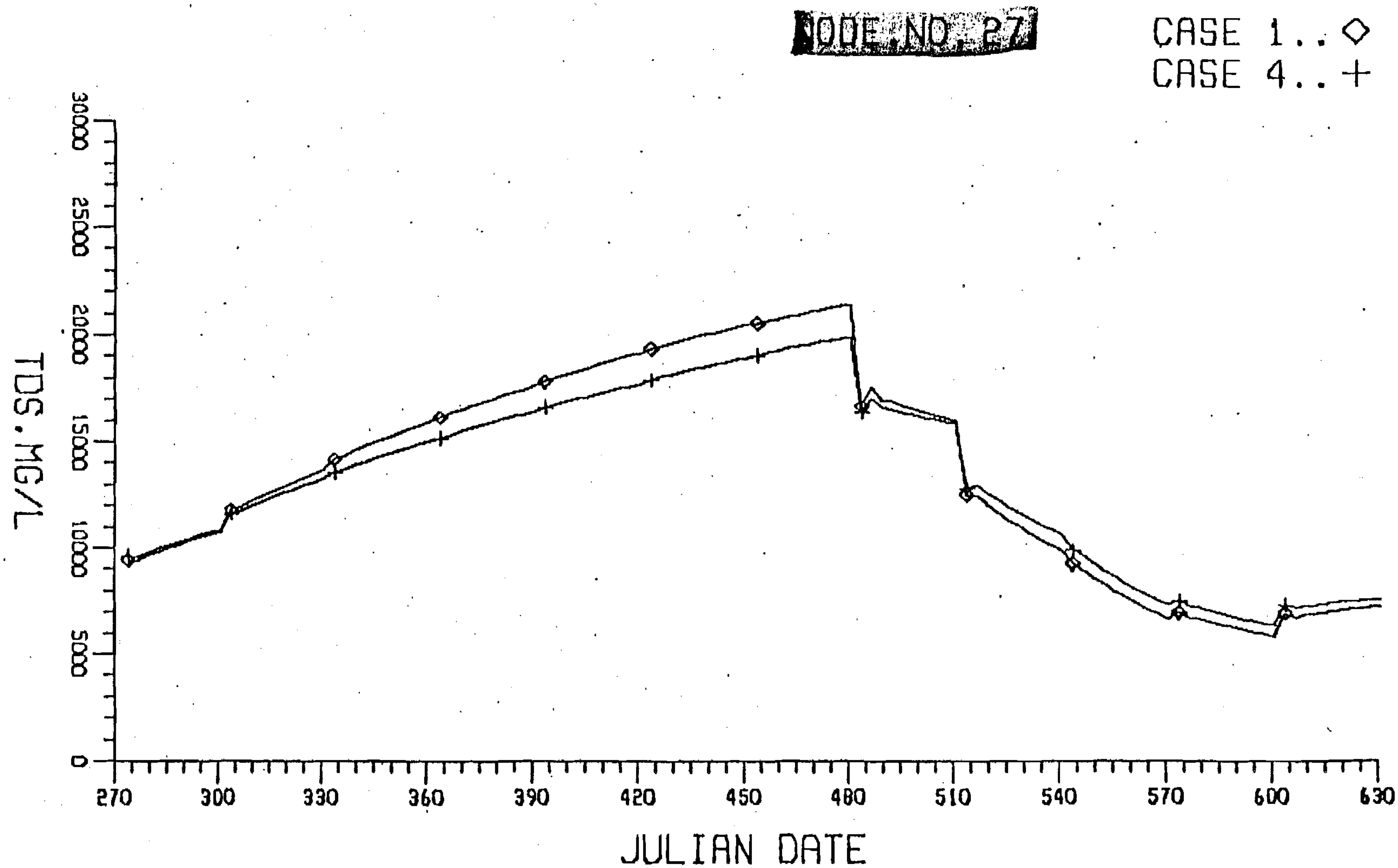


FIGURE 4

TEMPORAL VARIATION IN SALINITY WITHIN COOK INLET NEAR
THE SUSITNA RIVER UNDER PRE AND POST
SUSITNA HYDROELECTRIC PROJECT CONDITIONS

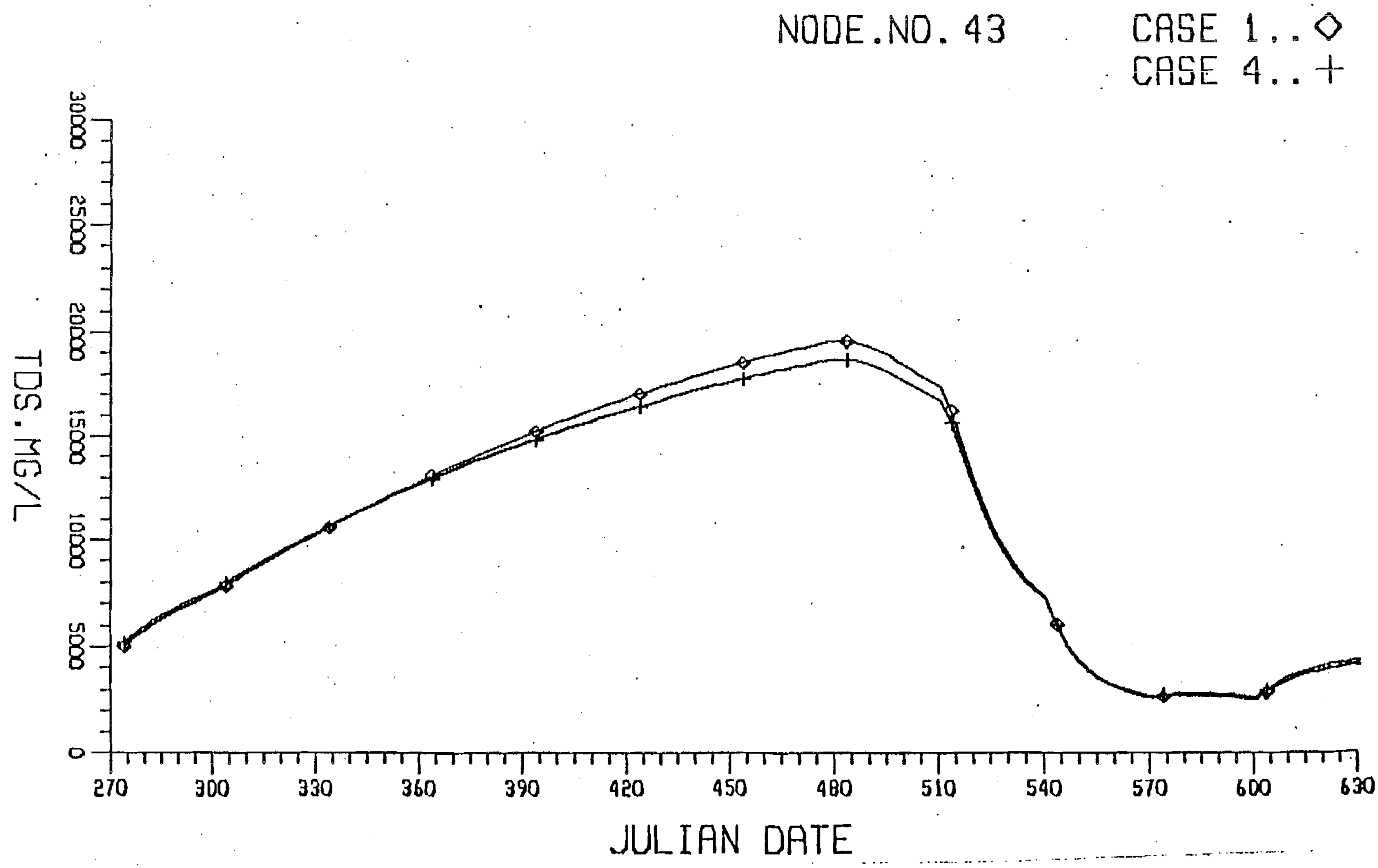


FIGURE 5

TEMPORAL VARIATION IN SALINITY WITHIN KNIK ARM NEAR ANCHORAGE UNDER PRE AND POST SUSITNA HYDROELECTRIC PROJECT CONDITIONS

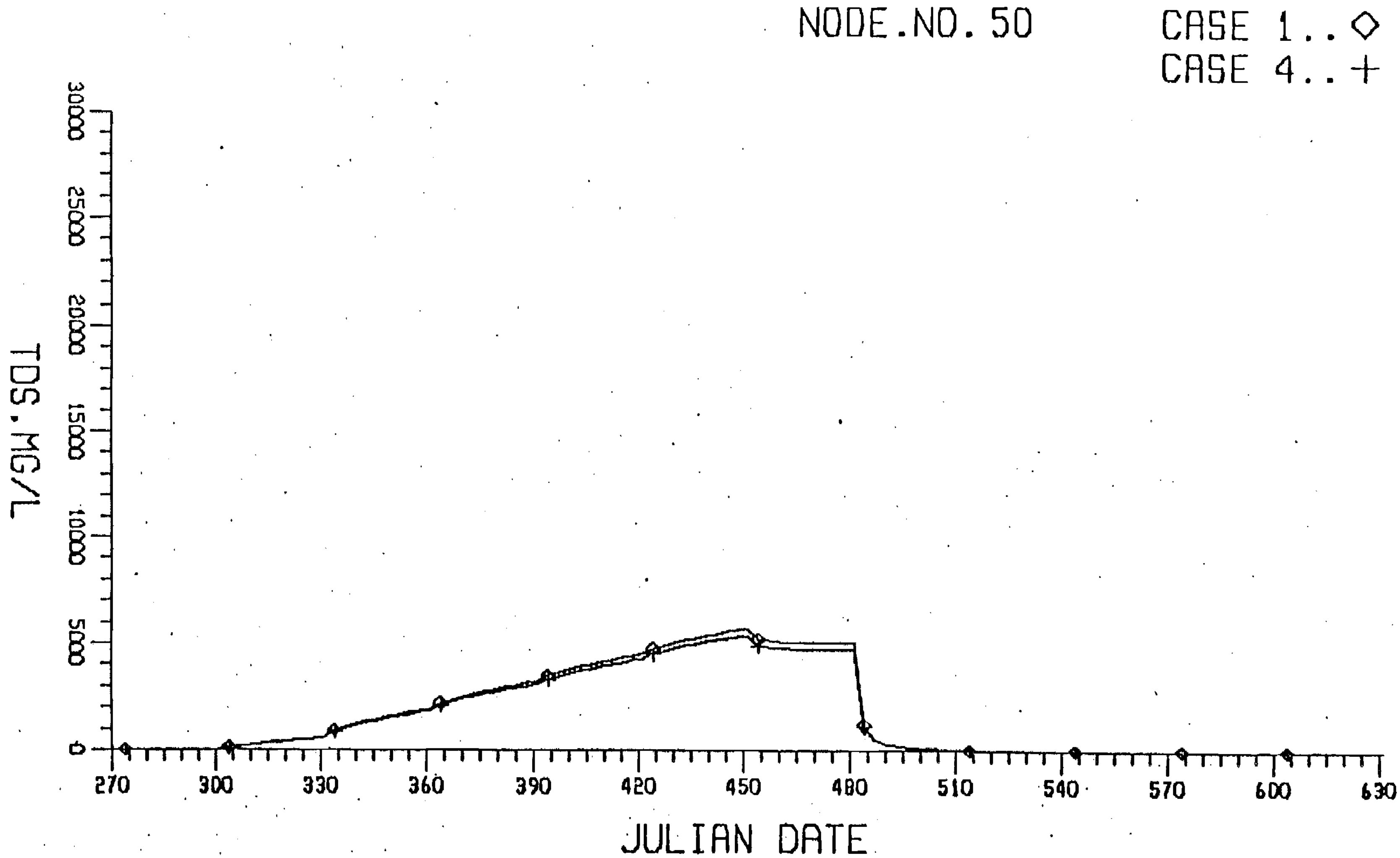


FIGURE 6

TEMPORAL VARIATION IN SALINITY NEAR THE UPPER END OF KNIK ARM UNDER PRE AND POST SUSITNA HYDROELECTRIC PROJECT CONDITIONS

2-25-14

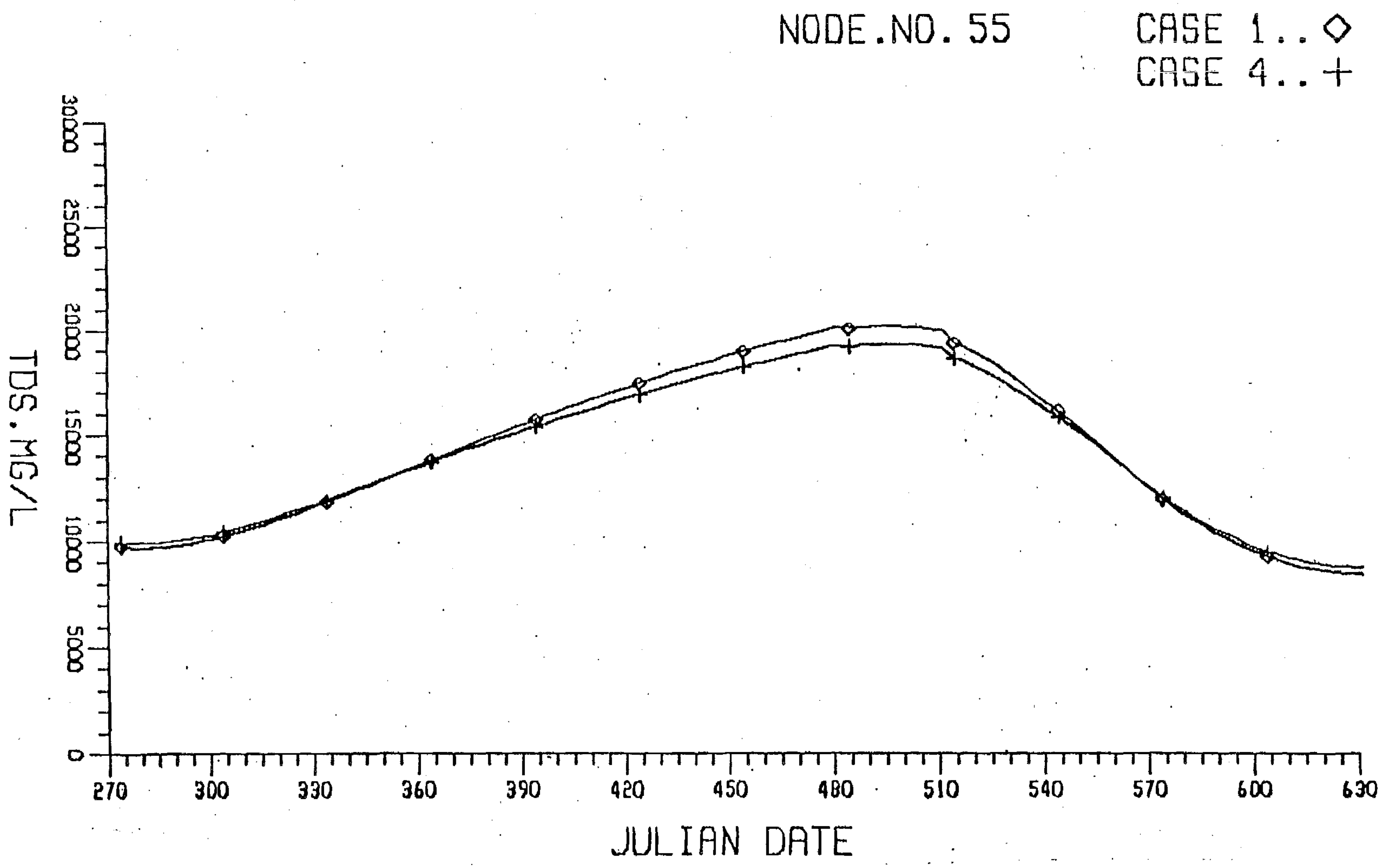


FIGURE 7

TEMPORAL VARIATION IN SALINITY WITHIN TURNAGAIN ARM
UNDER PRE AND POST SUSITNA
HYDROELECTRIC PROJECT CONDITIONS

EXHIBIT A

7.2 Estuary Model Application to Water Quality in Knik Arm and Upper Cook Inlet

7.2.1 Model Description

The numerical model used in this study was originally developed for the California State Water Resources Control Board (Evenson and Smith, 1974) and later modified for 208 planning studies on Long Island, New York (Johanson, et al., 1977). Further model modifications were made during this project and instruction on the model use can be found in the user's guide (Smith, 1977) prepared under this contract.

The model represents the estuarine system as a variable grid network of "nodes" and "channels." Nodes are discrete volume units of waterbody, characterized by surface area, depth, side slope and volume. The nodes are interconnected by channels, each having associated length, width, cross-sectional area, hydraulic radius, side scope and friction factor. Water is constrained to flow from one node to another through these defined channels, advecting and diffusing water quality constituents between nodes.

The following are underlying assumptions of the estuary model:

- The estuarine system is well mixed vertically.
- The law of conservation of mass is obeyed for water quality constituents.
- Chemical reaction rates may be estimated using first order kinetics characterized by reaction-specific rate coefficients.

The overall estuary model is composed of two separate components: a hydrodynamic model (HYDRO) and a tidally averaged dynamic/steady-state quality-model (AQUAL). These numerical models are used in sequence so that the results of the hydrodynamic model become input to the quality models. The advantage of dividing the overall model into modular units is that the individual models can be calibrated separately. Considerable savings of computer time is realized by storing results of the hydrodynamic model on disk files to be used repeatedly in the calibration of the quality model and during water quality evaluations.

HYDRO calculates the hydrodynamics of the estuary using tidal time-stage data at the estuary boundary, hydrologic conditions, and estuary geometry data such as depth, surface area, tidal flat slope and bottom roughness. HYDRO prepares a permanent file which portrays the two-dimensional hydrodynamic characteristics of the estuary, including tidally averaged values of flow, velocity, volume, depth, surface area and parameters indicative of the dispersive characteristics of tidal mixing.

AQUAL is a tidally averaged quality model which can be operated in either a steady-state or dynamic (time dependent) mode to simulate advective-diffusive transport as well as physical, chemical, and biological reactions of the parameters being modeled. Net advective flows and dispersion coefficients to simulate the effects of tidal mixing provide the physical mass transport. The results are representative of the two-dimensional distribution of daily average quality conditions in the estuary.

The dynamic mode is used when the estuary quality does not approach steady-state within the period of time the boundary conditions remain constant. If significant changes in tributary inflow occur before steady-state is approached, the dynamic operation gives more representative results. In the dynamic mode, the model uses multiples of the tidal cycles as the basic time step and yields average daily results.

The AQUAL code provides the option to include up to four user-specified constituents in addition to the following parameters which may be selected for simulation.

1. Salinity
2. Total Nitrogen
3. Total Phosphorus
4. Total Coliform Bacteria
5. Fecal Coliform Bacteria
6. Carbonaceous BOD
7. Nitrogenous BOD
8. Dissolved Oxygen
9. Temperature

A more detailed description of the model and its use can be found in the model documentation.

7.2.2 Model Adaptation and Calibration

A node-channel network scheme has been designed to represent the entire Cook Inlet study area. This network, shown in Figure 7.1, extends from Anchor Point on the south to the upper reaches of Knik Arm and Turnagain Arm. This network scheme employs a coarse representation in the southern portion of Cook Inlet where the impact of development in the Anchorage area is small. In Upper Cook Inlet and Knik Arm, where impact of waste discharge from the Anchorage area is greatest, a more detailed representation has been utilized. The node and channel data were generated from National Oceanic and Atmospheric Administration (NOAA) navigation charts numbers 16664, G&GS 8854, and 16660. The node and channel data are presented in Appendix III.

Calibration of a tidal hydrodynamic model entails a series of simulations during which boundary conditions are held constant and the frictional resistance is adjusted. When the tidal stage, current velocity, and the high and low water time lag are adequately represented throughout the estuary, the hydrodynamic model can be considered calibrated.

For model calibration, average 1972 tributary inflow rates were used. An average tide was selected from the daily predictions at Seldovia and adjusted to Port Graham, the NOAA tide station nearest the southerly boundary of the study area. This tide has approximately the same diurnal tide range as that reported in the 1973 NOAA Tide Tables. The results of the comparison are summarized in Table 7.3. Good agreement between the calculated values and tide table predictions of tidal stage and phase was observed at most locations.

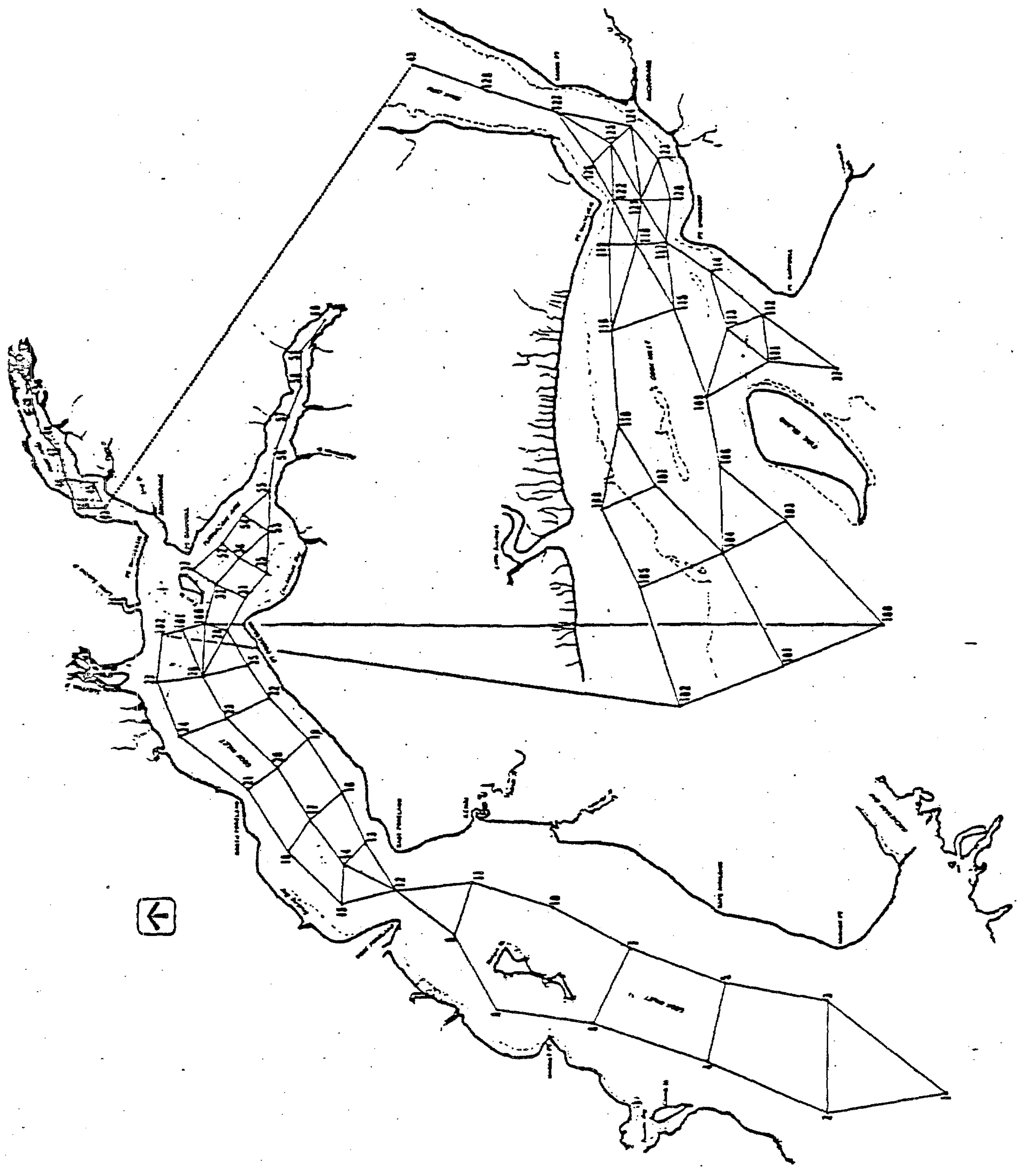


FIGURE 7.1 Node-Channel Network Scheme of Cook Inlet Study Area

Table 7.3

CALCULATED AND PREDICTED HIGH AND LOW WATER
TIME LAG AND DIURNAL TIDE RANGE

Location	Network Node Number	Time Lag(hrs) High Water Predicted	Time Lag(hrs) High Water Calculated	Time Lag(hrs) Low Water Predicted	Time Lag(hrs) Low Water Calculated	Diurnal Tidal Range(ft) Predicted	Diurnal Tidal Range(ft) Calculated
Port Graham	1	0	0	0	0	16.5	16.6
Cape Ninilchik	5	.7	.8	.8	1.1	19.1	18.1
Kenai River Entrance	11	1.9	2.0	2.2	2.7	20.7	19.2
Nikiski	12	2.4	2.7	2.7	3.3	20.7	20.0
East Foreland	12	2.6	2.7	2.9	3.3	21.0	20.0
Fire Island	100	4.5	4.1	4.8	4.9	27.5	28.9
Sunrise, Turnagain Arm	58	5.4	5.6	6.7	6.8	33.3	30.4
Anchorage	124	4.9	4.4	5.5	5.5	29.0	31.8
North Foreland	21	3.8	3.3	4.0	4.1	21.0	24.3
Drift River Terminal	8	1.7	1.7	2.0	2.1	18.1	19.5
Tuxedni Channel	4	.7	.8	.8	1.1	16.6	18.3

Comparisons between computed current velocities and those based on NOAA tidal current predictions were made. Figure 7.2 shows the calculated and predicted tidal stage and tidal current near Anchorage off Pt. Woronzof. The tidal current predictions were obtained by applying corrections to the daily predictions at the Wrangell Narrows. Both the computed tidal stage and current velocity compare well with predicted values.

Surface current velocity data (Britch, 1976) measured off Pt. Woronzof were compared with current velocities calculated for a similar period. Figure 7.3 shows the results of the current velocity comparison along with the corresponding tidal stage. The tidal stage comparison was used only to obtain the proper current phase. The model calculated current velocities slightly lower than those observed. However, it would be expected that vertical integrated currents would be less than those measured at the surface due to lower velocities near the bottom.

Based on the good agreement between calculated and reported tidal stage, tidal phase lag and current velocity, the hydrodynamic model can be considered calibrated.

Calibration of the water quality model is accomplished by first setting boundary conditions to observed values and then adjusting dispersion coefficients so that the measured concentrations of a conservative water quality parameter are matched adequately. Salinity is particularly suited to this procedure, since the concentrations in the tributary inflows are near zero with the sole source of salinity being the tidal boundary.

Changes in salinity take place rather slowly in such a large estuary; consequently, a dynamic water quality simulation is required for dispersion coefficient calibration. A steady-state approach would result in unrealistically high dispersion coefficients for high flow conditions, and low dispersion coefficients for low flow conditions.

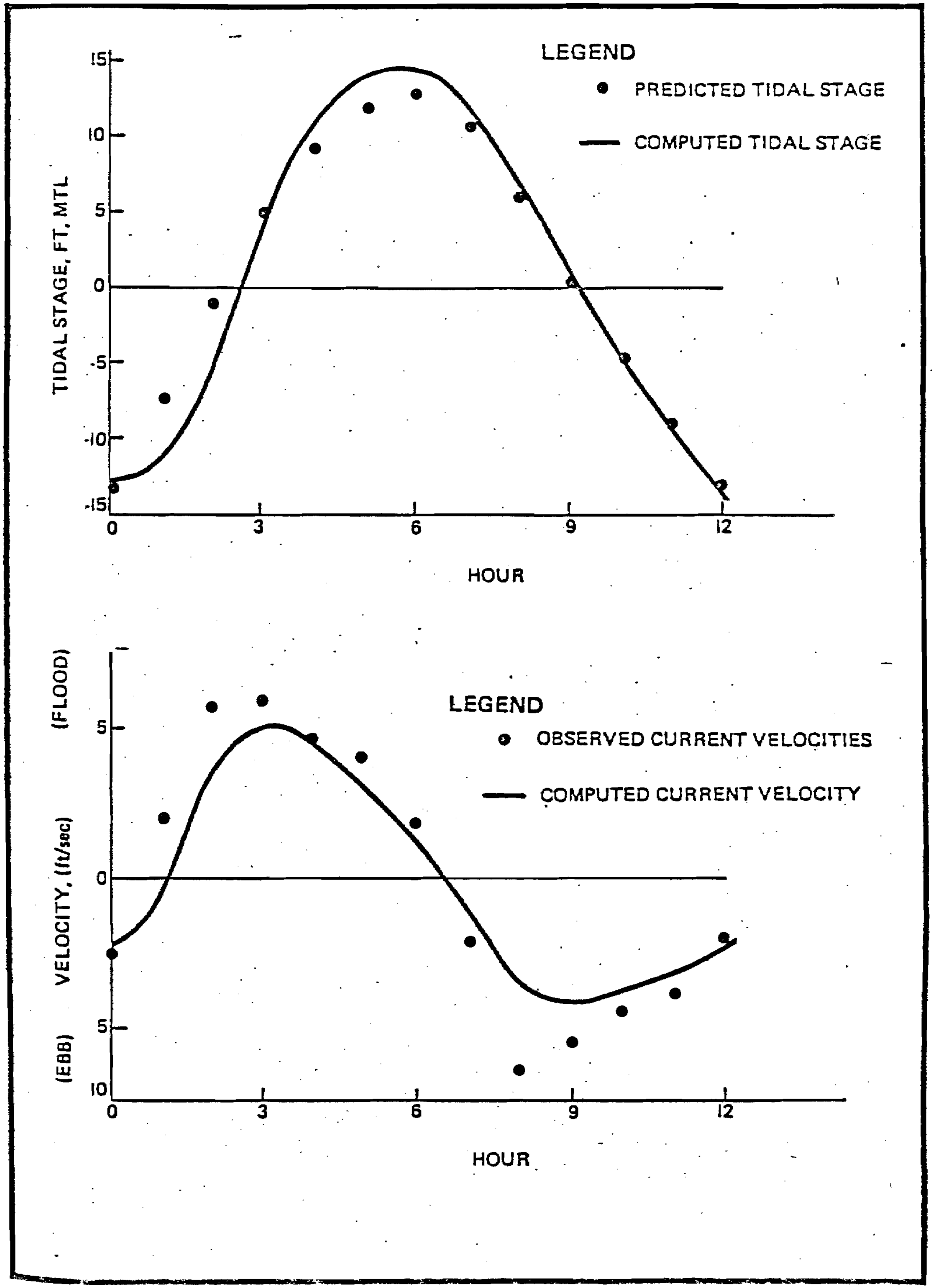


FIGURE 7.2 Computed and Predicted Tidal Stage and Tidal Current off Pt. Woronzof

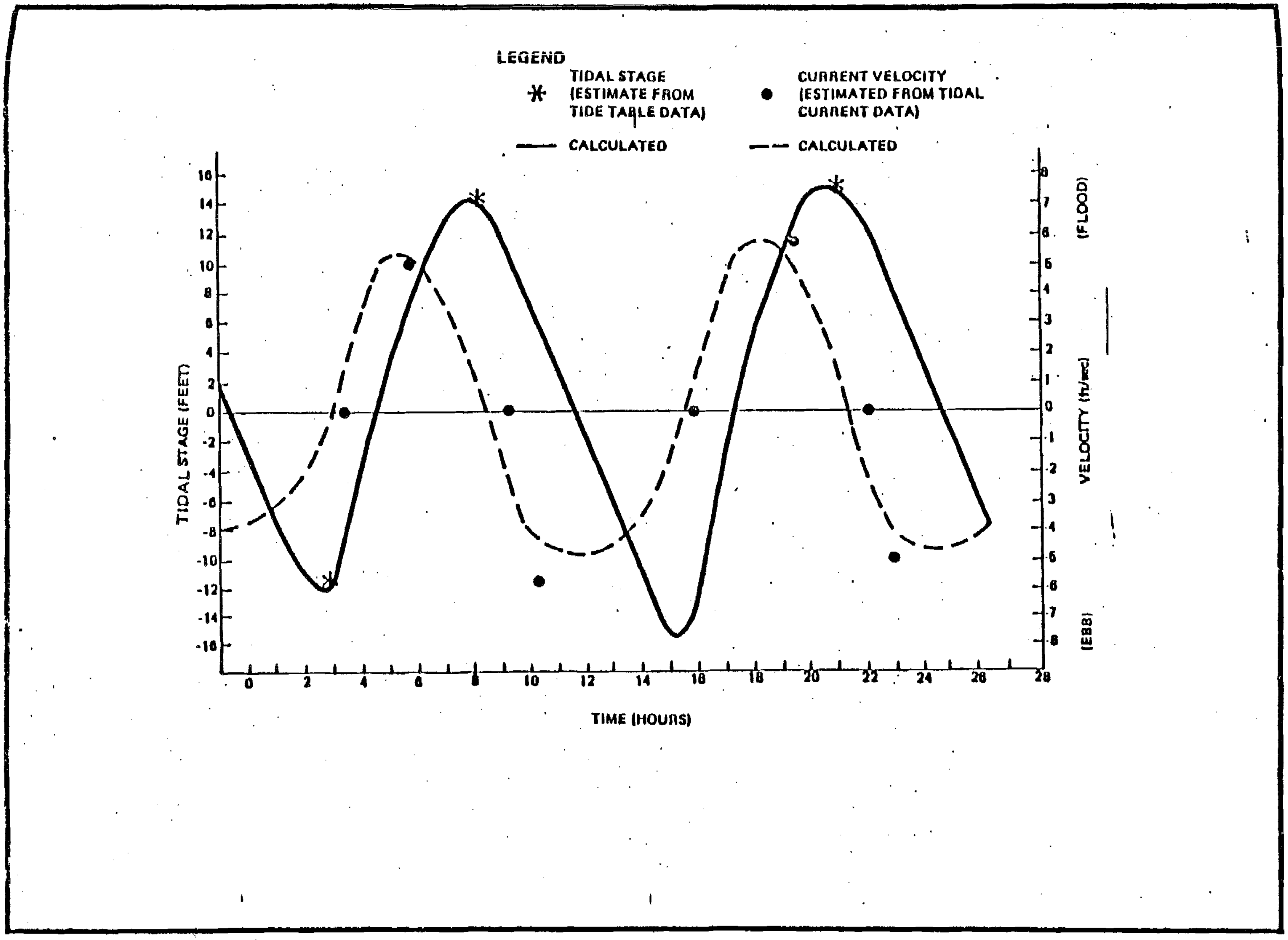


FIGURE 7.3 Current Velocity Compared with Tidal Stage

Flow data (U.S. Geological Survey, 1973) for water year 1972 (October, 1971, through September, 1972) were examined, and the average flows during four periods calculated for all major tributaries to Cook Inlet. Table 7.4 is a summary of the stream flows used for calibration. The November, 1971 through April, 1972, period is representative of low runoff conditions and the mid-June, 1972 through September, 1972, is representative of high runoff conditions. The other two periods serve as transitions between the major flow conditions.

Surface salinity data for Cook Inlet is available for the periods May 21-28, 1968, August 22-23, 1972, and September 25-29, 1972. To calibrate the dispersion coefficients, the model was run dynamically for the entire 1972 water year. A comparison between the calculated and observed salinity between Anchor Point and the end of Knik Arm are presented in Figure 7.4. The calculated salinity at the end of August and September, 1972, compares well with the observed salinities at those times. The salinities observed during the May 21-28, 1968, period were compared with the computed end of May, 1972, salinities. The observed and computed salinities for the end of May agree reasonably well, considering the dissimilar hydrology.

The above comparison indicates that the dispersion coefficients are adequately calibrated. The dispersion coefficients ranged from 2000 to 6000 sq ft/sec along the axis of the inlet and Knik Arm and 200 to 600 sq ft/sec perpendicular to that axis. These values are of the same magnitude as those reported by other investigators (Murphy et al., 1972).

Table 7.4

FLOW RATES OF MAJOR TRIBUTARIES TO COOK INLET

Stream	Average Flow Rate (cfs)			
	Oct 1971	Nov 1971–April 1972	May 1972–Mid-June 1972	Mid-June 1972–Sept 1972
Knik and Matanuska Rivers	7,170	1,420	7,590	31,200
Peters & Cottonwood Creeks	120	30	120	280
Eagle River	191	51	210	1,445
Ship Creek	126	25	114	270
Little Susitna River	200	60	250	1,800
Susitna River	18,600	5,800	58,300	77,500
Kenai River	4,800	1,310	2,590	11,600
	31,207	8,676	69,174	124,095

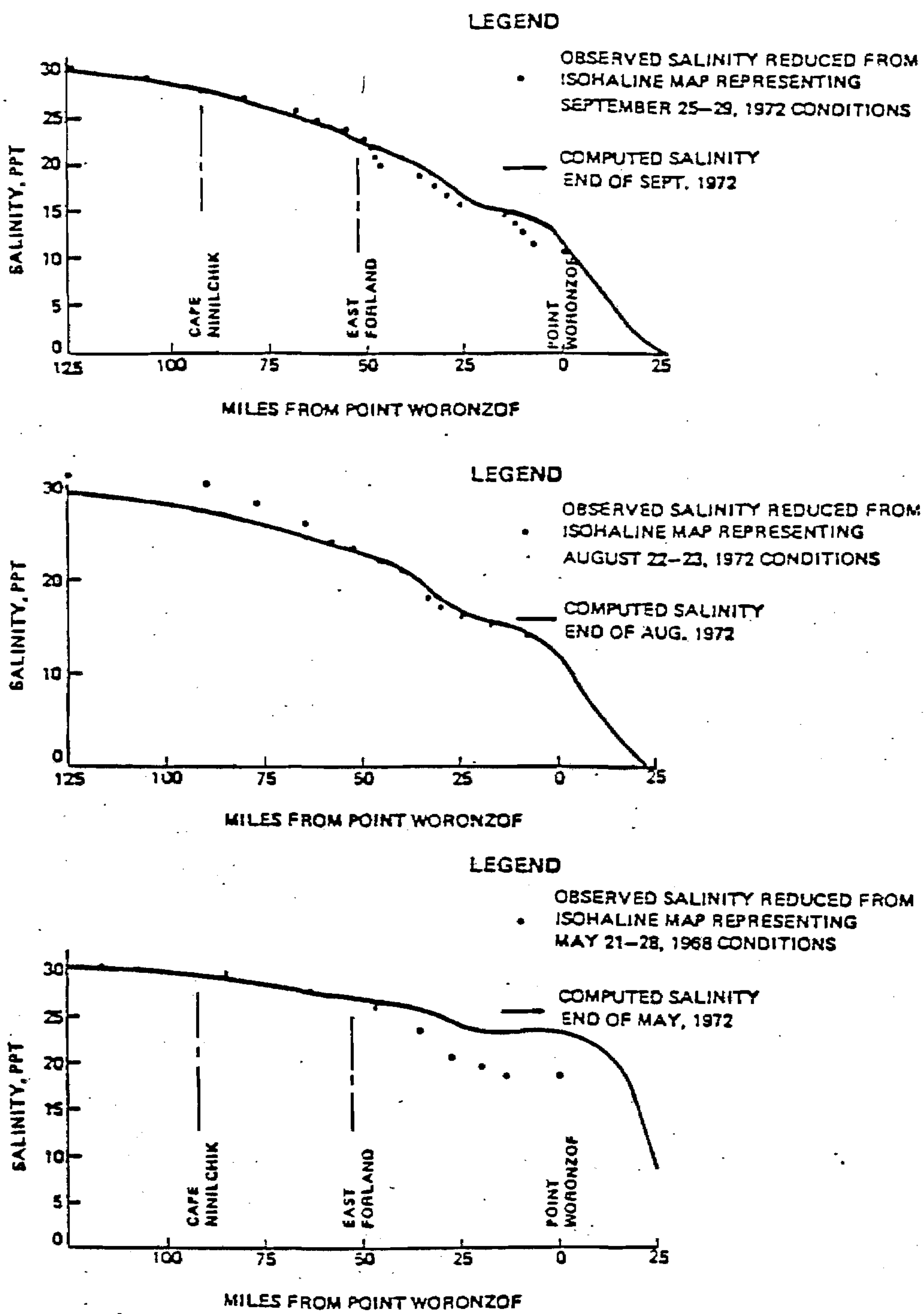


FIGURE 7.4 Computed and Observed Salinity between Anchor Point and Knik Arm

EXHIBIT B

TABLE B-I

COMPUTED SALINITY CONCENTRATION (MG/L) AT SELECTED LOCATIONS WITHIN COOK INLET

NODE #	OCTOBER APRIL		NOVEMBER MAY		DECEMBER JUNE		JANUARY JULY		FEBRUARY AUGUST		MARCH SEPTEMBER	
	CASE#1	CASE#3	CASE#1	CASE#3	CASE#1	CASE#3	CASE#1	CASE#3	CASE#1	CASE#3	CASE#1	CASE#3
1	29276	29278	29624	29589	29826	29763	29971	29900	30100	30023	30209	30127
	30281	30200	29851	29831	29031	29104	28298	28383	28135	28211	28585	28642
2	28033	28062	28377	28371	28693	28652	28971	28906	29219	29137	29437	29339
	29609	29503	29411	29339	28804	28802	27997	28041	27399	27477	27362	27448
3	27369	27409	27785	27784	28172	28130	28514	28443	28819	28724	29086	28971
	29299	29172	29128	29031	28483	28460	27491	27539	26673	26775	26577	26685
4	26976	27027	27315	27335	27727	27705	28116	28058	28468	28379	28777	28665
	29035	28906	29028	28910	28581	28516	27696	27705	26746	26826	26321	26430
5	25806	25876	26294	26319	26834	26806	27335	27261	27783	27669	28175	28030
	28500	28332	28508	28350	27907	27823	26625	26664	25348	25477	24918	25065
6	26706	26762	27050	27075	27486	27468	27903	27847	28281	28191	28612	28498
	28892	28757	28927	28799	28471	28392	27505	27507	26484	26563	26028	26141
7	24663	24751	25247	25286	25906	25882	26521	26437	27068	26934	27545	27372
	27943	27741	28025	27824	27328	27217	25721	25777	24154	24314	23628	23804
8	26182	26244	26610	26641	27104	27088	27572	27512	27990	27894	28357	28233
	28665	28519	28702	28559	27960	27872	26557	26564	25464	25551	25284	25406
9	25018	25097	25586	25618	26208	26178	26785	26700	27300	27169	27750	27583
	28128	27934	28158	27971	27251	27161	25523	25578	24164	24305	23931	24090
10	23555	23658	24284	24328	25068	25037	25788	25684	26424	26262	26979	26770
	27444	27201	27525	27284	26587	26473	24570	24663	22780	22979	22305	22510
11	22948	23058	23778	23817	24630	24584	25402	25277	26085	25897	26680	26442
	27179	26904	27193	26929	25983	25888	23668	23804	21847	22077	21532	21754
12	22673	22783	23555	23584	24442	24377	25239	25093	25942	25730	26553	26291
	27066	26767	26995	26723	25568	25504	23056	23234	21281	21538	21154	21389
13	20786	20922	21915	21939	23019	22919	23995	23792	24849	24565	25591	25245
	26212	25822	26062	25717	24288	24226	21290	21523	19138	19472	18992	19284
14	19717	19857	21049	21050	22279	22136	23347	23088	24276	23930	25082	24668
	25751	25290	25324	24939	22944	22974	19448	19790	17439	17819	17666	17979
15	21082	21211	22183	22204	23253	23153	24199	23999	25026	24749	25746	25408
	26347	25966	26151	25823	24308	24275	21300	21556	19333	19654	19310	19589
16	19023	19177	20403	20413	21711	21565	22848	22579	23838	23472	24696	24257
	25411	24921	25029	24632	22717	22705	19218	19535	16951	17340	16954	17285
17	18667	18815	20149	20141	21501	21328	22663	22363	23673	23275	24548	24075
	25271	24749	24673	24280	21881	21959	18037	18439	16000	16419	16402	16740
18	19740	19879	21063	21066	22291	22150	23356	23101	24285	23941	25090	24679
	25759	25301	25348	24982	22953	22985	19394	19744	17377	17764	17649	17965
19	15500	15668	17407	17365	19114	18846	20558	20122	21807	21244	22890	22229
	23773	23051	22545	22085	18810	18976	14438	14910	12325	12787	12867	13244
20	16238	16402	18043	18009	19668	19421	21046	20639	22239	21711	23273	22653
	24119	23440	23023	22581	19368	19549	15033	15516	13015	13478	13652	14025
21	17107	17268	18787	18767	20314	20099	21617	21252	22745	22267	23723	23158
	24526	23905	23651	23224	20431	20546	16283	16712	14198	14634	14669	15027
22	13861	14027	16021	15943	17911	17568	19489	18959	20856	20184	22039	21259
	22994	22149	21209	20738	16830	17076	12275	12777	10295	10760	11008	11394
23	14143	14294	16350	16244	18215	17839	19754	19198	21090	20398	22245	21449
	23167	22313	21090	20658	16446	16774	11904	12443	10163	10634	11147	11531

TABLE B-1
(continued)

COMPUTED SALINITY CONCENTRATION (MG/L) AT SELECTED LOCATIONS WITHIN COOK INLET

NODE #	OCTOBER / APRIL CASE#1	OCTOBER / APRIL CASE#3	NOVEMBER / MAY CASE#1	NOVEMBER / MAY CASE#3	DECEMBER / JUNE CASE#1	DECEMBER / JUNE CASE#3	JANUARY / JULY CASE#1	JANUARY / JULY CASE#3	FEBRUARY / AUGUST CASE#1	FEBRUARY / AUGUST CASE#3	MARCH / SEPTEMBER CASE#1	MARCH / SEPTEMBER CASE#3
24	14506	14644	16763	16642	18594	18203	20088	19523	21382	20686	22499	21703
	23378	22530	21134	20735	16379	16707	11337	11845	9845	10282	11302	11667
25	12819	13000	15003	14948	16990	16666	18672	18146	20131	19450	21394	20593
	22419	21544	20785	20261	16384	16551	11749	12200	9598	10045	10073	10458
26	12572	12717	14942	14795	16966	16507	18630	17969	20083	19268	21341	20409
	22337	21343	19607	19181	14389	14819	10168	10748	8578	9058	9534	9925
[redacted]												
28	11803	11991	14011	13969	16079	15765	17855	17326	19399	18702	20737	19909
	21824	20914	20160	19608	15504	15639	10842	11252	8755	9171	9144	9516
31	10976	11181	13116	13129	15236	14995	17103	16638	18729	18085	20138	19352
	21294	20412	20078	19459	15447	15432	10565	10869	8368	8730	8515	8866
32	10927	11127	13178	13177	15331	15069	17199	16714	18818	18156	20215	19413
	21349	20456	19875	19277	14711	14742	9723	10042	7852	8212	8302	8650
35	10514	10731	12433	12497	14512	14347	16425	16033	18113	17531	19585	18851
	20814	19971	20153	19474	16149	15976	11406	11605	8787	9103	8402	8735
36	10495	10710	12530	12580	14650	14464	16567	16153	18246	17645	19704	18954
	20912	20056	20051	19387	15611	15482	10688	10913	8337	8659	8228	8562
37	10489	10684	12927	12923	15160	14896	17066	16578	18705	18040	20107	19304
	21225	20333	19427	18841	13146	13191	7886	8170	6642	6963	7612	7938
43	7466	7641	10275	10341	12830	12697	15000	14651	16844	16309	18421	17734
	19584	18791	17328	16714	7231	7182	2535	2616	2489	2609	4103	4290
44	6117	6270	9045	9126	11714	11625	13979	13684	15902	15422	17552	16916
	18696	17950	15769	15186	4760	4721	1237	1276	1332	1398	2786	2918
45	5593	5734	8532	8612	11225	11149	13522	13247	15476	15018	17154	16539
	18300	17573	15050	14489	4114	4081	1012	1044	1099	1153	2408	2524
46	4076	4182	7100	7177	9883	9836	12245	12018	14260	13857	16000	15442
	17035	16367	12282	11815	1958	1943	329	340	405	426	1262	1325
47	2155	2208	4856	4899	7499	7457	9796	9615	11796	11464	13552	13080
	14338	13766	7477	7202	432	430	44	45	64	67	339	358
48	854	872	2961	2965	5297	5236	7373	7209	9235	8948	10906	10498
	11285	10800	3282	3174	51	51	3	3	5	5	51	54
49	213	217	1485	1468	3352	3275	5087	4933	6706	6456	8205	7855
	8098	7702	924	899	3	3	0	0	0	0	4	4
50	19	19	554	529	1878	1789	3188	3035	4479	4250	5722	5412
	5098	4780	85	83	0	0	0	0	0	0	0	0
52	10338	10548	12550	12586	14735	14527	16666	16230	18341	17722	19787	19021
	20966	20100	19776	19133	14497	14421	9320	9558	7474	7788	7830	8157
53	10231	10450	12000	12092	14036	13916	15969	15623	17692	17153	19203	18506
	20475	19660	20088	19379	16361	16096	11805	11930	9014	9291	8333	8648
54	10165	10387	11900	12000	13932	13824	15873	15538	17606	17076	19127	18437
	20411	19601	20123	19403	16525	16235	11966	12076	9090	9362	8322	8635
55	10069	10281	11637	11751	13579	13504	15505	15209	17253	16761	18799	18143
	20109	19326	19902	19178	16426	16082	12328	12375	9413	9644	8411	8701
56	10241	10429	11288	11422	12963	12948	14796	14578	16544	16130	18134	17549
	19521	18796	19848	19109	17437	16972	13779	13695	10574	10723	8989	9236

TABLE B-1
(continued)

COMPUTED SALINITY CONCENTRATION (MG/L) AT SELECTED LOCATIONS WITHIN COOK INLET

NODE #	OCTOBER / APRIL CASE#1	CASE#3	NOVEMBER / MAY CASE#1	CASE#3	DECEMBER / JUNE CASE#1	CASE#3	JANUARY / JULY CASE#1	CASE#3	FEBRUARY / AUGUST CASE#1	CASE#3	MARCH / SEPTEMBER CASE#1	CASE#3
57	10692	10834	11132	11269	12441	12472	14104	13960	15812	15478	17428	16918
	18880	18220	19609	18884	18157	17605	15095	14882	11848	11897	9794	9982
58	11275	11362	11143	11269	12067	12128	13531	13445	15171	14906	16792	16351
	18293	17694	19291	18593	18575	17971	16113	15792	12999	12950	10633	10757
59	12039	12057	11267	11372	11731	11816	12941	12914	14483	14293	16098	15732
	17643	17112	18874	18216	18875	18232	17103	16672	14250	14091	11626	11674
60	13014	12947	11574	11643	11512	11608	12404	12428	13804	13686	15388	15099
	16965	16506	18360	17756	18951	18294	17917	17391	15488	15213	12740	12700
100	11751	11936	13991	13941	16072	15744	17850	17306	19395	18683	20733	19890
	21817	20893	20036	19492	15248	15413	10599	11026	8592	9013	9050	9424
101	12212	12376	14537	14430	16592	16186	18307	17691	19800	19023	21092	20192
	22124	21155	19787	19311	14789	15110	10395	10913	8596	9055	9318	9705
102	11854	12029	14177	14097	16267	15894	18025	17438	19551	18799	20869	19990
	21928	20974	19780	19272	14754	14996	10207	10673	8389	8825	9036	9415
103	11672	11859	13921	13875	16014	15690	17802	17260	19354	18643	20696	19854
	21784	20860	20024	19475	15200	15354	10500	10919	8508	8925	8971	9344
104	11792	11973	14081	14017	16171	15821	17941	17375	19478	18745	20806	19944
	21877	20937	19922	19394	15003	15203	10365	10808	8457	8884	9021	9398
105	11489	11675	13805	13758	15928	15601	17733	17187	19295	18579	20640	19792
	21725	20797	19831	19285	14728	14881	9982	10389	8165	8572	8752	9121
106	11572	11759	13853	13807	15962	15638	17759	17216	19317	18605	20662	19819
	21750	20825	19948	19399	14964	15114	10194	10603	8299	8708	8837	9207
107	11276	11467	13617	13582	15765	15453	17594	17061	19174	18469	20530	19693
	21625	20704	19771	19213	14541	14660	9710	10089	7961	8354	8564	8926
108	10999	11193	13366	13344	15542	15249	17401	16885	19003	18313	20374	19549
	21479	20569	19638	19068	14176	14263	9288	9637	7652	8026	8305	8660
109	11348	11538	13662	13626	15797	15486	17617	17086	19192	18490	20549	19714
	21644	20726	19855	19297	14617	14740	9721	10101	7961	8352	8587	8948
110	10959	11153	13342	13321	15523	15231	17385	16871	18989	18301	20360	19537
	21465	20555	19591	19022	14051	14135	9172	9515	7578	7948	8259	8611
111	10498	10691	12946	12939	15179	14912	17083	16593	18720	18053	20119	19315
	21234	20341	19392	18810	13042	13093	7787	8072	6589	6908	7598	7923
115	11120	11311	13472	13445	15634	15335	17477	16957	19069	18376	20437	19610
	21537	20625	19724	19159	14196	14297	9212	9564	7605	7977	8330	8682
116	10825	11015	13244	13222	15440	15149	17312	16801	18924	18239	20296	19477
	21396	20491	19396	18834	13609	13694	8766	9096	7317	7674	8103	8447
117	10484	10676	12948	12939	15183	14914	17087	16595	18722	18055	20121	19316
	21232	20339	19344	18766	12912	12965	7674	7955	6517	6834	7563	7886
125	9584	9774	12168	12185	14503	14276	16488	16040	18187	17559	19637	18867
	20767	19902	18842	18245	11151	11161	5777	5983	5082	5329	6452	6733
127	8891	9077	11551	11587	13961	13767	16009	15595	17757	17160	19250	18507
	20396	19554	18432	17823	9862	9843	4542	4698	4128	4328	5651	5900
128	8233	8415	10968	11019	13447	13282	15553	15168	17345	16777	18878	18160
	20034	19214	17966	17352	8630	8593	3521	3639	3310	3470	4914	5133

TABLE B-2

COMPUTED SALINITY CONCENTRATION (MG/L) AT SELECTED LOCATIONS WITHIN COOK INLET

NODE #	OCTOBER APRIL		NOVEMBER MAY		DECEMBER JUNE		JANUARY JULY		FEBRUARY AUGUST		MARCH SEPTEMBER	
	CASE#1	CASE#4	CASE#1	CASE#4	CASE#1	CASE#4	CASE#1	CASE#4	CASE#1	CASE#4	CASE#1	CASE#4
1	29276	29282	29624	29586	29826	29759	29971	29894	30100	30012	30209	30117
	30281	30194	29851	29839	29031	29114	28298	28389	28135	28217	28585	28640
2	28033	28068	28377	28372	28693	28651	28971	28902	29219	29127	29437	29328
	29609	29493	29411	29338	28804	28806	27997	28046	27399	27486	27362	27451
3	27369	27416	27785	27786	28172	28128	28514	28437	28819	28713	29086	28958
	29299	29160	29128	29029	28483	28463	27491	27546	26673	26785	26577	26689
4	26976	27035	27315	27339	27727	27705	28116	28054	28468	28371	28777	28654
	29035	28893	29028	28904	28581	28516	27696	27711	26746	26836	26321	26437
5	25806	25886	26294	26324	26834	26807	27335	27256	27783	27658	28175	28015
	28500	28315	28508	28339	27907	27823	26625	26673	25348	25491	24918	25074
6	26706	26770	27050	27080	27486	27469	27903	27843	28281	28183	28612	28486
	28892	28744	28927	28791	28471	28391	27505	27512	26484	26573	26028	26149
7	24663	24763	25247	25293	25906	25883	26521	26432	27068	26922	27545	27354
	27943	27721	28025	27809	27328	27217	25721	25789	24154	24331	23628	23816
8	26182	26253	26610	26646	27104	27089	27572	27509	27990	27886	28357	28220
	28665	28504	28702	28549	27960	27871	26557	26570	25464	25562	25284	25415
9	25018	25108	25586	25624	26208	26179	26785	26695	27300	27157	27750	27566
	28128	27915	28158	27958	27251	27163	25523	25589	24164	24320	23931	24101
10	23555	23671	24284	24336	25068	25037	25788	25678	26424	26247	26979	26748
	27444	27176	27525	27266	26587	26475	24570	24680	22780	23000	22305	22523
11	22948	23072	23778	23824	24630	24584	25402	25269	26085	25880	26680	26416
	27179	26876	27193	26912	25983	25894	23668	23824	21847	22100	21532	21767
12	22673	22797	23555	23590	24442	24375	25239	25082	25942	25710	26553	26262
	27066	26736	26995	26708	25568	25515	23056	23257	21281	21562	21154	21402
13	20786	20938	21915	21945	23019	22916	23995	23778	24849	24536	25591	25206
	26212	25781	26062	25699	24288	24243	21290	21553	19138	19503	18992	19300
14	19717	19874	21049	21055	22279	22129	23347	23069	24276	23893	25082	24621
	25751	25244	25324	24946	22944	23002	19448	19826	17439	17854	17666	17993
15	21082	21227	22183	22210	23253	23150	24199	23985	25026	24721	25746	25370
	26347	25927	26151	25807	24308	24293	21300	21585	19333	19685	19310	19603
16	19023	19194	20403	20418	21711	21559	22848	22559	23838	23434	24696	24207
	25411	24871	25029	24616	22717	22730	19218	19571	16951	17378	16954	17302
17	18667	18832	20149	20144	21501	21319	22663	22340	23673	23232	24548	24021
	25271	24697	24673	24270	21881	21994	18037	18479	16000	16457	16402	16753
18	19740	19896	21063	21071	22291	22143	23356	23082	24285	23905	25090	24632
	25759	25255	25348	24970	22953	23013	19394	19781	17377	17799	17649	17979
19	15500	15687	17407	17366	19114	18831	20558	20086	21807	21181	22890	22152
	23773	22981	22545	22086	18610	19026	14438	14955	12325	12828	12867	13258
20	16238	16421	18043	18011	19668	19407	21046	20606	22239	21653	23273	22581
	24119	23374	23023	22580	19368	19599	15033	15561	13015	13519	13652	14038
21	17107	17287	18787	18770	20314	20088	21617	21224	22745	22215	23723	23093
	24526	23844	23651	23218	20431	20588	16283	16754	14198	14673	14669	15040
22	13861	14048	16021	15940	17911	17548	19489	18915	20856	20107	22039	21168
	22994	22070	21209	20751	16830	17135	12275	12823	10295	10801	11008	11406
23	14143	14315	16350	16239	18215	17818	19754	19151	21090	20317	22245	21356
	23167	22234	21090	20681	16446	16840	11904	12490	10163	10675	11147	11540

TABLE B-2
(continued)

[redacted]

NODE #	OCTOBER / APRIL CASE#1	OCTOBER / APRIL CASE#4	NOVEMBER / MAY CASE#1	NOVEMBER / MAY CASE#4	DECEMBER / JUNE CASE#1	DECEMBER / JUNE CASE#4	JANUARY / JULY CASE#1	JANUARY / JULY CASE#4	FEBRUARY / AUGUST CASE#1	FEBRUARY / AUGUST CASE#4	MARCH / SEPTEMBER CASE#1	MARCH / SEPTEMBER CASE#4
24	14506	14665	16763	16636	18594	18180	20088	19475	21382	20604	22499	21611
	23378	22454	21134	20761	16379	16770	11337	11887	9845	10319	11302	11674
25	12819	13021	15003	14948	16990	16648	18672	18104	20131	19374	21394	20501
	22419	21461	20785	20266	16384	16604	11749	12246	9598	10085	10073	10472
26	12572	12740	14942	14787	16966	16480	18630	17912	20083	19171	21341	20301
	22337	21255	19607	19220	14389	14896	10168	10796	8578	9100	9534	9931
[redacted]	[redacted]											
28	11803	12012	14011	13970	16079	15747	17855	17283	19399	18625	20737	19814
	21824	20827	20160	19609	15504	15688	10842	11294	8755	9209	9144	9530
31	10976	11202	13116	13135	15236	14982	17103	16602	18729	18017	20138	19262
	21294	20325	20078	19440	15447	15465	10565	10906	8368	8765	8515	8884
32	10927	11147	13178	13181	15331	15055	17199	16676	18818	18085	20215	19322
	21349	20369	19875	19263	14711	14780	9723	10078	7852	8245	8302	8666
35	10514	10752	12433	12507	14512	14340	16425	16004	18113	17474	19585	18770
	20814	19884	20153	19437	16149	15994	11406	11637	8787	9136	8402	8757
36	10495	10730	12530	12589	14650	14455	16567	16123	18246	17585	19704	18870
	20912	19969	20051	19355	15611	15505	10688	10946	8337	8692	8228	8583
37	10489	10703	12927	12927	15160	14881	17066	16540	18705	17969	20107	19212
	21225	20245	19427	18829	13146	13227	7886	8202	6642	6992	7612	7953
43	7466	7655	10275	10350	12830	12691	15000	14626	16844	16257	18421	17658
	19584	18708	17328	16675	7231	7194	2535	2626	2489	2620	4103	4300
44	6117	6281	9045	9135	11714	11621	13979	13664	15902	15378	17552	16847
	18696	17871	15769	15143	4760	4729	1237	1281	1332	1404	2786	2925
45	5593	5745	8532	8621	11225	11146	13522	13229	15476	14977	17154	16473
	18300	17496	15050	14447	4114	4088	1012	1048	1099	1158	2408	2530
46	4076	4190	.7100	7185	9883	9835	12245	12004	14260	13823	16000	15383
	17035	16295	12282	11780	1958	1947	329	341	405	428	1262	1329
47	2155	2213	4856	4903	7499	7456	9796	9603	11796	11436	13552	13031
	14338	13705	7477	7189	432	431	44	46	64	68	339	358
48	854	874	2961	2966	5297	5232	7373	7197	9235	8922	10906	10456
	11285	10751	3282	3177	51	51	3	3	5	5	51	54
49	213	217	1485	1466	3352	3270	5087	4921	6706	6431	8205	7819
	8098	7665	924	902	3	3	0	0	0	0	4	4
50	19	19	554	527	1878	1783	3188	3021	4479	4223	5722	5379
	5098	4753	85	84	0	0	0	0	0	0	0	0
52	10338	10568	12550	12594	14735	14517	16666	16198	18341	17658	19787	18934
	20966	20012	19776	19106	14497	14447	9320	9590	7474	7818	7830	8176
53	10231	10471	12000	12105	14036	13913	15969	15600	17692	17102	19203	18429
	20475	19574	20088	19332	16361	16103	11805	11958	9014	9322	8333	8671
54	10165	10408	11900	12013	13932	13821	15873	15516	17606	17027	19127	18362
	20411	19516	20123	19353	16525	16240	11966	12104	9090	9392	8322	8659
55	10069	10302	11637	11766	13579	13504	15505	15191	17253	16717	18799	18072
	20109	19243	19902	19123	16426	16080	12328	12398	9413	9671	8411	8725
56	10241	10452	11288	11440	12963	12954	14796	14567	16544	16096	18134	17488
	19521	18719	19848	19045	17437	16954	13779	13709	10574	10746	8989	9260

7-25-34

TABLE B-2
(continued)

COMPUTED SALINITY CONCENTRATION (MG/L) AT SELECTED LOCATIONS WITHIN COOK INLET

NODE #	OCTOBER APRIL		NOVEMBER MAY		DECEMBER JUNE		JANUARY JULY		FEBRUARY AUGUST		MARCH SEPTEMBER	
	CASE#1	CASE#4	CASE#1	CASE#4	CASE#1	CASE#4	CASE#1	CASE#4	CASE#1	CASE#4	CASE#1	CASE#4
57	10692	10859	11132	11290	12441	12482	14104	13955	15812	15453	17428	16868
	18880	18151	19609	18816	18157	17573	15095	14884	11848	11914	9794	10003
58	11275	11388	11143	11291	12067	12141	13531	13446	15171	14889	16792	16310
	18293	17632	19291	18525	18575	17929	16113	15782	12999	12960	10633	10776
59	12039	12083	11267	11395	11731	11833	12941	12920	14483	14283	16098	15701
	17643	17059	18874	18150	18875	18179	17103	16649	14250	14093	11626	11689
60	13014	12972	11574	11667	11512	11628	12404	12438	13804	13683	15388	15077
	16965	16462	18360	17694	18951	18235	17917	17355	15488	15205	12740	12709
100	11751	11957	13991	13941	16072	15725	17850	17262	19395	18604	20733	19793
	21817	20805	20036	19497	15248	15465	10599	11068	8592	9051	9050	9438
101	12212	12398	14537	14425	16592	16162	18307	17639	19800	18933	21092	20087
	22124	21067	19787	19336	14789	15177	10395	10960	8596	9096	9318	9715
102	11854	12050	14177	14094	16267	15873	18025	17389	19551	18713	20869	19889
	21928	20885	19780	19288	14754	15055	10207	10717	8389	8864	9036	9427
103	11672	11880	13921	13876	16014	15671	17802	17216	19354	18564	20696	19757
	21784	20772	20024	19478	15200	15405	10500	10961	8508	8963	8971	9358
104	11792	11994	14081	14016	16171	15801	17941	17329	19478	18662	20806	19845
	21877	20849	19922	19404	15003	15258	10365	10851	8457	8923	9021	9410
105	11489	11696	13805	13758	15928	15582	17733	17142	19295	18499	20640	19695
	21725	20708	19831	19289	14728	14931	9982	10430	8165	8609	8752	9134
106	11572	11780	13853	13808	15962	15619	17759	17172	19317	18525	20662	19722
	21750	20736	19948	19402	14964	15164	10194	10644	8299	8746	8837	9221
107	11276	11487	13617	13583	15765	15436	17594	17018	19174	18391	20530	19596
	21625	20615	19771	19212	14541	14706	9710	10128	7961	8390	8564	8941
108	10999	11212	13366	13346	15542	15232	17401	16844	19003	18238	20374	19454
	21479	20480	19638	19062	14176	14305	9288	9675	7652	8060	8305	8675
109	11348	11558	13662	13627	15797	15468	17617	17044	19192	18412	20549	19618
	21644	20638	19855	19296	14617	14787	9721	10141	7961	8387	8587	8962
110	10959	11172	13342	13323	15523	15215	17385	16830	18989	18226	20360	19443
	21465	20467	19591	19016	14051	14177	9172	9552	7578	7981	8259	8626
111	10498	10710	12946	12943	15179	14897	17083	16554	18720	17982	20119	19223
	21234	20253	19392	18799	13042	13129	7787	8103	6589	6938	7598	7938
115	11120	11331	13472	13446	15634	15318	17477	16916	19069	18300	20437	19515
	21537	20536	19724	19156	14196	14341	9212	9601	7605	8010	8330	8697
116	10825	11034	13244	13225	15440	15133	17312	16760	18924	18164	20296	19383
	21396	20403	19396	18828	13609	13735	8766	9131	7317	7707	8103	8462
117	10484	10695	12948	12943	15183	14899	17087	16556	18722	17983	20121	19224
	21232	20251	19344	18755	12912	13001	7674	7985	6517	6863	7563	7901
125	9584	9791	12168	12191	14503	14264	16488	16005	18187	17493	19637	18780
	20767	19816	18842	18224	11151	11188	5777	6006	5082	5352	6452	6747
127	8891	9093	11551	11594	13961	13757	16009	15563	17757	17099	19250	18424
	20396	19469	18432	17795	9862	9864	4542	4716	4128	4347	5651	5913

1-47k

USER'S GUIDE FOR THE ESTUARY HYDRODYNAMIC AND WATER QUALITY MODELS

Prepared for the

Department of the Army
Alaska District
Corps of Engineers
Anchorage, Alaska

Prepared by

Donald J. Smith

Tetra Tech Contract TC-827
DACW85-76-C-0044

September, 1977

Tetra Tech, Inc.
3700 Mt. Diablo Boulevard
Lafayette, California 94549
(415) 283-3771

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

2-35-39

I. INTRODUCTION

BACKGROUND

The Federal Water Pollution Control Act Amendments (PL 92-500) of 1972 establishes specific requirements directed to the control of point sources of pollution. The Department of the Army, Alaska District, Corps of Engineers was given the responsibility to determine the effects of various levels of treatment and levels of wastewater effluent discharges, as defined in PL 92-500, on the water quality of Upper Cook Inlet including Knik Arm.

Tetra Tech, Inc. was contracted to prepare the Knik Arm and Upper Cook Inlet water quality report. Included in the study was the selection and use of appropriate mathematical models to aid in the evaluation of the effects of wastewater effluent discharges. The models selected and documented herein are:

- A two-dimensional horizontal, complete mixed vertical, dynamic hydrodynamic model interfaced with
- A two-dimensional horizontal, complete mixed vertical tidally averaged dynamic/steady-state water quality model.

This manual provides basic instructions for the set-up and use of the general estuary hydrodynamics and quality models. An example problem data set and simulation results are presented in Appendix A through D. The example utilizes the node-channel representation (see Figure I-1) used for the water quality evaluation portion of this project. A listing of the computer program codes for the hydrodynamic and water quality models are presented in Appendix E and F.

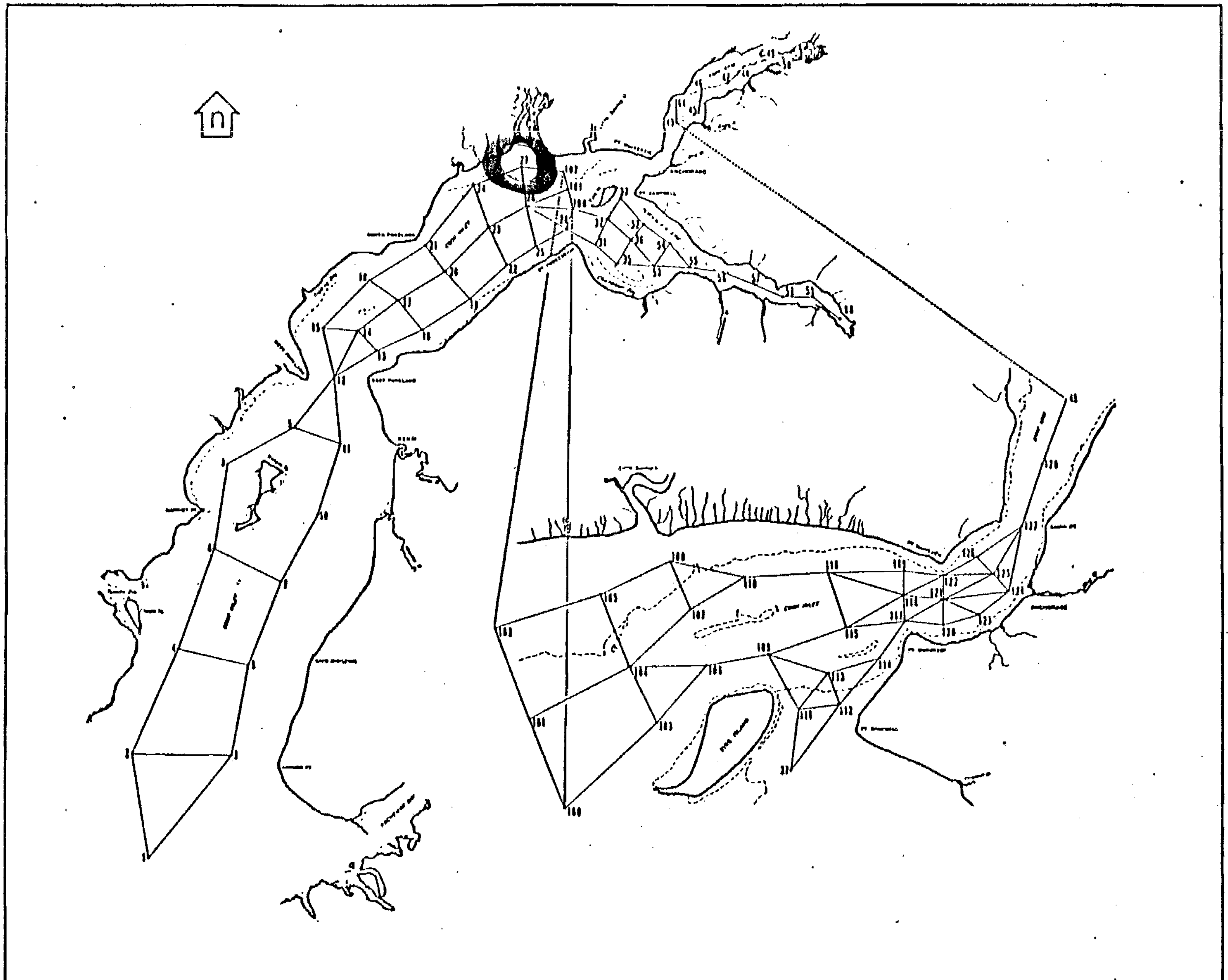


FIGURE I-1 NODE AND CHANNEL LAYOUT FOR UPPER COOK INLET INCLUDING KNIK AND TURNAGAIN ARMS

Detailed descriptions of the theoretical background and mathematical formulations essential in the estuary model development are presented in the Documentation Report*.

PURPOSE AND SCOPE

This manual is intended to provide the user with information which is fundamental in the set up and use of the estuary hydrodynamic and quality models. It includes general instructions regarding:

- Geometric representations of the prototype system;
- Data requirements and input format specifications;
- Program subroutines and computational sequence;
- General modeling procedure; and
- Interpretation of model results.

MODEL DESCRIPTION

Conceptual Formulation

The numerical model represents the estuarine system as a variable grid network of "nodes" and "channels". Nodes are discrete volume units of waterbody, characterized by surface area, depth, side slope and volume. The nodes are interconnected by channels, each having associated length, width, cross sectional area, hydraulic radius, side slope and friction factor. Water is constrained to flow from one node to another through these defined channels, advecting and diffusing water quality constituents between nodes.

---

*Johanson, P.J., D.J. Smith, F.M. Haydock, and M.W. Lorenzen, "Documentation Report for the Estuary Water Quality Models." A Report to Nassau-Suffolk Regional Planning Board, Long Island, New York, May, 1977.

The following are underlying assumptions of the estuary model.

- The estuarine system is well mixed vertically.
- The law of conservation of mass is obeyed for water quality constituents.
- Chemical reaction rates may be estimated using first order kinetics characterized by reaction-specific rate coefficients.

Program Operational Sequence

The overall two-dimensional estuary model is composed of two separate components, a hydrodynamic model (HYDRO) and a tidally averaged quality model (AQUAL).

The numerical models are used in sequence so that the results of the hydrodynamic model become input for the water quality model. The chief advantage of dividing the overall model into segments is that HYDRO can be calibrated separately and then used repeatedly in the calibration and application of AQUAL.

HYDRO calculates the hydrodynamics of the estuary using detailed information about geometric configurations, hydrologic conditions and predicted tidal time-stage relationships. The equations of motion and continuity are applied to determine the physical transport mechanisms of water flows and velocities in channels, and volume changes in nodes. The resulting data are averaged over the complete tidal cycle and written on disk files to be used as input to AQUAL.

AQUAL combines formulations for biological and chemical reactions with advective and diffusive properties in a mass balance equation to calculate tidally averaged water quality at any location and time. Required inputs include system geometry and tidally averaged hydrodynamics from HYDRO, boundary conditions, dispersion coefficients, point and non-point source quality, reaction rate coefficients, and meteorological conditions. The dispersion coefficients are used to estimate net dispersion in the prototype since tidally induced advection is not directly modeled. AQUAL may be operated in either a steady-state or dynamic mode. The final results in the steady-state mode are representative of daily average conditions which would prevail if all inputs remained constant over time. The dynamic mode is useful for simulating long-term changes in water quality which result when system conditions or waste inputs change significantly over time. In this mode the model uses tidal cycles as the basic time step and yields average daily results. Figure I-2 summarizes the program operational sequence for the tidally averaged quality model.

The quality model can be used to simulate any combination of the following thirteen parameters and have the capability to include up to four additional user specified constituents. Optional constituents may include any dissolved or particulate constituent with first order decay, settling and transfer between constituents through decay.

1. Salinity
2. Total Nitrogen
3. Total Phosphorus
4. Total Coliform Bacteria
5. Fecal Coliform Bacteria
6. Carbonaceous BOD
7. Nitrogenous BOD
8. Dissolved Oxygen
9. Temperature

10.-13. Optional Constituents

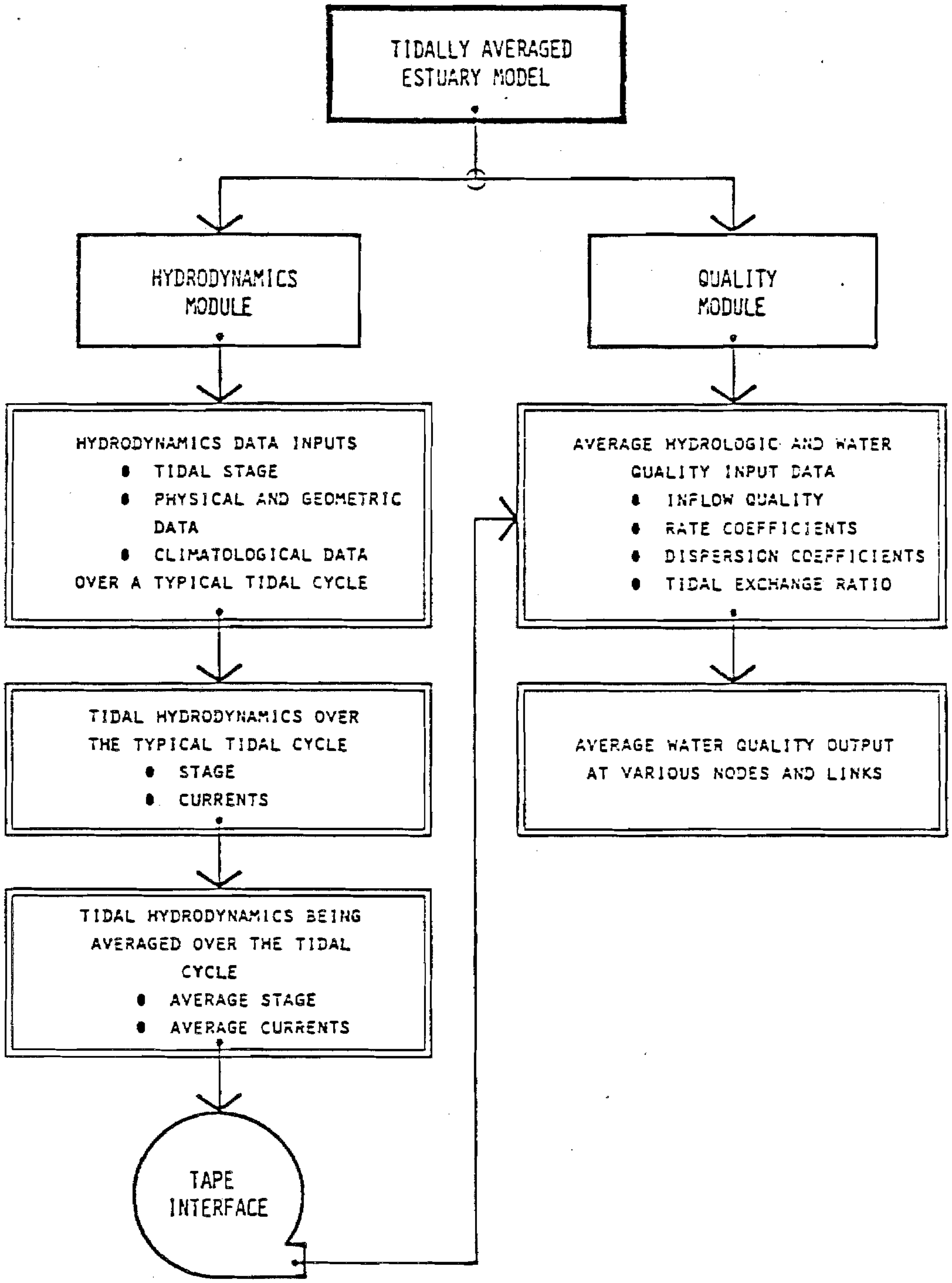


FIGURE I-2 TIDALLY AVERAGED ESTUARY MODEL FLOW CHART

2-3545

General Modeling Approach

The first phase of the modeling procedure is to "calibrate" the model using synoptic survey data from a suitable study period. Boundary conditions (tides, flows, waste discharges, etc.) which characterize the study period are input to the model and the results are compared to *in situ* data. Calibration involves adjusting system coefficients or modifying the network until reasonable agreement between model and prototype is achieved.

Once the model has been calibrated, a second study period may be selected for model "verification". Model inputs are changed in accordance with results of this study period while system coefficients and network geometry are maintained. If agreement between calculated and observed concentrations is good, the model can be considered verified. If agreement is poor, the reasons for the discrepancy must be determined and satisfactorily resolved. Any adjustments made to the model at this point must also be shown to improve the calibration results.

The third phase of the modeling procedure is to evaluate model sensitivity to modifications in system coefficients, and unit response to changes in individual loading sources. This is accomplished by examining the effect of varying one parameter while holding all others constant. The sensitivity analysis allows estimation of the range of results possible and the relative importance of each system coefficient. The unit response analysis shows the relative importance of various waste sources and boundary conditions on water quality.

System Layout

The nonuniform grid system used in the numerical models enables the user to specify greater detail in areas where the impact of pollutants is the greatest. Efficient utilization of computer resources weighs heavily on judicious preparation of the node and channel system. Among the most important considerations are computational time step increment, system geometry and location of waste sources.

The computational (hydrodynamic) time step increment is governed by the stability criteria of the channel according to the following relationship:

$$\Delta t < \frac{L}{\sqrt{gR}} \qquad (1)$$

where:

Δt = maximum hydrodynamic time step
L = channel length
g = gravitational constant
R = hydraulic radius (approximately equal to the average channel depth)

Since the same time step is used for the entire system, a single short deep channel can necessitate the use of a much smaller time step than would otherwise be required. Channel lengths should be selected to minimize this constraint as much as possible without interfering with natural system geometry.

In order to obtain the greatest possible correspondence between model and prototype hydrodynamics it is important to attempt to align model channels with natural channels as much as possible. In addition, areas with widely varying characteristics (e.g. depth, roughness) should not be combined in one node. Smaller nodes and shorter channels are warranted in regions which are known to have water quality problems or where major gradients in water quality parameters exist.

II. HYDRODYNAMIC MODULE

INPUT REQUIREMENTS

The following inputs are required for the computation of estuary hydrodynamics:

- Physical and geometric characteristics of the node-channel representation of the estuary;
- Tidal time-stage relationships at seaward boundaries;
- Meteorological and climatological data, including evaporation, wind speed and direction, and precipitation;
- Point inflows and outflows;
- Non-point inflows; and
- Control specifications for computational options and output formats.

Table II-1 outlines the card groups and format specifications required to set up the hydrodynamic model card deck. These card descriptions together with the illustrative example data presented in Appendix A and the simulation results presented in Appendix B should enable the user to set up, run, and interpret the results of the estuary hydrodynamics model.

Table II-1

HYDRO

Estuary Hydrodynamic Model
Data Requirements

Card Number	Card Column	Format	Variable	Description

Card Group 1 - Title Cards

These headings will be printed on each page of the input data summary.

1a	1-80	20A4	TITLE	Main heading
1b	1-80	20A4	TITL	Subheading

Card Group 2 - Input/Output Control Card

Two or three tidal cycles are normally required to reach steady-state hydrodynamics. Results of the final tidal cycle for each hydrologic condition are averaged and stored through NSTEAD for later use as input to AQUAL. Examples of the plotting options are presented in Appendix B.

A renumbering routine is included in the HYDRO code which arranges the channel-node system to minimize storage and computational requirements. Internal renumbering should begin with a node located at some extreme of the network such as a tidal boundary or lengthwise end of the system.

2a	1-5	11I5	NSESON	Sets of hydrologic conditions (48 maximum)
	6-10		NHPRT	Number of nodes specified for printout (1-30 allowed)
	11-15		NQPRT	Number of channels specified for printout (1-30 allowed)
	16-20		NTSL	Number of nodes specified for plots of mean tidal range and time of high water (max. 48)

2-35-40

Table II-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 2 - Input/Output Control Card - Cont.				
2a	21-25		NSTAGE	Number of pages of tidal stage plots (3 plots per page)
	26-30		NTFLOW	Number of pages of channel velocity and flow plots (3 plots per page)
	31-35		NDYNAM	Not used
	36-40		NSTEAD	HYDRO/AQUAL interface unit number
	41-45		NN	Node number to begin internal renumbering
2b	1-5	16I5	MDAY(1)	
	6-10		MDAY(2)	Number of tidal cycles for each hydrologic condition
	.		.	
	.		.	
	.		.	
			MDAY(NSESON)	
Card Group 3				
	1-5	16I5	JPRT(1)	
	6-10		JPRT(2)	Nodes specified for stage printout (NHPRT nodes required)
	.		.	
	.		.	
	.		.	
			JPRT(NHPRT)	

Repeat card type 3 as necessary to conform to limits set on card 2.

Table II-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 4				
4	1-5	16I5	CPRT(1)	Channels specified for velocity and flow printout (NQPRT channels required)
	6-10		CPRT(2)	
	.		.	
	.		.	
	.		.	
			CPRT(NQPRT)	

Repeat card type 4 as necessary to conform to limits set on card 2.

Card Number	Card Column	Format	Variable	Description
Card Group 5				
5	1-5	3I5	NJPLOT(NSTAGE,1)	Node specified for stage plots
	6-10		NJPLOT(NSTAGE,2)	
	11-15		NJPLOT(NSTAGE,3)	

Nodes specified here must have been included in JPRT array (card 3). NSTAGE (card 2) cards are required.

Omit card 5 if NSTAGE = 0.

Card Number	Card Column	Format	Variable	Description
Card Group 6				
6	1-5	3I5	NCPLOT(NTFLOW,1)	Channel specified for velocity plots
	6-10		NCPLOT(NTFLOW,2)	
	11-15		NCPLOT(NTFLOW,3)	

Channels specified here must have been included in CPRT array (card 4). NTFLOW (card 2) cards are required.

Omit card 6 if NTFLOW = 0.

Table II-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 7				
7	1-5	16I5	JTR(1)	
	6-10		JTR(2)	Nodes specified for profile plot of mean tidal range and time of high water (NTSL nodes required)
	.		.	
	.		.	
	.		.	
			JTR(NTSL)	

Repeat card 7 as required to conform to the limits set on card 2.

Omit card 7 if NTSL = 0.

Card Group 8

Hydrodynamic time step increment which is based on channel stability criteria can be determined by using Equation 1 or by previewing invariant channel data output generated by the model in a preliminary run using a large hydrodynamic time step.

Card Number	Card Column	Format	Variable	Description
8	1-10	4F10.0	DELT	Hydrodynamic time step increment, sec.
	11-20		DELTQ	Printed output interval, sec.
	21-30		PERIOD	Length of tidal cycle, hours
	31-40		DMIN	Anticipated maximum diurnal range in stage within the estuary (ft)

Table II-1 - Cont.

Card Number	Card Column	Format	Variable	Description

Card Group 9 - Node Geometry

Node numbers greater than 200 are not allowed. Average nodal depth at mean sea level can be estimated from nautical charts keeping in mind that the charts show mean low water. Nodes with sizeable tide flat areas require an estimate of change in surface area per foot of change in depth. The X-Y coordinate location of nodes relative to some origin is measured in arbitrary units.

Card Number	Card Column	Format	Variable	Description
9	1-5	I5	J	Node number
	6-15	2F10.0	AREA	Water surface area at mean sea level, sq. ft.
	16-25		SLOPE	Change in surface area with increase in water surface elevation, sq. ft/ft.
	26-30	3F5.0	DEP	Water depth at mean sea level, ft.
	31-35		X1	X-coordinate, any unit
	36-40		Y1	Y-coordinate, any unit
	41-45	8I5	NTEMP(1)	
	46-50		NTEMP(2)	
	.		.	Channels entering node
	.		.	
	.		.	
	76-80		NTEMP(8)	

Repeat card 9 for each node in the system terminating with a blank card. A maximum of 200 cards (including the blank card) is allowed.

2-35-5

Table II-1 - Cont.

Card Number	Card Column	Format	Variable	Description

Card Group 10 - Channel Geometry

Channel numbers greater than 300 are not allowed. Channel length, average width, and the change in width per foot of change in depth in tide flat areas (side slope) can be estimated from nautical charts. The hydraulic radius is essentially equal to the channel depth except in tide flat areas where it is approximately equal to the average cross-sectional area at mean sea level divided by the surface width at mean sea level. Channel roughness, as represented by Mannings coefficient, is a function of channel configuration, bottom roughness and obstructions. Coefficients range from .02 for smooth straight channels to 0.08 for rough, irregular, obstructed channels.

Card Number	Card Column	Format	Variable	Description
10	1-5	I5	N	Channel number
	6-15	4F10.0	ALEN	Channel length, ft.
	16-25		WIDTH	Channel width at mean sea level, ft.
	26-35		RAD	Hydraulic radius at mean sea level, ft.
	36-45		COEF	Mannings roughness coefficient
	46-50	2I5	NTEMP (1)	Nodes at each end of channel
	51-55		NTEMP (2)	
	56-65	F10.0	SLOPE	Change in width with increase in water surface elevation, ft/ft.

Repeat card 10 for each channel in the system terminating with a blank card. A maximum of 300 cards (including the blank card) is allowed.

Card Group 11

This subheading replaces the title read from card 1b and will be printed with the following set of hydrologic conditions.

Card Number	Card Column	Format	Variable	Description
11	1-80	20A4	TITL	Subheading

Table II-1 - Cont.

Card Group 12 - Hydrologic Input Control Switch

Set NTEMP( ) = 1 to skip the following inputs; new data will be read if NTEMP( ) = 0. Hydrological conditions are assumed zero until otherwise specified. Inputs are retained until replaced with new values.

Card Number	Card Column	Format	Variable	Description
12	1-5	6I5	NTEMP(1)	Read new tide data
	6-10		NTEMP(2)	Read new evaporation data
	11-15		NTEMP(3)	Read new wind velocity and direction
	16-20		NTEMP(4)	Read new point inflows and outflows
	21-25		NTEMP(5)	Read new groundwater inflow data
	26-30		NTEMP(6)	Read new storm water inflow data

Card Group 13 - Tidally Influenced Nodes

Card Number	Card Column	Format	Variable	Description
13	1-5	I5	NJEX	Number of nodes with specified stage relationships

Omit card 13 if NTEMP(1) (card 12) = 1.

Card Group 14 - Tide Data

Card Number	Card Column	Format	Variable	Description
14a	1-5	4F5.0	JEX(NJEX)	Node number with specified stage relationships
	6-10		NI	Number of points defining stage relationship (must equal 6 or 25)
	11-15		MAXIT	Maximum number of iterations for tide fit (50)
	16-20		NCHTID	Print control, tidal curve fit results will be printed if equal to 1

Table II-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 14 - Tide Data - Cont.				
14b	1-5	16F5.0	TT(1)	Time (TT=hrs) and stage (YY=ft) defining tide wave (NI pairs of data are required)
	6-10		YY(1)	
	11-15		TT(2)	
	16-20		YY(2)	
	.		.	
	.		.	
	.		.	
			TT(NI)	
			YY(NI)	

Repeat card 14b as required to define NI time-stage relationships. NJEX sets of card group 14 are required to define tides at all boundary nodes.

Omit card group 14 if NTEMP(1) (card 12) = 1.

Card Number	Card Column	Format	Variable	Description
Card Group 15 - Evaporation				
15	1-5	2I5	J1	First node of an evaporation zone
	6-10		J2	Last node of an evaporation zone
	11-20	F10.0	EVAPA	Evaporation rate, inches/ month

Repeat card 15 as necessary terminating with a blank card. A maximum of 20 evaporation zones are allowed which overrides the blank card requirement.

Omit card group 15 if NTEMP(2) (card 12) = 1.

Table II-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 16 - Wind Velocity and Direction				
16a	1-5	2I5	J1	First channel of a wind zone
	6-10		J2	Last channel of a wind zone
16b	1-5	16F5.0	WIND(,1)	Wind speed (mph) and direction blowing from (degrees clockwise from Y-axis) at hour one
	6-10		WDIR(,1)	
	.		.	
	.		.	
	.		.	
			WIND(,25)	One set of values for each hour
	6-10 (Fourth Card)		WDIR(,25)	

Four 16b cards required for each wind zone. Repeat card group 16 as necessary terminating with a blank card. No blank card is required if 5 wind zones (the maximum allowed) are defined.

Omit card group 16 if NTEMP(3) (card 12) = 1.

Card Number	Card Column	Format	Variable	Description
Card Group 17 - Point Inflows/Outflows				
17	1-5	I5	N	Node number
	6-15	2F10.0	QQIN	Inflow to node, cfs
	16-25		QQOU	Outflow from node, cfs

Repeat as necessary terminating with a blank card. A maximum of NJ cards are allowed where NJ = number of nodes in the network.

Omit card group 17 if NTEMP(4) (card 12) = 1.

Table II-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 18 - Groundwater Inflows				
18	1-5	2I5	J1	First node for which groundwater inflow rate applies
	6-10		J2	Last node for which groundwater inflow rate applies
	11-15	F5.0	GROUND	Groundwater inflow rate, cfs

Repeat as necessary terminating with a blank card. A maximum of 199 groundwater inflows are allowed.

Omit card group 18 if NTEMP(5) (card 12) = 1.

Card Number	Card Column	Format	Variable	Description
Card Group 19 - Storm Water Inflows				
19a	1-5	I5	N	Node number
	6-10	12F5.0	TN(1)	
	11-15		TN(2)	Average hourly storm inflows (cfs) for first 12 hours of tidal cycle
	.		.	
	.		.	
	66-70		TN(12)	
19b	1-5	13F5.0	TN(13)	
	6-10		TN(14)	Average hourly storm inflows (cfs) for last 13 hours of tidal cycle
	.		.	
	.		.	
	.		.	
	61-65		TN(25)	

Repeat card group 19 as necessary terminating with a blank card. A maximum of 39 pairs are allowed.

Omit card group 19 if NTEMP(6) = 1.

Repeat card groups 11-19 for each hydrologic condition. There must be NSESON sets as specified on card 2.

PROGRAM ROUTINES

Figure II-1 summarizes the general structure of the hydrodynamic model. Complete descriptions of model structure and solution techniques are included in the documentation report and will not be duplicated herein. The following brief synopsis is intended to serve only as a guide to aid in the interpretation of model outputs.

The main program HYDRO coordinates the hydrodynamic calculations, first reading title and control information for printing and plotting, and then calling GEOMET. This subroutine reads channel and junction configurations, including interconnectivity of nodes and channels, and computes invariant node and channel data before returning control to HYDRO.

HYDRO then calls NUMBER which renumbers the nodes internally so as to produce a more efficient matrix configuration for tidally averaged quality computations. The original numbering system is retained for output purposes. Control returns to HYDRO which prints the invariant geometric data and stores duplicates on disk files for later use in the quality model AQUAL.

The model then cycles through the following steps as often as required to compute steady-state hydrodynamics for each hydrologic condition. HYDRO calls TIDCF to fit the tide specifications with a polynomial which describes the time-stage relationship at a seaward boundary. Comparisons of observed and computed values are computed and printed. TIDCF is called repeatedly until the time-stage relationships are defined for each seaward boundary. Control is returned to HYDRO which then reads the remaining hydrodynamic inputs. At this point the major daily time step and quality time step loops are initiated and subroutine DYNFLO is called.

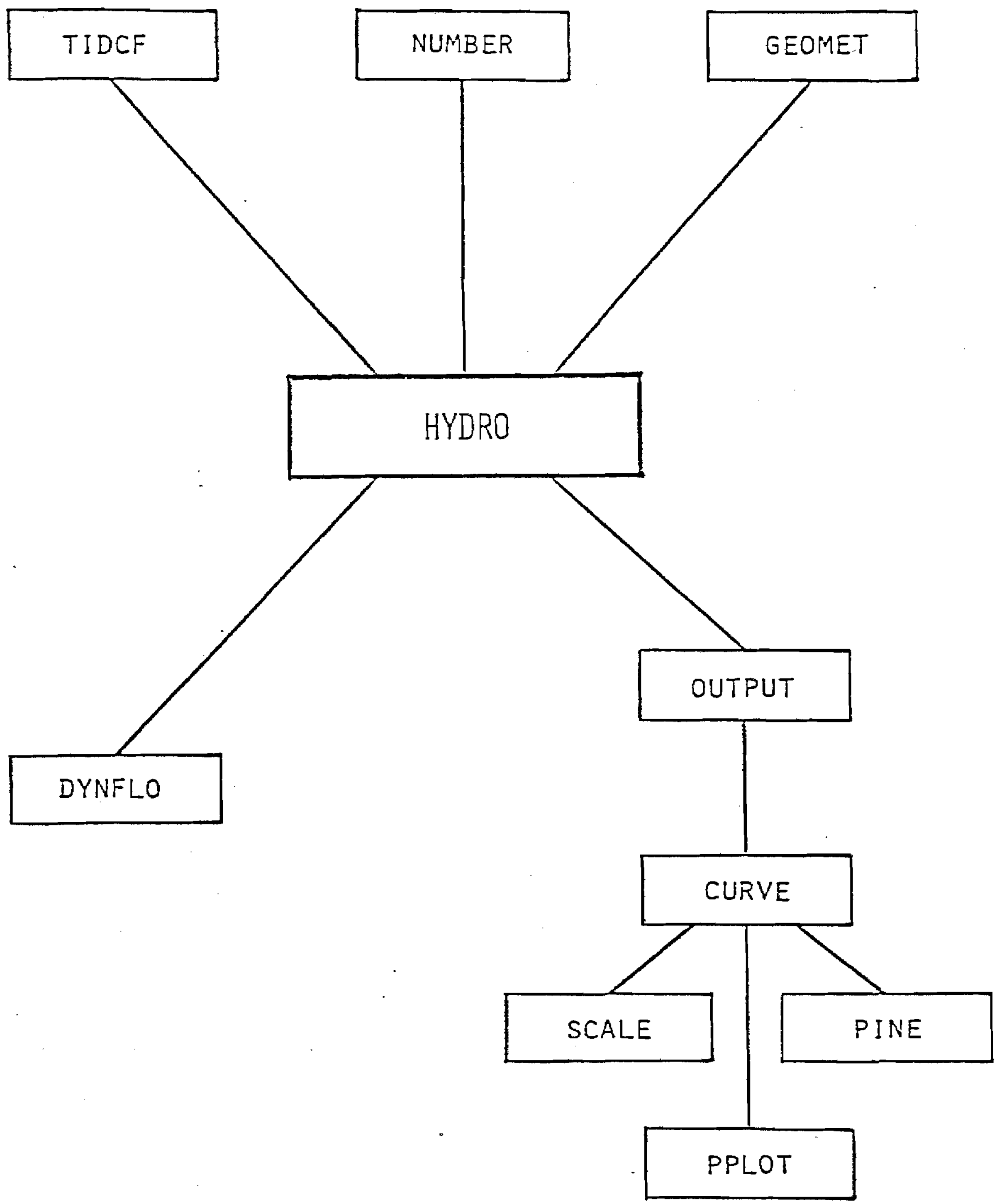


FIGURE II-1 ESTUARY HYDRODYNAMIC MODEL SUBROUTINES

DYNFLO solves the equations of motion and continuity to determine fundamental hydrodynamic properties including velocities, discharges, water volumes, depths, surface areas and channel cross sectional areas. DYNFLO is called repeatedly to compute hydrodynamic properties for each simulation day of the hydrologic period.

Control then returns to HYDRO which averages the results of the final day of simulation over a complete tidal cycle and stored for later use in AQUAL. Finally, the subroutine OUTPUT is called which prints the results and controls the sequencing of the remaining subroutines which produce the user specified plots.

INTERPRETATION OF RESULTS

If errors occur in the node and channel inputs, one or more of the following messages will be printed:

- JUNCTION NUMBER _____ IS LARGER THAN PROGRAM DIMENSIONS.
  Junction numbers must not be greater than 200.

- CHANNEL NUMBER _____ IS LARGER THAN PROGRAM DIMENSIONS.
  Channel numbers must not be greater than 300.

- CHANNEL CARD COMPATIBILITY CHECK, CHANNEL _____ AND JUNCTION _____.
  Channel-junction interconnectivity is erroneous.

- JUNCTION CARD COMPATIBILITY CHECK, JUNCTION _____ AND CHANNEL _____.
  Junction-channel interconnectivity is erroneous.

Assuming a HYDRO/AQUAL interface unit number was assigned, the first printed output (see Appendix Table B-1) shows the node renumbering scheme which is used internally in the steady-state/dynamic tidally averaged quality model. The maximum diagonal matrix width and the half band widths are also shown. The dimension limits in AQUAL will be exceeded if either of the half band widths are greater than ten (10). In this case the following error message is printed:

THE HALF BAND WIDTH OF _____ FOR EQUATION
NUMBER _____, NODE _____, EXCEEDS THE DIMENSION
LIMITS IN PROGRAM AQUAL. PROGRAM EXECUTION
WILL TERMINATE LATER.

If this message is printed, one of the following modifications is required.

- Select a different node which is located at some extremity of the network to begin renumbering (i.e., a tidal boundary or lengthwise end of the system).

- Restructure the grid system eliminating excess nodes which extend laterally from the lengthwise axis of the system.

- Increase the DIMENSION limits in program AQUAL.

When any of these errors occur, the model run will continue until invariant junction and channel data have been printed at which time the simulation will terminate.

The next output (see Appendix Table B-2) summarizes the computational and output control options specified on Card Groups 1-8.

Invariant node and channel data follows the control summaries. An example of this output is presented in Appendix Table B-3 and B-4. In addition to printing input data, some computed data are included.

The column labeled "MAX TIME, SEC" on the channel data printout is useful for checking the maximum allowable computational time step. The hydrodynamic time step increment specified in columns 1-5 of Card 8 must not exceed the smallest value appearing in this column. The user may wish to modify the network layout slightly by lengthening channels or decrease the depth (along with an appropriate increase in width) which will increase the allowable time step.

The column labeled MIN ELEV, FT on the channel data printout is the water surface elevation at which the channel width becomes negative. The column labeled MIN ELEV, FT on the node data printout is the water surface elevation at which either the nodal volume or surface area will become negative.

The model checks to see if the anticipated low water level is exceeded by either of these minimum elevations. If potential problems exist, they will be noted by the following warnings incorporated in the list of junction and channel data.

- NOTE -- * INDICATES NEGATIVE WIDTH IS POSSIBLE WITH ANTICIPATED TIDAL STAGE.

- NOTE -- * INDICATES THAT DEPTH OF CHANNEL ENTERING JUNCTION IS LARGER THAN JUNCTION DEPTH.

  The latter message is to aid the user in modifying channel geometry data in the event that a negative node volume or surface area is encountered later in the hydrodynamic simulation.

- ** INDICATES NEGATIVE VOLUME OR SURFACE AREA IS POSSIBLE WITH ANTICIPATED TIDAL STAGE.

It should be stressed that these are only warnings and may not cause further problems since the actual nodal stage often does not reach the anticipated low water level. If any of these anticipated problems materialize later in the simulation, error messages will be printed and the model run terminated at that time.

The remaining outputs will be repeated for each set of hydrodynamic conditions. Appendix Table B-5 shows an example of the output which is generated when the TIDCF subroutine successfully fits a polynomial with the input time-stage tide data*. The model will iterate until reasonable agreement is achieved between observed and computed values. The model computes and prints the individual and total differences between derived and observed time-stage relationships. These results should be checked for individual differences exceeding 5% of the maximum tide range which suggest possible errors in tide data inputs. One or more of the following variables may be the cause:

- Erroneous time-stage pairs defining the tide wave.
- Insufficient iterations for the tide fit. (50 is usually enough).
- Irregular spacing of tidal extremes.

The next page of output (see Appendix Table B-6) summarizes the evaporation, wind, inflows, and withdrawal data entered for the given hydrodynamic condition.

---

*The user may suppress this output (see Card 14a).

Model outputs to this point may be previewed most cost-effectively by setting the hydrodynamic time step increment to well in excess of a reasonable time step increment. The run will not go to completion, however, the output which is generated can be reviewed for input errors. The correct time step can be selected based on derived channel data output.

Selecting too large a time step will result in an unstable solution, terminates the runstream and cause the following error message to be printed:

HYDRODYNAMIC SOLUTION WAS UNSTABLE AT HOUR ___________
IN CHANNEL ________, FLOW = ________ CFS, DEPTH = _______ FEET,
VELOCITY = ________ FT/SEC

As noted earlier, termination of the runstream will occur if negative nodal surface areas or volumes are encountered causing the following error messages to be printed:

- NEGATIVE SURFACE AREA ENCOUNTERED AT HOUR ________
  AT NODE _____, HEAD = ______ FEET, AREA = _______ SQ FT.

- NEGATIVE VOLUME ENCOUNTERED AT HOUR ______ AT NODE _____,
  HEAD = ______ FEET, VOLUME = _______ CU FT.

If this occurs one or both of the following adjustments in junction/channel configurations are required:

- Increase depth of node.

- Decrease area slope (change in surface area with respect to depth) in the junction. This adjustment may not be applicable when tide flats are being modeled.

7-35-(

- Decrease depth in channels which drain the junction. The channels which are sufficiently deep to cause the difficulty will have to be noted in the invariant channel data printout.

Once all errors are corrected the computations will go to completion. Appendix Tables B-7, B-8, B-9, and Appendix Figures B-1 through B-4 show examples of the model outputs. The following is a check list for testing the hydrodynamic model results before proceeding to the quality codes:

- Check for steady-state hydrodynamics by comparing heads at hour 25 with those at hour 50 for a given node. A similar check of flows and velocities for a given channel should also be made. Differences of more than 1% indicate that the model should be run for a longer period of time.

- Predicted time-stage relationships should be reasonable within the system.

- Check channel flows in tide flat areas to see whether times of no (or very little) flow are actually predicted.

- The values of average head should be approximately the same everywhere except where there is a large net flow or in tide flat areas where average heads will be greater since the flow out of these areas is stopped when a minimum depth is reached.

- The average velocity should be near zero except where there are net inflows or rapid changes in velocity such as in a narrow channel draining a large area.

- Water balance at each junction should be zero except at tidal exchange nodes where it is equal to the net gain or loss at the boundaries.

- A flow diagram showing direction and magnitude of the average flows is useful in detecting circular flow patterns. While minor eddies are acceptable, unexplainable major circular flows should be corrected by adjusting the roughness coefficients in the channels.

Modifications in roughness coefficients or node-channel configurations may be required in order to produce acceptable model-prototype conformance. Once the above requirements are met to the satisfaction of the user, the model is considered calibrated and water quality computations can proceed.

III. TIDALLY AVERAGED QUALITY MODULE

INPUT REQUIREMENTS

The following inputs are required for the computation of tidally averaged water quality:

- Steady-state hydrodynamics as computed by HYDRO;
- Tidal exchange ratio and water quality at seaward boundaries;
- [redacted]
- [redacted]
- Dispersion coefficients;
- Reaction rate coefficients (benthic oxygen demand, coliform decay, photosynthesis oxygenation, etc.);
- Meteorological data, including cloud cover, dry and wet bulb air temperature, wind speed, and atmospheric pressure; and
- Control specifications for computational options and output formats.

Table III-1 outlines the card groups and format specifications required to set up the card deck for the AQUAL quality model. These card descriptions together with the illustrative example data presented in Appendix C and the formulation results presented in Appendix D should enable the user to set up, run, and interpret the results of the tidally averaged water quality model.

Table III-1

AQUAL

Data Requirements
Tidal Average Estuary Quality Model

Card Number	Card Column	Format	Variable	Description
Card Group 1 - Title Cards				
These headings will be printed on each page of the input data summary.				
1a	1-80	20A4	TITLE	Main heading
1b	1-80	20A4	TITL	Subheading
Card Group 2 - Input/Output Control Card				
2	1-5	10I5	NHYD	Sets of boundary conditions
	6-10		IDAY	First Julian day of simulation
	11-15		IDELT	Computational time step increment, hours
	16-20		IALT	Print format option switch, (IALT = 0 for standard, IALT = 1 for alternate)
	21-25		IPCYC	Printout interval, days
	26-30		NJP	Number of junctions for time history plots (6 max.)
	31-35		NPP	Number of concentration profile plots (2 max.)
	36-40		IEE	Number of iterations for computing dispersion coefficients. (Default value = 10, five is usually sufficient)

2-35-19

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 2 - Input/Output Control Card - Cont.				
2	41-45		NFILE	HYDRO/AQUAL interface unit number
	46-50		INQUAL	Not used

Card Group 3 - Steady-State/Dynamic Mode Switch

The code allows the user to select either steady-state or dynamic solutions for each set of boundary conditions. Set IDYN ( ) = 1 for steady-state solution, IDYN ( ) = 0 for steady-state.

Card Number	Card Column	Format	Variable	Description
3	1-5	16I5	NQPERH(1)	Number of days for first boundary condition
	6-10		IDYN(1)	Solution type selector
	.		.	
	.		.	
	.		.	
			NQPERH(NHYD)	NHYD pairs required
			IDYN(NHYD)	

Repeat as necessary to conform to limits set on card 2.

Card Group 4 - Parameter Selection

Set ISKIP( ) = 0 to simulate any of the following 13 constituents. If ISKIP( ) = 1 the constituent will be omitted.

Card Number	Card Column	Format	Variable	Description
4	1-5	13I5	ISKIP(1)	[redacted]
	6-10		ISKIP(2)	Total nitrogen, mg/l as N
	11-15		ISKIP(3)	Total phosphorus, mg/l as P
	16-20		ISKIP(4)	Total coliforms, MPN/100 ml
	21-25		ISKIP(5)	Fecal coliforms, MPN/100 ml

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 4 - Parameter Selection - Cont.				
4	26-30		ISKIP(6)	Ultimate carbonaceous BOD, mg/l
	31-35		ISKIP(7)	Nitrogenous BOD, mg/l
	36-40		ISKIP(8)	Dissolved oxygen, mg/l
	41-45		ISKIP(9)	Temperature, °C
	46-50		ISKIP(10)	Optional constituent #1
	51-55		ISKIP(11)	Optional constituent #2
	56-60		ISKIP(12)	Optional constituent #3
	61-65		ISKIP(13)	Optional constituent #4

<u>Card Group 5 - Optional Constituent Name</u>

The names will be printed on the first page of output for optional constituent identification.

Card Number	Card Column	Format	Variable	Description
5	1-16	16A4	CNAME(1)	Optional constituent #1
			CNAME(4)	
	17-32		CNAME(5)	Optional constituent #2
			CNAME(8)	
	33-48		CNAME(9)	Optional constituent #3
			CNAME(12)	
	49-64		CNAME(13)	Optional constituent #4
			CNAME(16)	

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description

Card Group 6 - Time History Plot Control

One to four constituents may be selected for time history plots. Constituents are numbered from 1 to 13 in the order shown on card 4.

Card Number	Card Column	Format	Variable	Description
6	1-5	10I5	IPLOT(1)	
	6-10		IPLOT(2)	Constituents for time history plots (constituent number)
	11-15		IPLOT(3)	
	16-20		IPLOT(4)	
	21-25		JPLOT(1)	
	26-30		JPLOT(2)	Junctions for time history plots (NJP junctions required)
	.		.	
	.		.	
	.		.	
			JPLOT(NJP)	

Omit card 6 if NJP (card 2) = 0.

Card Group 7 - Profile Plot Control

One to four constituents may be specified for concentration profiles. Constituents are numbered from 1 to 13 in the order shown on card 4.

Card Number	Card Column	Format	Variable	Description
7a	1-5	7I5	NCONP(1)	
	6-10		NCONP(2)	Constituents for concentration profiles (constituent number)
	11-15		NCONP(3)	
	16-20		NCONP(4)	
	21-25		IPDAY(1)	
	26-30		IPDAY(2)	Julian day of profile plot
	31-35		IPDAY(3)	

Card Number	Card Column	Format	Variable	Description

Card Group 7 - Profile Plot Control - Cont.

Card Number	Card Column	Format	Variable	Description
7b	1-5	16I5	NODEP(1,NPP)	
	6-10		NODEP(2,NPP)	Junction for concentration profile (21 required)
	.		.	
	.		.	
	.		.	
	21-25 (Second Card)		NODEP(21,NPP)	

NPP (card 2) sets of card group 7b are required.

Omit card group 7 if NPP = 0.

Card Group 8 - Initial Conditions

A negative oxygen concentration signifies the fraction of saturation.

Card Number	Card Column	Format	Variable	Description
8	1-5	2I5	J1	First junction for which data applies
	6-10		J2	Last junction for which data applies
	11-15	13F5.0	ALL(1)	[redacted]
	16-20		ALL(2)	Total nitrogen, mg/l as N
	21-25		ALL(3)	Total phosphorus, mg/l as P
	26-30		ALL(4)	Total coliforms, MPN/100 ml
	31-35		ALL(5)	Fecal coliforms, MPN/100 ml
	36-40		ALL(6)	Ultimate carbonaceous BOD, mg/l
	41-45		ALL(7)	Nitrogenous BOD, mg/l

2-35-7

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 8 - Initial Conditions - Cont.				
8	46-50		ALL(8)	Dissolved oxygen, mg/l
	51-55		ALL(9)	Temperature, °C
	56-60		ALL(10)	Optional constituent #1
	61-65		ALL(11)	Optional constituent #2
	66-70		ALL(12)	Optional constituent #3
	71-75		ALL(13)	Optional constituent #4

Repeat as necessary terminating with a blank card. NJ initial condition cards are allowed, where NJ - number of junctions in the network.

Card Group 9 - Dispersion Parameters

Dispersion coefficients provide a means for simulating estuarine mixing. Generally these coefficients are adjusted as required for calibration based on a conservative constituent and then do not change thereafter.

The tidally induced dispersion parameter (C1) includes the effect of flow induced and tidal mixing. Open embayments and estuaries which are strongly influenced by tidal effects will generally require a larger C1 than more protected regions. The values for this coefficient generally range from 5 to 25.

[redacted]

Card Number	Card Column	Format	Variable	Description
9	1-5	2I5	J1	First channel for which data applies
	6-10		J2	Last channel for which data applies
	11-15	2F5.0	C1	Dispersion parameter

Card Number	Card Column	Format	Variable	Description

Card Group 9 - Dispersion Coefficient - Cont.

9	16-20		[redacted]	[redacted]

Repeat card 9 as required to define all dispersion zones terminating with a blank card. NC cards are allowed, where NC = number of channels in the network.

Card Group 10 - Tidal Boundary Nodes

10	1-5	11I5	NBOUND	Number of tidal boundary nodes (10 max)
	6-10		JBOUND(1)	
	.		.	Tidal boundary node numbers
	.		.	
	.		.	
			JBOUND(NBOUND)	

Card Group 11 - Title Card

This subheading replaces the title read from card 1b. It will be printed with the output for the following set of boundary conditions.

11	1-80	20A4	TITL	Subheading

Card Group 12 - Read/Write Control Switches

Set NTEMP( ) = 0 to read new data; skip if NTEMP( ) = 1. Hydrodynamic conditions are normally read in order from the HYDRO/AQUAL interface tape; however the file may be repositioned if the user wishes a computation sequence different from that of the hydrodynamic simulation. Positive values of NTEMP(10) will advance the file and negative values will rewind it a specified number of records.

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 12 - Read/Write Control Switches - Cont.				
12	1-5	10I5	NTEMP(1)	Read new hydrodynamic conditions
	6-10		NTEMP(2)	Read new tidal exchange ratios and quality
	11-15		NTEMP(3)	Read new inflow quality
	16-20		NTEMP(4)	Print aggregated inflow quality if NTEMP(4) = 0.
	21-25		NTEMP(5)	Read new non-point source quality
	26-30		NTEMP(6)	Read new return water quality increments
	31-35		NTEMP(7)	Read new system coefficients
	36-40		NTEMP(8)	Read new meteorological data
	41-45		NTEMP(9)	Print weather data if NTEMP(9) = 0
	46-50		NTEMP(10)	Position of HYDRO/AQUAL hydrodynamic file

Card Group 13 - Tidal Exchange Ratios and Quality

The tidal exchange ratio refers to the fraction of ebbing estuary water which is lost from the system at the boundary node and does not return. Values can range from 0.-1.

13a	1-5	5X		Card identification

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 13 - Tidal Exchange Ratios and Quality - Cont.				
13a	6-10	10F5.0	XR(1)	
	.		.	Tidal exchange ratio
	.		.	at each tidal input node
	.		.	
			XR(NBOUND)	

If salinity is not modeled as constituent 1 then it must be entered as CEX(1,14) for dispersion coefficient calculations. A negative value for dissolved oxygen signifies a fraction of saturation.

Card Number	Card Column	Format	Variable	Description
13b	1-5	5X		Card identification
	6-10	14F5.0	CEX(1,1)	[redacted]
	11-15		CEX(1,2)	Total nitrogen, mg/l as N
	16-20		CEX(1,3)	Total phosphorus, mg/l as P
	21-25		CEX(1,4)	Total coliforms, MPN/100 ml
	26-30		CEX(1,5)	Fecal coliforms, MPN/100 ml
	31-35		CEX(1,6)	Ultimate carbonaceous BOD, mg/l
	36-40		CEX(1,7)	Nitrogenous BOD, mg/l
	41-45		CEX(1,8)	Dissolved oxygen, mg/l
	46-50		CEX(1,9)	Temperature, °C
	51-55		CEX(1,10)	Optional constituent #1
	56-60		CEX(1,11)	Optional constituent #2
	61-65		CEX(1,12)	Optional constituent #3
	66-70		CEX(1,13)	Optional constituent #4

Card Number	Card Column	Format	Variable	Description
Card Group 13 - Tidal Exchange Ratios and Quality - Cont.				
13b	71-75		CEX(1,14)	[redacted]

Repeat as necessary to define conditions at all boundary nodes. NBOUND cards are required.

Omit card group 13 if NTEMP(2) = 1 (card 12).

Card Group 14 - Inflow Quality

The model will aggregate the water quality into a given node when multiple point source inflows occur. A negative concentration signifies a mass emission rate in pounds per day or equivalent except for oxygen where it signifies a fraction of saturation. No more than 500 inflows are allowed which can be distributed into a maximum of 100 junctions.

Card Number	Card Column	Format	Variable	Description
14	1-5	I5	JJ	Junction number
	6-10	14F5.0	QQ	Inflow, cfs
	11-15		ALL(1)	[redacted]
	16-20		ALL(2)	Total nitrogen, mg/l as N
	21-25		ALL(3)	Total phosphorus, mg/l as P
	26-30		ALL(4)	Total coliforms, MPN/100 ml
	31-35		ALL(5)	Fecal coliforms, MPN/100 ml
	36-40		ALL(6)	Ultimate carbonaceous BOD, mg/l
	41-45		ALL(7)	Nitrogenous BOD, mg/l
	46-50		ALL(8)	Dissolved oxygen, mg/l
	51-55		ALL(9)	Temperature, °C
	56-60		ALL(10)	Optional constituent #1

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description

Card Group 14 - Inflow Quality - Cont.

Card Number	Card Column	Format	Variable	Description
14	61-65		ALL(11)	Optional constituent #2
	66-70		ALL(12)	Optional constituent #3
	71-75		All(13)	Optional constituent #4
	76-80		ALL(14)	[redacted]

Repeat as necessary terminating with a blank card. The blank card is not allowed when 500 inflows are specified.

Omit card 14 if NTEMP(3) = 1 (card 12).

Card Group 15 - Non-Point Source

These constituent concentrations represent aggregated quality of all non-point sources entering a given node or successive group of nodes at the flow rate specified in HYDRO. A negative dissolved oxygen concentration signifies a fraction of saturation.

Card Number	Card Column	Format	Variable	Description
15	1-5	16I5	J1	First junction for which quality applies
	6-10		J2	Last junction for which quality applies
	11-15		ALL(1)	[redacted]
	16-20		ALL(2)	Total nitrogen, mg/l as N
	21-25		ALL(3)	Total phosphorus, mg/l as P
	26-30		ALL(4)	Total coliforms, MPN/100 ml
	31-35		ALL(5)	Fecal coliforms, MPN/100 ml
	36-40		ALL(6)	Ultimate carbonaceous BOD, mg/l

7-25-79

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description

<u>Card Group 15 - Non-Point Source</u>

Card Number	Card Column	Format	Variable	Description
15	41-45		ALL(7)	Nitrogenous BOD, mg/l
	46-50		ALL(8)	Dissolved oxygen, mg/l
	51-55		ALL(9)	Temperature, °C
	56-60		ALL(10)	Discharge influence #1
	61-65		ALL(11)	Discharge influence #2
	66-70		ALL(12)	Discharge influence #3
	71-75		ALL(13)	Discharge influence #4
	76-80		ALL(14)	[redacted]

Repeat as necessary terminating with a blank card. A maximum of 29 non-point water types are allowed.

Omit card 15 if NTEMP(5) = 1 (card 12).

<u>Card Group 16 - Return Water</u>

Return water to any node may originate from as many as five other nodes. The model aggregates the initial concentration given the fraction from each node. Incremental changes specified on card 16b are then added to determine the return water concentration.

Card Number	Card Column	Format	Variable	Description
16a	1-5	I5	J1	Discharge junction
	6-10	I5	NTEMP(1)	Junctions from which discharge is withdrawn (NTEMP) and fraction of withdrawal which is discharged to junction J1(ALL)
	11-16	F5.0	ALL(1)	
	.		.	
	.		.	
	.		.	
	46-50		NTEMP(5)	
	51-55	F5.0	ALL(5)	

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 16 - Return Water - Cont.				
16b	1-5	14F5.0	ALL(1)	[redacted]
	6-10		ALL(2)	Incremental total nitrogen
	11-15		ALL(3)	Incremental total phosphorus
	16-20		ALL(4)	Incremental total coliforms
	21-25		ALL(5)	Incremental fecal coliforms
	26-30		ALL(6)	Incremental carbonaceous BOD
	31-35		ALL(7)	Incremental nitrogenous BOD
	36-40		ALL(8)	Incremental dissolved oxygen
	41-45		ALL(9)	Incremental temperature, °C
	46-50		ALL(10)	Incremental optional constituent #1
	51-55		ALL(11)	Incremental optional constituent #2
	56-60		ALL(12)	Incremental optional constituent #3
	61-65		ALL(13)	Incremental optional constituent #4

Repeat card group 16 as necessary terminating with a blank card. The blank card is not required if 20 sets of card group 16 are entered. Omit card group 16 if NTEMP(6) (card 11) = 1.

2-35-81

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description

Card Group 17 - Quality Coefficients

The following coefficients representing first order decay kinetics vary as a function of temperature, oxygen concentration, salinity, light intensity, wind speed and many other physical and chemical influences. Optional constituent may include any dissolved or particulate constituent with first order decay, settling and transfer between constituents (i.e., ammonia decay to nitrate). Rate coefficients of constituents which may be of interest have been included. Typical values (at 20°C) are as follows:

Chemical, Physical and Biological Coefficient	*Range of Values*
Stoichiometric equivalence between optional constituent decay	*.0-1.0*
Rate coefficient temperature adjustment constant	*1.02-1.08*
Carbonaceous BOD decay rate, day^{-1}	*.1-.3*
Nitrogenous BOD decay rate, day^{-1}	*.05-.15*
Coliform die-off rate, day^{-1}	*.5-8.0*
Total nitrogen benthic sink rate, mg/m^2/day	*0-500*
Total phosphorus benthic sink rate, mg/m^2/day	*0-200*
Algal photosynthetic oxygen production, mg/m^2/day	*0-15,000*
Algae oxygen consumption due to respiration, mg/m^2/day	*0-7,500*
Benthic oxygen demand rate, mg/m^2/day	*0-5,000*
Reaeration rate, days^{-1}	*.1-10.*
Ammonia decay, day^{-1}	*.05-.2*

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description

Card Group 17 - Quality Coefficients - Cont.

Chemical, Physical and Biological Coefficient	*Range of Values*
Nitrite decay, day^{-1}	*.2-1.*
Volatile suspended solids decay, day^{-1}	*.002-.05*
Suspended solids settling, meters/day	*0-2*

Card Number	Card Column	Format	Variable	Description
17a	1-5	5F5.0	TYPEEQ(1)	Fraction of an optional constituent produced with the decay at one unit of the preceding optional constituent (stoichiometric equivalence).
	6-10		TYPEEQ(2)	
	11-15		TYPEEQ(3)	
	16-20		QTEN(1)	Rate coefficient temperature adjustment constant for carbonaceous BOD decay (default = 1.05)
	21-25		QTEN(2)	Rate coefficient temperature adjustment constant for the remaining rate coefficients (default = 1.03)
17b	1-5	2I5	J1	Junction limits for which coefficients apply
	6-10		J2	
	11-15	4F5.0	ALL(2)	Carbonaceous BOD decay rate, day^{-1}
	16-20		ALL(3)	Nitrogenous BOD decay rate, day^{-1}
	21-25		ALL(4)	Total coliform die-off rate, day^{-1}
	26-30		ALL(5)	Fecal coliform die-off rate, day^{-1}

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 17 - Quality Coefficients - Cont.				
17c	1-5	15F5.0	ALL(6)	Total nitrogen benthic sink rate, mg/m^2/day
	6-10		ALL(7)	Total phosphorus benthic sink rate, mg/m^2/day
	11-15		ALL(8)	Algal photosynthetic oxygen production, mg/m^2/day
	16-20		ALL(9)	Algae oxygen consumption due to respiration, mg/m^2/day
	21-25		ALL(10)	Benthic oxygen demand rate, mg/m^2/day
	26-30		ALL(11)	Minimum reaeration rate, day^{-1}
	31-35		ALL(12)	Maximum reaeration rate, day^{-1}
	36-40		ALL(13)	Optional constituents #1 through #4 decay, day^{-1}
	41-45		ALL(14)	
	46-50		ALL(15)	
	51-55		ALL(16)	
	56-60		ALL(17)	Optional constituents #1 through #4 settling rate, meters/day
	61-65		ALL(18)	
	66-70		ALL(19)	
	71-75		ALL(20)	

One card 17a is required. Repeat sets of cards 17b and 17c as required terminating with a blank card. No blank card is required if NJ sets of card 17b and 17c are entered.

Omit card group 17 if NTEMP(7) = 1 (card 12).

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 18 - Meteorological Conditions				
18a	1-5	I5	NWZONE	Number of weather zones (5 max.)
	6-10	5F5.0	DAY	Julian date
	11-15		EPS	East west longitude switch (-1 for U.S.A.)
	16-20		AA	Evaporation coefficient a
	21-25		BB	Evaporation coefficient b (Default = 1.5×10^{-9})
	26-30		DEW	Wet bulb/dew point switch, dew = 1 for wet bulb temperature
Hourly meteorological conditions for each weather zone are computed by interpolation of the information supplied on card 18c.				
18b	1-5	2I5	JWZONE(1)	Junction limits of weather zone
	6-10		JWZONE(2)	
	11-15	3F5.0	XLAT	Latitude, degrees
	16-20		XLON	Longitude, degrees
	21-25		TURB	Atmospheric turbidity (2 for clear up to 5 for smog)
18c	1-5	I5	J2	Hour of observation
	6-10	5F5.0	CLOUD	Cloud cover, fraction
	11-15		DBT	Dry bulb temperature, °C

2-35-85

Table III-1 - Cont.

Card Number	Card Column	Format	Variable	Description
Card Group 18 - Meteorological Conditions - Cont.				
18c	16-20		WBT	Wet bulb or dew point temperature
	21-25		WIND	Wind speed, meters/sec
	26-30		APR	Atmospheric pressure, mb

A set of between 2 and 25 cards (type 18c) are required for each weather zone. Each set must begin with values for hour 1 and ending with values for hour 25. Repeat sets of cards 18b and 18c as required to define all weather zones (NWZONE sets).

Repeat card groups 11-18 as necessary to define all boundary conditions. There must be NHYD sets as specified on card 2.

PROGRAM ROUTINES

Figure III-1 summarizes the general structure of the tidally averaged quality model. The following brief description is intended to serve only as a guide to aid in the interpretation of model outputs. The reader is again referred to the documentation report for a more thorough treatment of model development, theoretical considerations, and solution techniques.

The main program AQUAL calls INPUT to read system geometry, hydrodynamics, input/output controls, boundary conditions, dispersion and system coefficients and inflow quality. INPUT calls METDAT to read meteorological conditions, compute derived conditions, and write results. Control then returns to AQUAL which directs SETUP, FORM and SOLVIT to compute salinity for dispersion coefficient computations. AQUAL then computes oxygen saturation based on salinity and temperature. SETUP is then called to set up the final coefficient matrix which is used in SOLVIT to compute the concentration of the water quality constituents in all nodes. The constituent concentrations are determined in the following order:

- [redacted]
- Temperature
- Optional coefficients (user specified)
- Total nitrogen
- Total phosphorus
- Total coliform
- Fecal coliform
- Carbonaceous BOD
- Nitrogenous BOD
- Dissolved oxygen

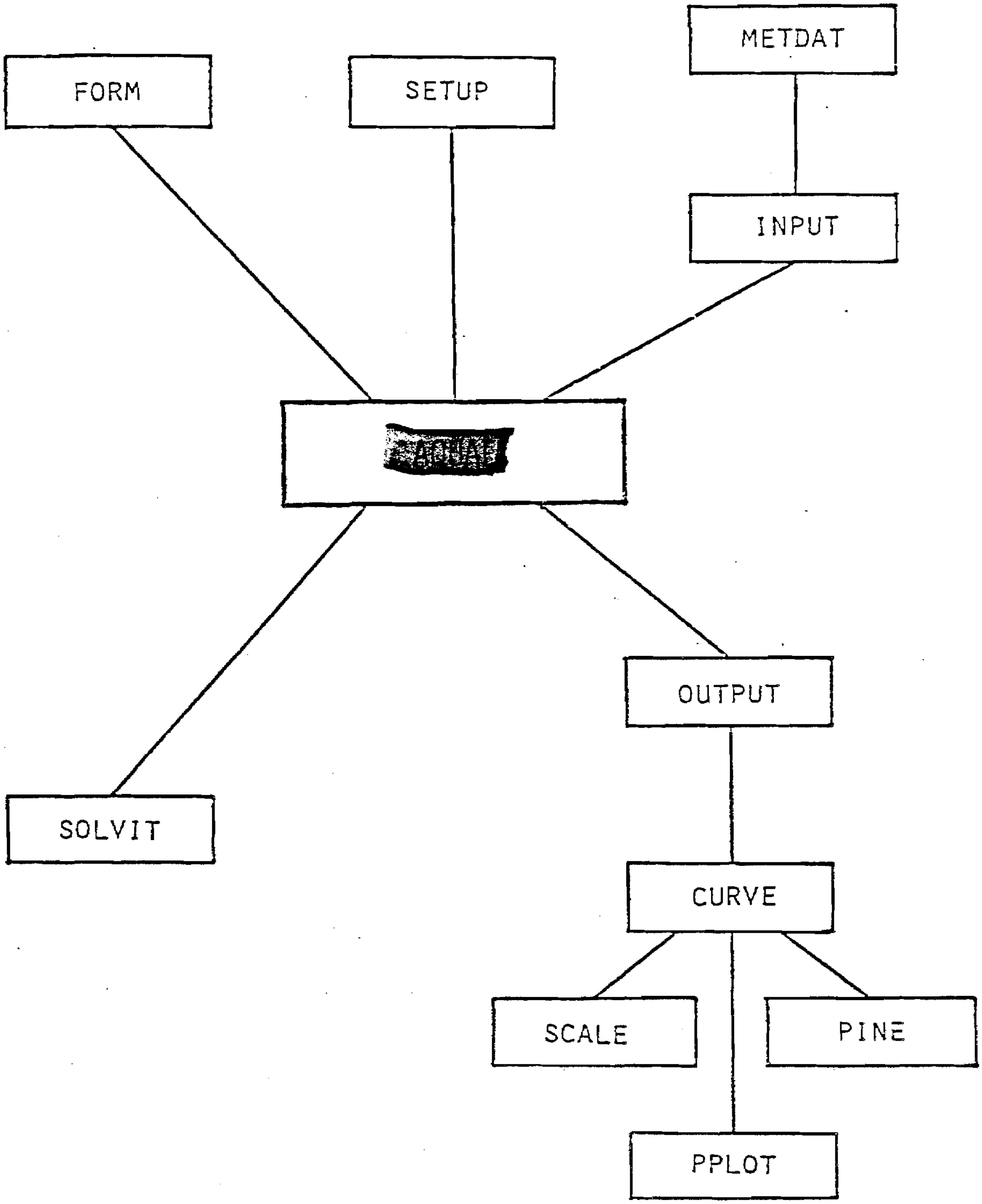


FIGURE III-1 TIDALLY AVERAGED QUALITY MODEL SUBROUTINES

AQUAL then calls OUTPUT which controls the remaining subroutines in printing and plotting the results. The process repeats for each set of boundary conditions.

INTERPRETATION OF RESULTS

Provided input formats are correct and program dimensions have not been exceeded the model will print out invariant data including computational control specifications, initial conditions, and dispersion parameters as shown in Appendix Table D-1 and D-2. The model will check the junction limits assigned to the initial conditions and print the following message if errors are found:

* ERROR * THE FOLLOWING NODE LIMITS ARE IN ERROR:

The remaining outputs will be repeated for each set of boundary conditions. Appendix Table D-3 shows an example of the output which summarizes exchange conditions, observed and aggregated† inflow quality, non-point inflow quality, return water quality, system coefficients, derived flow and wind induced reaeration coefficients, and coefficients used by nodes. If dimension limits have been exceeded the runstream will terminate and one of the following messages will be printed:

- WARNING ** THE MAXIMUM OF 100 INFLOW LOCATIONS HAS BEEN EXCEEDED.**
- * ERROR * A MAXIMUM OF 29 GROUNDWATER TYPES ARE ALLOWED.
- * ERROR * RETURN WATER IS ALLOWED AT 20 NODES MAXIMUM.

---

†The user may suppress this aggregated inflow quality printout.

Appendix Table D-4 shows an example of the printout of observed and derived meteorological data*. [redacted] Since calculation of dispersion coefficients is an iterative process, the last two values of the coefficients are printed for comparison. If there is a significant difference between the values, dispersion parameter C4 may need to be reduced or the number of iterations for computing dispersion coefficients increased. [redacted]

[redacted] Appendix Table D-7 shows the alternate output format. Examples of the plotting options are shown in Appendix Figures D-1 and D-2.

Calibration of the tidally averaged quality model is accomplished in two phases. The first is to simulate a conservative substance such as salinity to establish the mixing characteristics of the estuary.

The dispersion coefficients can not generally be specified *a priori*. The procedure is to start with values which have proven effective before and proceed, on a trial and error basis, to adjust the coefficients until model results compare reasonably well with field data. The model is then considered calibrated for advective and dispersive transport. The second phase of the model calibration is to adjust reaction rate coefficients (benthic oxygen demand, photosynthesis oxygenation, coliform decay, etc.) until *in situ* data are reasonably reproduced.

---

*The user may suppress this output.

2-35-90

2-35-91

APPENDIX

APPENDIX A

2-35-92

Table A-1

Hydrodynamic Model Input Card Specification

Card Group \ Col.	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
1a	UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM															
1b	SAMPLE PROBLEM															
2a	1	6	6	28	1	1	0	12	1							
2b	3															
3	1	12	26	49	56	117										
4	18	72	83	127	140	157										
5	1	117	49													
6	72	127	140													
7	1	3	5	7	10	11	12	14	17	20	23	26	101	104	106	109
	115	118	121	125	127	128	43	46	47	48	49	50				
8	100	3600	25	40												
9	01		999,+7		00,+6	150	610	470	01	02						
	02		850,+7		00,+6	130	600	527	01	03	04					
	03		850,+7		00,+6	140	654	525	02	03	05					
	04		900,+7		20,+6	150	624	564	04	06	07					
	05		690,+7		00,+6	130	665	574	05	06	08					
	06		500,+7		18,+6	100	645	636	07	09	10					
	07		760,+7		00,+6	100	682	619	08	09	12					
	08		370,+7		30,+6	080	652	661	10	11						
	09		420,+7		21,+6	050	688	701	11	14	15					
	10		690,+7		12,+6	080	702	655	12	13						
	11		460,+7		02,+6	100	714	693	13	14	16					
	12		240,+7		00,+6	130	711	729	15	16	17	18	19			
	13		120,+7		01,+6	070	735	744	17	21	22					
	14		097,+7		00,+6	100	724	754	18	20	21	23				
	16		140,+7		02,+6	053	759	756	22	25	27					
	15		200,+7		25,+6	110	704	756	19	20	24					
	17		135,+7		00,+6	085	746	770	23	25	26	28				
	18		197,+7		18,+6	70	730	781	24	26	29					
	19		140,+7		07,+6	047	786	770	27	30	32					
	20		161,+7		00,+6	095	772	785	28	30	31	33				
	21		168,+7		01,+6	025	762	799	29	31	34					
	22		116,+7		04,+6	055	806	768	32	35	37					
	23		176,+7		00,+6	080	796	809	33	35	36	38				
	24		165,+7		25,+6	060	788	832	34	36	39					
	25		088,+7		01,+6	070	822	799	37	40	42					
	26		120,+7		00,+6	060	817	820	38	40	41	101	102	100		
	27		095,+7		40,+6	022	815	841	39	41	44					
	28		067,+7		00,+6	065	839	808	42	47	100	103				
	31		070,+7		03,+6	050	854	799	47	51	53					
	32		067,+7		3,+6	43	861	814	48	51	54	55				
	35		092,+7		20,+6	020	864	788	53	75	77					
	36		058,+7		00,+6	036	874	802	54	75	76	78				
	37		25,+7		15,+6	9	869	824	55	56	126	127				
	43		039,+7		04,+6	035	901	865	65	66	67					
	44		023,+7		03,+6	025	901	878	66	69						
	45		025,+7		03,+6	025	913	870	67	68						
	46		051,+7		15,+6	015	915	864	68	69	70					
	47		026,+7		18,+6	012	929	867	70	71						
	48		013,+7		22,+6	0 6	938	896	71	72						
	49		005,+7		45,+6	2	950	899	72	73						
	50		002,+7		10,+6	1	959	901	73							
	52		036,+7		28,+6	8	882	810	56	76	79					
	53		102,+7		10,+6	030	887	788	77	78	80	89				

Table A-1 - (Cont.)

Hydrodynamic Model Input Card Specification

	54	049,+7	23,+6	010	895	800	79	81	89				
	55	059,+7	30,+6	020	906	787	80	81	82				
	56	062,+7	30,+6	020	925	784	82	83					
	57	38,+7	20,+6	15	943	777	83	84					
	58	25,+7	10,+6	12	957	771	84	85					
	59	32,+7	15,+6	12	974	771	85	86					
	60	18,+7	10,+6	10	989	759	86						
	100	580,+6	0,+6	80	843	820	101	103	104	48	106		
	101	516,+6	0,+6	75	839	829	102	104	105	107			
	102	340,+6	15,+6	10	835	839	44	105	108				
	103	229,+6	1,+6	60	853	829	106	109	111				
	104	231,+6	0,+6	50	850	835	107	109	110	112	113		
	105	156,+6	10,+6	10	847	843	108	110	114				
	106	149,+6	0,+6	80	860	836	111	112	115				
	107	108,+6	0,+6	30	857	842	113	116	117				
	108	90,+6	6,+6	6	855	847	114	116	118				
9	109	160,+6	0,+6	70	867	837	115	119	120	121			
	110	178,+6	5,+6	30	863	845	117	118	122				
	111	84,+6	0,+6	15	870	830	126	119	123	125			
	112	46,+6	2,5+6	15	873	831	127	125	124	128			
	113	54,+6	0,+6	45	874	835	120	123	124	129			
	114	52,+6	1,+6	30	879	836	128	129	131				
	115	124,+6	0,+6	55	875	840	121	130	132	133			
	116	149,+6	4,+6	40	873	846	122	130	134	135			
	117	41,+6	0,+6	45	881	840	131	132	136	138	139		
	118	56,+6	0,+6	60	881	843	133	134	136	137	140	141	
	119	60,+6	1,+6	35	881	846	135	137	142				
	120	30,+6	0,+6	30	886	840	136	143	145				
	121	40,+6	0,+6	90	886	843	139	140	143	144	146	147	148
	122	32,+6	,+6	50	886	846	141	142	144	149	150		
	123	33,+6	1,+6	30	890	841	145	146	151				
	124	44,+6	0,+6	55	894	844	147	151	152	154			
	125	33,+6	0,+6	70	891	846	148	149	152	153	155		
	126	37,+6	1,+6	40	889	848	150	153	156				
	127	96,+6	0,+6	95	895	851	154	155	156	157			
	128	136,+6	1,+6	50	897	858	157	65					
	01	090000	80000		130		.072	01	02		0000		
	02	90000	80000		130		.022	01	03		0000		
	03	089000	080000		200		.022	02	03		0000		
	04	100000	070000		120		.022	02	04		0000		
	05	080000	088000		130		.022	03	05		0000		
	06	064000	085000		120		.022	04	05		0000		
	07	092000	070000		130		.022	04	06		0100		
	08	077000	092000		105		.022	05	07		0000		
	09	056000	070000		050		.022	06	07		0000		
10	10	075000	040000		085		.025	06	08		0300		
	11	068000	040000		070		.025	08	09		0300		
	12	067000	110000		090		.022	07	10		0000		
	13	065000	095000		090		.072	10	11		0000		
	14	037000	055000		050		.022	09	11		0000		
	15	058000	040000		060		.022	09	12		0300		
	16	060000	055000		100		.022	11	12		0000		
	17	044000	023000		070		.075	12	13		0000		
	18	045000	023000		100		.022	12	14		0000		
	19	043000	030000		130		.022	12	15		0000		
	20	031000	038000		040		.022	14	15		0000		

Table A-1 - (Cont.)

Hydrodynamic Model Input Card Specification

10

21	025000	042000	080	.022	13	14	0000
22	044000	025000	080	.025	13	16	0000
23	044000	022000	140	.022	14	17	0000
24	058000	036000	130	.025	15	18	0500
25	033000	046000	070	.022	16	17	0000
26	031000	053000	040	.025	17	18	0000
27	050000	033000	050	.025	16	19	0100
28	048000	031000	100	.022	17	20	0000
29	058000	028000	100	.022	18	21	0050
30	033000	050000	070	.022	19	20	0000
31	028000	055000	100	.022	20	21	0000
32	044000	027000	040	.025	19	22	0200
33	055000	033000	090	.022	20	23	0000
34	068000	030000	070	.025	21	24	0100
35	037000	045000	060	.022	22	23	0000
36	039000	052000	100	.022	23	24	0000
37	032000	030000	060	.025	22	25	0050
38	038000	037000	085	.022	23	26	0000
39	046000	025000	030	.025	24	27	0700
40	035000	030000	080	.022	25	26	0000
41	035000	034000	070	.022	26	27	0000
42	031000	022000	065	.022	25	28	0000
44	38000	18000	7	.025	27	102	1200
47	029000	019000	040	.022	28	31	0000
48	32000	16000	50	.022	32	100	0
51	025000	028000	045	.022	31	32	0000
53	026000	026000	040	.025	31	35	0500
54	027000	022000	040	.022	32	36	0000
55	022000	022000	010	.025	32	37	0000
56	030000	022000	006	.025	37	52	1000
65	12500	13000	50	.020	43	128	30
66	020000	015000	025	.025	43	44	0100
67	022000	014000	020	.025	43	45	0100
68	023000	012000	20	.025	45	46	0100
69	025000	012000	20	.025	44	46	0100
70	023000	016000	8	.025	46	47	0800
71	021000	008000	3	.025	47	48	1000
72	020000	004000	1	.025	48	49	1000
73	018000	002000	0.5	.025	49	50	1000
75	024000	022000	030	.025	35	36	0000
76	018000	030000	010	.025	36	52	0000
77	033000	034000	030	.025	35	53	0400
78	031000	019000	035	.025	36	53	0000
79	028000	015000	68	.025	52	54	1000
80	032000	015000	040	.025	53	55	0100
81	028000	025000	010	.025	54	55	0500
82	031000	015000	35	.025	55	56	0200
83	030000	012000	25	.022	56	57	300
84	026000	010000	20	.022	57	58	400
85	027000	010000	15	.022	58	59	500
86	031000	6000	15	.022	59	60	350
89	24000	25000	15	.025	53	54	0
100	40000	12000	75	.020	26	28	0
101	41000	12000	75	.020	26	100	0
102	41000	18000	75	.020	26	101	0
103	18000	19000	60	.020	28	100	0
104	17300	27000	40	.020	100	101	0

Table A-1 - (Cont.)

Hydrodynamic Model Input Card Specification

	105	17600	30000	13	.020	101	102	0
	106	23000	14000	60	.020	100	103	0
	107	20500	15000	60	.020	101	104	0
	108	21000	10000	7	.025	102	105	700
	109	11300	15000	60	.020	103	104	0
	110	14000	17000	14	.025	104	105	0
	111	13800	9000	85	.020	103	106	0
	112	14100	7000	75	.020	104	106	0
	113	15200	8000	25	.022	104	107	0
	114	14000	7000	7	.025	105	108	500
	115	11500	12000	75	.020	106	109	30
	116	9400	11000	14	.025	107	108	0
	117	11400	6500	30	.022	107	110	0
	118	13600	6000	8	.025	108	110	300
	119	11300	5500	15	.025	109	111	0
	120	11500	4800	65	.020	109	113	0
	121	15200	8700	50	.020	109	115	0
	122	15200	12700	35	.022	110	116	150
	123	8500	5500	15	.022	111	113	0
	124	6000	5800	15	.025	112	113	0
	125	7700	7000	10	.025	111	112	0
	126	11000	7000	15	.025	37	111	0
	127	15000	4000	5	.025	37	112	250
	128	11000	3700	15	.025	112	114	70
10	129	9700	4200	40	.022	113	114	0
	130	10300	11500	35	.020	115	116	0
	131	8200	3800	35	.020	114	117	25
	132	10600	4500	55	.020	115	117	0
	133	12000	4800	60	.020	115	118	0
	134	14500	4000	40	.020	116	118	0
	135	14200	6500	35	.022	116	119	50
	136	8000	10000	60	.020	117	118	0
	137	8000	10000	60	.020	118	119	0
	138	7000	4000	30	.022	117	120	0
	139	8000	3000	75	.020	117	121	0
	140	7300	4000	75	.020	118	121	0
	141	6200	3000	85	.020	118	122	0
	142	7300	3800	35	.022	119	122	60
	143	10000	8000	60	.020	120	121	0
	144	10000	8000	60	.020	121	122	0
	145	6800	4300	30	.022	120	123	20
	146	7000	3300	40	.022	121	123	0
	147	12000	2300	75	.020	121	124	0
	148	10100	2700	80	.020	121	125	0
	149	9000	2500	75	.020	122	125	0
	150	6600	3500	40	.022	122	126	40
	151	6600	4800	35	.022	123	124	20
	152	8000	10000	60	.020	124	125	0
	153	8000	10000	60	.020	125	126	0
	154	12000	3500	80	.020	124	127	0
	155	10100	3500	80	.020	125	127	0
	156	9900	3000	50	.020	126	127	20
	157	11800	8000	75	.020	127	128	30

11 WATER YEAR 1972 AVERAGE TRIBUTARY INFLOWS

12 0 0 0 0 0 0 0

13 1

Table A-1 - (Cont.)

Hydrodynamic Model Input Card Specification

14a	1	6	50	1												
14b	-2.9	-6.5	3.4	7.4	9.6	-9.	16.	7.6	22.1	-6.5	28.4	7.4				
15	1	130	3.													
16a	1	160														
16b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0														
17	11	4600.														
	27	33000.														
	45	470.														
	48	120.														
	50	10860.														
	60	1000.														
	108	600.														
	117	75.														
	124	110.														
18	1	130	0													
19																

APPENDIX B

Table B-1

Node Renumbering Scheme

CROSS REFERENCE - - INTERNAL NODE NUMBER VS, EXTERNAL NODE NUMBER (USED IN QUALITY PROGRAM AQUAL)

1	1	2	2	3	3	4	4	5	5	6	6	7	7	8	8	9	10	10	9
11	11	12	12	13	13	14	14	15	15	16	16	17	17	18	18	19	19	20	20
21	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29	100	30	101
31	102	32	31	33	32	34	103	35	104	36	105	37	35	38	36	39	37	40	106
41	107	42	108	43	53	44	52	45	111	46	112	47	109	48	110	49	55	50	54
51	113	52	114	53	115	54	116	55	56	56	117	57	118	58	119	59	57	60	120
61	121	62	122	63	58	64	123	65	124	66	125	67	126	68	59	69	127	70	60
71	128	72	43	73	44	74	45	75	46	76	47	77	48	78	49	79	50		

THE WIDEST TOTAL BAND WIDTH IS 14 , THE HIGH SIDE MAXIMUM WIDTH IS 7 , AND THE LOW SIDE MAXIMUM WIDTH IS 7

2-35-99

Table B-2

Computational and Output Control Options

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
SAMPLE PROBLEM

NUMBER OF HYDRAULIC CONDITIONS	1
NUMBER OF TIDAL CYCLES PER CONDITION	3
NUMBER OF HYDRAULIC TIME STEPS PER CYCLE	900
NUMBER OF QUALITY TIME STEPS PER CYCLE	25
NUMBER OF TIDAL STAGE PLOTS	1
NUMBER OF TIDAL VELOCITY PLOTS	1
DYNAMIC HYDRAULIC OUTPUT UNIT	0
STEADY STATE HYDRAULICS OUTPUT UNIT	12
TIDAL PERIOD, HOURS	25.

RESULTS PRINTED AT THE FOLLOWING 6 JUNCTIONS

1 12 26 49 56 117

AND FOR THE FOLLOWING 6 CHANNELS

18 72 83 127 140 157

FOLLOWING PLOTS ARE MADE

TIDAL STAGE FOR JUNCTIONS	1	117	49
TIDAL FLOW FOR CHANNELS	72	127	140

Table B-3

Invariant Channel Data

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
SAMPLE PROBLEM

INVARIANT CHANNEL DATA

CHANNEL	LENGTH, FT	WIDTH, FT	HYD RAD, FT	MIN ELEV, FT	MANNINGS N	END JUNCTIONS		SIDE SLOPE	MAX TIME, SEC
1	90000.	80000.	130.0	130.0	.022	1	2	0.	1295.
2	90000.	80000.	130.0	130.0	.022	1	3	0.	1295.
3	89000.	80000.	200.0	200.0	.022	2	3	0.	1057.
4	100000.	70000.	120.0	120.0	.022	2	4	0.	1489.
5	80000.	80000.	130.0	130.0	.022	3	5	0.	1151.
6	64000.	85000.	120.0	120.0	.022	4	5	0.	953.
7	92000.	70000.	130.0	145.1	.022	4	6	100.	1324.
8	77000.	92000.	105.0	105.0	.022	5	7	0.	1214.
9	66000.	70000.	50.0	50.0	.022	6	7	0.	1390.
10	75000.	40000.	65.0	133.3	.025	6	8	300.	1290.
11	68000.	40000.	70.0	133.3	.025	8	9	300.	1263.
12	67000.	110000.	90.0	90.0	.022	7	10	0.	1126.
13	65000.	95000.	90.0	90.0	.022	10	11	0.	1092.
14	37000.	55000.	50.0	50.0	.022	9	11	0.	779.
15	58000.	40000.	60.0	91.2	.022	9	12	300.	1143.
16	60000.	55000.	100.0	100.0	.022	11	12	0.	965.
17	44000.	23000.	70.0	70.0	.025	12	13	0.	817.
18	45000.	23000.	100.0	100.0	.022	12	14	0.	724.
19	43000.	30000.	130.0	130.0	.022	12	15	0.	619.
20	31000.	38000.	40.0	40.0	.022	14	15	0.	705.
21	25000.	42000.	80.0	80.0	.022	13	14	0.	441.
22	44000.	25000.	80.0	80.0	.025	13	16	0.	775.
23	44000.	22000.	140.0	140.0	.022	14	17	0.	613.
24	58000.	36000.	130.0	72.0	.025	15	18	500.	835.
25	33000.	46000.	70.0	70.0	.022	16	17	0.	613.
26	31000.	53000.	40.0	40.0	.025	17	18	0.	705.
27	50000.	33000.	50.0	54.6	.025	16	19	100.	1053.
28	48000.	31000.	100.0	100.0	.022	17	20	0.	772.
29	58000.	20000.	100.0	111.1	.022	18	21	50.	933.
30	33000.	50000.	70.0	70.0	.022	19	20	0.	613.
31	20000.	55000.	100.0	100.0	.022	20	21	0.	450.
32	44000.	27000.	40.0	40.9	.025	19	22	200.	1001.
33	55000.	33000.	90.0	90.0	.022	20	23	0.	924.
34	60000.	30000.	70.0	81.0	.025	21	24	100.	1263.
35	37000.	45000.	60.0	60.0	.022	22	23	0.	729.
36	39000.	52000.	100.0	100.0	.022	23	24	0.	627.
37	32000.	30000.	60.0	63.4	.025	22	25	50.	630.
38	38000.	37000.	85.0	85.0	.022	23	26	0.	654.
39	46000.	25000.	30.0	35.7	.025	24	27	700.	1146.
40	35000.	30000.	80.0	80.0	.022	25	26	0.	617.
41	35000.	38000.	70.0	70.0	.022	26	27	0.	650.
42	31000.	22000.	65.0	65.0	.022	25	28	0.	593.
44	39000.	18000.	7.0	11.2	.025	27	102	1200.	1289.
47	27000.	19000.	40.0	40.0	.022	28	31	0.	660.
48	32000.	16000.	50.0	50.0	.022	32	100	0.	674.

NOTE - - * INDICATES NEGATIVE WIDTH IS POSSIBLE WITH ANTICIPATED TIDAL STAGE

Table B-3 - (Cont.)

Invariant Channel Data

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
SAMPLE PROBLEM

INVARIANT CHANNEL DATA

CHANNEL	LENGTH, FT	WIDTH, FT	HYD RAD, FT	MIN ELEV, FT	MANNINGS N	END JUNCTIONS		SIDE SLOPE	MAX TIME, SEC
51	25000.	28000.	45.0	45.0	.022	31	32	0.	546.
53	26000.	28000.	40.0	56.0	.025	31	35	500.	592.
54	27000.	22000.	40.0	40.0	.022	32	36	0.	614.
55	22000.	22000.	10.0	10.0	.025	32	37	0.	708.
56	30000.	22000.	6.0	7.2	.025	37	52	1000.	1037.
65	12500.	13000.	50.0	53.3	.020	43	128	30.	263.
66	20000.	15000.	25.C	27.6	.025	43	44	100.	525.
67	22000.	14000.	20.0	21.7	.025	43	45	100.	613.
68	23000.	12000.	20.0	22.1	.025	45	46	100.	641.
69	25000.	12000.	20.0	22.1	.025	44	46	100.	697.
70	23000.	16000.	8.0	11.1	.025	46	47	800.	766.
71	21000.	8000.	3.0	4.1	.025	47	48	1000.	772.
72	20000.	4000.	1.0	1.2	.025	48	49	1000.	769.
73	18000.	2000.	.5	.6	.025	49	50	1000.	701.
75	24000.	22000.	30.0	30.0	.025	35	36	0.	598.
76	18000.	30000.	10.0	10.0	.025	36	52	0.	579.
77	33000.	30000.	30.0	41.5	.025	35	53	400.	822.
78	31000.	19000.	35.0	35.0	.025	36	53	0.	737.
79*	28000.	15000.	68.0	15.0	.025	52	54	1000.	526.
80	32000.	15000.	40.0	47.6	.025	53	55	100.	728.
81	28000.	25000.	10.0	11.3	.025	54	55	500.	901.
82	31000.	15000.	35.0	55.7	.025	55	56	200.	737.
83	30000.	12000.	25.0	40.0	.022	56	57	300.	788.
84	26000.	10000.	20.0	25.0	.022	57	58	400.	724.
85	27000.	10000.	15.0	20.0	.022	58	59	500.	804.
86*	31000.	6000.	15.0	17.1	.022	59	60	350.	923.
89	24000.	25000.	15.0	15.0	.025	53	54	0.	715.
100	40000.	12000.	75.0	75.0	.020	26	28	0.	723.
101	41000.	12000.	75.0	75.0	.020	26	100	0.	741.
102	41000.	18000.	75.0	75.0	.020	26	101	0.	741.
103	18000.	19000.	60.0	60.0	.020	28	100	0.	355.
104	17300.	27000.	40.0	40.0	.020	100	101	0.	394.
105	17600.	30000.	13.0	13.0	.020	101	102	0.	540.
106	23000.	14000.	60.0	60.0	.020	100	103	0.	453.
107	20500.	15000.	60.0	60.0	.020	101	104	0.	404.
108	21000.	10000.	7.0	12.3	.025	102	105	700.	712.
109	11300.	15000.	60.0	60.0	.020	103	104	0.	223.
110	14000.	17000.	14.0	14.0	.025	104	105	0.	423.
111	13800.	9000.	85.0	85.0	.020	103	106	0.	237.
112	14100.	7000.	75.0	75.0	.020	104	106	0.	255.
113	15200.	8000.	25.0	25.0	.022	104	107	0.	399.
114	14000.	7000.	7.0	14.0	.025	105	108	500.	475.
115	11500.	12000.	75.0	63.8	.020	106	109	30.	208.
116	9400.	11000.	14.0	14.0	.025	107	108	0.	284.
117	11400.	8500.	30.0	30.0	.022	107	110	0.	284.

NOTE - - * INDICATES NEGATIVE WIDTH IS POSSIBLE WITH ANTICIPATED TIDAL STAGE

2-35-102

Table B-3 - (Cont.)

Invariant Channel Data

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
SAMPLE PROBLEM

INVARIANT CHANNEL DATA

CHANNEL	LENGTH, FT	WIDTH, FT	HYD RAD, FT	MIN ELEV, FT	MANNINGS N	END JUNCTIONS		SIDE SLOPE	MAX TIME, SEC
118	13500.	6000.	8.0	11.1	.025	108	110	300.	460.
119	11300.	5500.	15.0	15.0	.025	109	111	0.	337.
120	11500.	4800.	65.0	65.0	.020	109	113	0.	220.
121	15200.	8700.	50.0	50.0	.020	109	115	0.	320.
122	15200.	12700.	35.0	49.5	.022	110	116	150.	361.
123	8500.	5500.	15.0	15.0	.022	111	113	0.	253.
124	6000.	5800.	15.0	15.0	.025	112	113	0.	179.
125	7700.	7000.	10.0	10.0	.025	111	112	0.	248.
126	11000.	7000.	15.0	15.0	.025	37	111	0.	324.
127	15000.	4000.	5.0	6.3	.025	37	112	250.	529.
128	11000.	3700.	15.0	18.1	.025	112	114	70.	328.
129	9700.	4200.	40.0	40.0	.022	113	114	0.	221.
130	10300.	11500.	35.0	35.0	.020	115	116	0.	245.
131	8200.	3800.	35.0	40.4	.020	114	117	25.	195.
132	10500.	4500.	55.0	55.0	.020	115	117	0.	220.
133	12000.	4800.	60.0	60.0	.020	115	118	0.	236.
134	14500.	4000.	40.0	40.0	.020	116	118	0.	330.
135	14200.	6500.	35.0	41.7	.022	116	119	50.	337.
136	8000.	10000.	60.0	60.0	.020	117	118	0.	158.
137	8000.	10000.	60.0	60.0	.020	118	119	0.	158.
138	7000.	4000.	30.0	30.0	.022	117	120	0.	174.
139	8000.	3000.	75.0	75.0	.020	117	121	0.	145.
140	7300.	4000.	75.0	75.0	.020	118	121	0.	132.
141	8200.	3000.	85.0	85.0	.020	118	122	0.	141.
142	7300.	3800.	35.0	63.3	.022	119	122	60.	173.
143	10000.	8000.	60.0	60.0	.020	120	121	0.	197.
144	10000.	8000.	60.0	60.0	.020	121	122	0.	197.
145	6800.	4300.	30.0	32.5	.022	120	123	20.	169.
146	7000.	3300.	40.0	40.0	.022	121	123	0.	159.
147	12000.	2300.	75.0	75.0	.020	121	124	0.	217.
148	10100.	2700.	80.0	80.0	.020	121	125	0.	178.
149	9000.	2500.	75.0	75.0	.020	122	125	0.	163.
150	6800.	3800.	40.0	57.3	.022	122	126	40.	155.
151	6000.	4800.	35.0	38.1	.022	123	124	20.	162.
152	8000.	10000.	60.0	60.0	.020	124	125	0.	158.
153	8000.	10000.	60.0	60.0	.020	125	126	0.	158.
154	12000.	3500.	80.0	80.0	.020	124	127	0.	211.
155	10100.	3500.	80.0	80.0	.020	125	127	0.	178.
156	9900.	3000.	50.0	63.4	.020	126	127	20.	209.
157	11800.	8000.	75.0	90.3	.020	127	128	30.	213.

NOTE - - * INDICATES NEGATIVE WIDTH IS POSSIBLE WITH ANTICIPATED TIDAL STAGE

Table B-4

Invariant Node Data

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
SAMPLE PROBLEM

INVARIANT JUNCTION DATA

JUNCTION	AREA, MSF	SLOPE, MSF/FT	DEPTH, FT	MIN ELEV, FT	X-CORD	Y-CORD	CHANNELS ENTERING JUNCTION							
1	9990.	.0	150.0	150.0	610.0	470.0	1	2	0	0	0	0	0	0
2	8500.	.0	130.0	130.0	600.0	527.0	1	3*	4	0	0	0	0	0
3	8500.	.0	140.0	140.0	654.0	525.0	2	3*	5	0	0	0	0	0
4	9000.	20.0	150.0	190.2	624.0	584.0	4	6	7	0	0	0	0	0
5	6900.	.0	130.0	130.0	665.0	574.0	5	6	8	0	0	0	0	0
6	5000.	18.0	100.0	130.8	645.0	636.0	7*	9	10*	0	0	0	0	0
7	7600.	.0	100.0	100.0	682.0	619.0	8*	9	12	0	0	0	0	0
8	3700.	30.0	80.0	123.3	652.0	681.0	10*	11*	0	0	0	0	0	0
9	4200.	21.0	50.0	58.6	688.0	701.0	11*	14	15*	0	0	0	0	0
10	6900.	12.0	80.0	86.6	702.0	655.0	12*	13*	0	0	0	0	0	0
11	4600.	2.0	100.0	102.3	714.0	693.0	13	14	16	0	0	0	0	0
12	2400.	.0	130.0	130.0	711.0	729.0	15	16	17	18	19	0	0	0
13	1200.	1.0	70.0	72.2	735.0	744.0	17	21*	22*	0	0	0	0	0
14	970.	.0	100.0	100.0	724.0	754.0	18	20	21	23*	0	0	0	0
15	2000.	25.0	110.0	80.0	704.0	756.0	19*	20	24	0	0	0	0	0
16	1400.	2.0	53.0	55.2	759.0	756.0	22*	25*	27	0	0	0	0	0
17	1350.	.0	85.0	85.0	746.0	770.0	23*	25	26	28*	0	0	0	0
18	1970.	18.0	70.0	109.4	730.0	781.0	24	26	29*	0	0	0	0	0
19	1400.	7.0	47.0	54.4	786.0	770.0	27*	30*	32	0	0	0	0	0
20	1610.	.0	95.0	95.0	772.0	765.0	28*	30	31*	33	0	0	0	0
21	1680.	1.0	85.0	87.3	762.0	799.0	29*	31*	34	0	0	0	0	0
22	1160.	4.0	55.0	61.6	806.0	788.0	32	35	37*	0	0	0	0	0
23	1760.	.0	80.0	80.0	796.0	809.0	33*	35	36*	38*	0	0	0	0
24	1650.	25.0	60.0	66.0	788.0	832.0	34*	36*	39	0	0	0	0	0
25	880.	1.0	70.0	73.1	822.0	799.0	37	40*	42	0	0	0	0	0
26	1200.	.0	80.0	80.0	817.0	820.0	38*	40	41	101	102	100	0	0
27	950.	40.0	22.0	23.7	815.0	841.0	39*	41*	44	0	0	0	0	0
28	670.	.0	65.0	65.0	639.0	808.0	42	47	100*	103	0	0	0	0
31	700.	3.0	50.0	57.0	854.0	799.0	47	51	53	0	0	0	0	0
32	670.	3.0	43.0	48.3	861.0	814.0	48*	51	54	55	0	0	0	0
35	920.	20.0	20.0	29.4	864.0	788.0	53*	75*	77*	0	0	0	0	0
36	580.	.0	36.0	36.0	874.0	802.0	54*	75	76	78	0	0	0	0
37**	250.	15.0	9.0	16.7	869.0	824.0	55	56	126	127	0	0	0	0
43	390.	4.0	35.0	45.8	901.0	865.0	65*	66	67	0	0	0	0	0
44	230.	3.0	25.0	31.5	901.0	878.0	66	69	0	0	0	0	0	0
45	250.	3.0	25.0	30.7	913.0	870.0	67	68	0	0	0	0	0	0
46	510.	15.0	15.0	22.4	915.0	884.0	68	69	70	0	0	0	0	0
47**	260.	18.0	12.0	14.4	929.0	887.0	70	71	0	0	0	0	0	0
48**	130.	22.0	6.0	5.9	938.0	896.0	71	72	0	0	0	0	0	0
49**	50.	45.0	2.0	1.1	950.0	899.0	72*	73	0	0	0	0	0	0
50	20.	10.0	1.0	2.0	959.0	901.0	73	0	0	0	0	0	0	0
52**	360.	28.0	8.0	12.9	882.0	810.0	56	76	79*	0	0	0	0	0
53	1020.	10.0	30.0	36.6	887.0	788.0	77*	78	80*	89	0	0	0	0
54	490.	23.0	10.0	16.1	895.0	800.0	79	81	89	0	0	0	0	0
55**	590.	30.0	20.0	19.7	906.0	787.0	80*	81	82*	0	0	0	0	0

NOTE - - * INDICATES THAT DEPTH OF CHANNEL ENTERING JUNCTION IS LARGER THAN JUNCTION DEPTH
** INDICATES NEGATIVE VOLUME OR AREA IS POSSIBLE WITH ANTICIPATED TIDAL STAGE

Table B-4 - (Cont.)

Invariant Node Data

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
SAMPLE PROBLEM

INVARIANT JUNCTION DATA

JUNCTION	AREA, MSF	SLOPE, MSF/FT	DEPTH, FT	MIN ELEV, FT	X-CORD	Y-CORD	CHANNELS ENTERING JUNCTION							
56	620.	30.0	20.0	20.7	925.0	784.0	82*	83*	0	0	0	0	0	0
57**	380.	20.0	15.0	19.0	943.0	777.0	83*	84*	0	0	0	0	0	0
58	230.	10.0	12.0	20.1	957.0	771.0	84*	65	0	0	0	0	0	0
59	320.	15.0	12.0	21.3	974.0	771.0	85	86	0	0	0	0	0	0
60**	180.	10.0	10.0	18.0	989.0	759.0	86	0	0	0	0	0	0	0
100	580.	.0	80.0	80.0	843.0	820.0	101	103	104	48	106	0	0	0
101	516.	.0	75.0	75.0	839.0	829.0	102	104	105	107	0	0	0	0
102	340.	15.0	10.0	14.9	835.0	839.0	44	105	108	0	0	0	0	0
103	227.	1.0	60.0	71.1	853.0	829.0	106	109	111*	0	0	0	0	0
104	231.	.0	50.0	50.0	850.0	835.0	107*	109*	110	112*	113	0	0	0
105**	156.	10.0	10.0	15.6	847.0	843.0	108	110	114	0	0	0	0	0
106	149.	.0	80.0	80.0	860.0	836.0	111*	112	115*	0	0	0	0	0
107	108.	.0	30.0	30.0	857.0	842.0	113	116	117	0	0	0	0	0
108**	90.	6.0	8.0	15.0	855.0	847.0	114	116	118	0	0	0	0	0
109	160.	.0	70.0	70.0	867.0	837.0	115*	119	120	121	0	0	0	0
110	178.	5.0	30.0	35.6	863.0	845.0	117	118	122*	0	0	0	0	0
111	84.	.0	15.0	15.0	870.0	830.0	126	119	123	125	0	0	0	0
112**	46.	2.5	15.0	18.4	873.0	831.0	127	125	124	128	0	0	0	0
113	54.	.0	45.0	45.0	874.0	835.0	120*	123	124	129	0	0	0	0
114	52.	1.0	30.0	52.0	879.0	836.0	128	129	131	0	0	0	0	0
115	124.	.0	55.0	55.0	875.0	840.0	121	130	132	133*	0	0	0	0
116	149.	4.0	40.0	37.2	873.0	846.0	122*	130	134*	135*	0	0	0	0
117	41.	.0	45.0	45.0	881.0	840.0	131	132*	136*	138	139*	0	0	0
118	56.	.0	60.0	60.0	881.0	843.0	133	134	136	137	140*	141*	0	0
119	60.	1.0	35.0	60.0	881.0	846.0	135	137	142*	0	0	0	0	0
120	30.	.0	30.0	30.0	886.0	840.0	138	143*	145*	0	0	0	0	0
121	40.	.0	90.0	90.0	886.0	843.0	139	140	143	144	146	147	148	0
122	32.	.0	50.0	50.0	886.0	846.0	141*	142*	144*	149*	150*	0	0	0
123	33.	1.0	30.0	33.0	890.0	841.0	145	146*	151*	0	0	0	0	0
124	44.	.0	55.0	55.0	894.0	844.0	147*	151	152*	154*	0	0	0	0
125	33.	.0	70.0	70.0	891.0	846.0	148*	149*	152	153	155*	0	0	0
126	37.	1.0	40.0	37.0	889.0	848.0	150*	153*	156*	0	0	0	0	0
127	96.	.0	95.0	95.0	895.0	851.0	154	155	156	157	0	0	0	0
128	136.	1.0	50.0	66.1	897.0	858.0	157*	65	0	0	0	0	0	0

NOTE - - * INDICATES THAT DEPTH OF CHANNEL ENTERING JUNCTION IS LARGER THAN JUNCTION DEPTH
** INDICATES NEGATIVE VOLUME OR AREA IS POSSIBLE WITH ANTICIPATED TIDAL STAGE

ESTUARY STATISTICS (AT MSL)
TOTAL VOLUME, CU FT .1117+14
TOTAL SURFACE AREA, SQ FT .1122+12
MEAN DEPTH, FT .9954+02

Table B-5

Tidal Time-Stage Data

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
WATER YEAR 1972 AVERAGE TRIBUTARY INFLOWS

TIDAL COEFFICIENTS FOR JUNCTION 1

-,1307 -,8067 7,5438 -,1313 ,7974 -1,0495 -,0606

TIME	OBSERVED	COMPUTED	DIFF
-2,9000	-6,5000	-6,4705	,0295
3,4000	7,4000	7,3798	-,0202
9,6000	-9,0000	-9,0190	-,0190
16,0000	7,6000	7,5996	-,0004
22,1000	-6,5000	-6,4705	,0295
28,4000	7,4000	7,3798	-,0202
-1,3250	-4,4637	-4,5220	-,0584
,2500	,4500	,4346	-,0154
1,8250	5,3636	5,4342	,0745
4,9500	4,9974	4,9040	-,0934
6,5000	-,8000	-,7725	,0275
8,0500	-6,5974	-6,5193	,0781
11,2000	-6,5681	-6,6396	-,0715
12,8000	-,7000	-,6810	,0190
14,4000	5,1681	5,2223	,0542
17,5250	5,5343	5,4829	-,0514
19,0500	,5500	,5239	-,0261
20,5750	-4,4344	-4,3719	,0625
23,6750	-4,4637	-4,5221	-,0584
25,2500	,4500	,4345	-,0155
26,8250	5,3636	5,4381	,0745
TOTAL			,8993

SUMMARY BY HOUR

1	3,02	2	5,85	3	7,30	4	6,93	5	4,76	6	1,24	7	-2,80	8	-6,37	9	-8,59	10	-8,89
11	-7,19	12	-3,91	13	,14	14	3,97	15	6,65	16	7,60	17	6,65	18	4,12	19	,70	20	-2,73
21	-5,32	22	-6,45	23	-5,85	24	-3,67	25	-,44	26	3,02								

Table B-6

Summary of Boundary Conditions

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
WATER YEAR 1972 AVERAGE TRIBUTARY INFLOWS

JUNCTION	TO JUNCTION	EVAPORATION RATE, INCHES/MONTH
1	130	3.00

HOURLY WIND VELOCITY (MPH) AND DIRECTION (DEGREES CLOCKWISE FROM NORTH)
CHANNEL TO CHANNEL

1	160	1	.0	0.	2	.0	0.	3	.0	0.	4	.0	0.	5	.0	0.
		6	.0	0.	7	.0	0.	8	.0	0.	9	.0	0.	10	.0	0.
		11	.0	0.	12	.0	0.	13	.0	0.	14	.0	0.	15	.0	0.
		16	.0	0.	17	.0	0.	18	.0	0.	19	.0	0.	20	.0	0.
		21	.0	0.	22	.0	0.	23	.0	0.	24	.0	0.	25	.0	0.

INFLOW AND OUTFLOW DATA

JUNCTION	INFLOW, CFS	WITHDRAWL, CFS
11	4600.00	.00
27	33000.00	.00
45	470.00	.00
48	120.00	.00
50	10680.00	.00
60	1000.00	.00
108	600.00	.00
117	75.00	.00
124	110.00	.00

JUNCTION	TO JUNCTION	GROUND WATER INFLOW, CFS
1	130	.00

JUNCTION STORM WATER INFLOW, HOUR AND FLOW, CFS

2-35-107

Table B-7

Computed Time-Stage at Selected Nodes

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
WATER YEAR 1972 AVERAGE TRIBUTARY INFLOWS

HOUR	JUNCTION 1 HEAD(FEET)	JUNCTION 12 HEAD(FEET)	JUNCTION 26 HEAD(FEET)	JUNCTION 49 HEAD(FEET)	JUNCTION 56 HEAD(FEET)	JUNCTION 117 HEAD(FEET)
1.00	3.02	-7.28	-10.12	10.78	-2.82	-9.40
2.00	5.85	-3.23	-11.20	9.86	-7.14	-12.47
3.00	7.30	1.33	-6.79	9.06	-11.12	-11.99
4.00	6.93	5.31	-.14	8.35	-11.01	-4.61
5.00	4.76	8.07	5.83	7.71	-2.52	3.81
6.00	1.24	8.98	10.35	7.15	5.16	10.41
7.00	-2.80	7.74	12.68	7.27	11.25	14.13
8.00	-6.37	4.40	11.96	9.46	15.05	14.79
9.00	-8.59	.79	8.45	12.16	15.01	12.20
10.00	-8.89	-2.65	3.51	13.64	11.09	7.09
11.00	-7.19	-6.14	-1.69	12.86	7.12	1.11
12.00	-3.91	-9.12	-6.62	11.74	2.46	-4.52
13.00	.14	-10.33	-10.86	10.72	-2.22	-9.38
14.00	3.97	-7.61	-13.63	9.81	-6.72	-13.36
15.00	6.65	-1.91	-12.17	9.02	-11.19	-15.63
16.00	7.60	2.86	-4.39	8.31	-14.76	-10.74
17.00	6.65	6.93	2.42	7.68	-7.16	-.99
18.00	4.12	9.23	8.48	7.12	.21	7.01
19.00	.70	9.54	12.32	6.63	8.13	12.93
20.00	-2.73	7.58	13.65	7.88	13.84	15.56
21.00	-5.32	4.17	11.65	10.80	16.48	15.15
22.00	-6.45	.81	7.76	13.50	14.58	11.49
23.00	-5.85	-2.35	2.76	14.22	10.63	5.95
24.00	-3.67	-5.44	-2.19	13.09	6.42	.12
25.00	-.44	-7.53	-6.66	11.92	1.70	-5.06
26.00	3.02	-7.26	-10.09	10.87	-2.85	-9.38
27.00	5.85	-3.22	-11.18	9.94	-7.16	-12.44
28.00	7.30	1.34	-6.78	9.13	-11.13	-11.96
29.00	6.93	5.31	-.14	8.41	-10.98	-4.60
30.00	4.76	8.07	5.83	7.77	-2.52	3.81
31.00	1.24	8.98	10.35	7.20	5.16	10.42
32.00	-2.80	7.73	12.68	7.31	11.25	14.13
33.00	-6.37	4.40	11.95	9.50	15.05	14.79
34.00	-8.59	.79	6.45	12.19	15.00	12.19
35.00	-8.89	-2.66	3.50	13.66	11.09	7.09
36.00	-7.19	-6.14	-1.69	12.87	7.11	1.11
37.00	-3.91	-9.12	-6.62	11.75	2.46	-4.52
38.00	.14	-10.33	-10.87	10.73	-2.22	-9.38
39.00	3.97	-7.61	-13.63	9.82	-6.73	-13.37
40.00	6.66	-1.91	-12.17	9.02	-11.19	-15.63
41.00	7.60	2.87	-4.38	8.31	-14.76	-10.74
42.00	6.65	6.93	2.42	7.68	-7.16	-.99
43.00	4.12	9.23	8.49	7.12	.21	7.01
44.00	.70	9.54	12.32	6.63	8.13	12.93
45.00	-2.73	7.58	13.65	7.89	13.84	15.56
46.00	-5.32	4.17	11.85	10.80	16.48	15.15
47.00	-6.45	.81	7.76	13.50	14.58	11.49
48.00	-5.85	-2.35	2.76	14.22	10.63	5.95
49.00	-3.67	-5.44	-2.19	13.09	6.42	.12
50.00	-.44	-7.53	-6.66	11.92	1.70	-5.06

Table B-8

Computed Flow and Velocity in Selected Channels

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
WATER YEAR 1972 AVERAGE TRIBUTARY INFLOWS

	CHANNEL 18		CHANNEL 72		CHANNEL 83		CHANNEL 127		CHANNEL 140		CHANNEL 137	
HOUR	FLOW (CFS)	VEL. (FPS)	FLOW (CFS)	VEL. (FPS)	FLOW (CFS)	VEL. (FPS)	FLOW (CFS)	VEL. (FPS)	FLOW (CFS)	VEL. (FPS)	FLOW (CFS)	VEL. (FPS)
1.00	-5516137.	-2.58	-191106.	-2.12	-1416006.	-5.00	0.	.00	-741366.	-2.82	-1843617.	-3.49
2.00	4032225.	1.87	-157056.	-2.01	-1131625.	-4.80	0.	.00	-508879.	-2.03	-1236665.	-2.46
3.00	13055712.	5.67	-130323.	-1.91	-881862.	-4.49	0.	.00	-67976.	-.25	-245198.	-.47
4.00	16710525.	6.94	-109507.	-1.83	-499315.	-2.71	-672.	-.49	967181.	3.47	2653444.	4.65
5.00	16120833.	6.49	-92521.	-1.74	1043164.	4.02	-69893.	-1.87	1628563.	5.18	4605526.	7.38
6.00	11782740.	4.67	-79968.	-1.69	1924263.	5.55	-178443.	-2.52	1517019.	4.43	4151891.	6.05
7.00	4283398.	1.69	156219.	2.10	2509075.	5.76	-212347.	-2.16	1123842.	3.14	2975000.	4.12
8.00	-5566803.	-2.33	427380.	3.54	2522007.	5.00	-91991.	-.87	479272.	1.32	913813.	1.23
9.00	-13021632.	-5.58	498215.	3.24	1339124.	2.55	63170.	.75	-393080.	-1.14	-1754202.	-2.50
10.00	-15589311.	-6.96	75890.	.49	-1362350.	-2.95	71553.	1.37	-1163165.	-3.54	-3700787.	-5.57
11.00	-15123041.	-6.96	-254530.	-2.04	-2102561.	-5.11	38906.	1.58	-1276370.	-4.18	-3610244.	-5.87
12.00	-12677975.	-6.04	-224709.	-2.14	-1806388.	-5.19	5753.	.99	-1058064.	-3.74	-2780918.	-4.90
13.00	-8622689.	-4.18	-188387.	-2.10	-1469392.	-5.06	0.	.00	-816265.	-3.10	-2032426.	-3.84
14.00	-884126.	-.38	-155304.	-2.00	-1183491.	-4.91	0.	.00	-605990.	-2.45	-1452286.	-2.92
15.00	11024386.	4.97	-128979.	-1.90	-938852.	-4.75	0.	.00	-349943.	-1.46	-845584.	-1.77
16.00	17216028.	7.34	-108448.	-1.83	-697645.	-4.26	0.	.00	504433.	2.01	1132499.	2.31
17.00	18438397.	7.52	-92100.	-1.76	416818.	2.11	-29117.	-2.04	1477122.	5.02	3898596.	6.70
18.00	15810787.	6.28	-78192.	-1.68	1391206.	4.84	-124044.	-2.43	1786918.	5.45	4949007.	7.56
19.00	9650968.	3.79	-54528.	-1.03	2357999.	6.10	-229931.	-2.59	1489251.	4.23	4027935.	5.69
20.00	1127001.	.43	295629.	3.12	2804474.	5.88	-197888.	-1.78	968407.	2.66	2454119.	3.33
21.00	-8669117.	-3.61	574295.	3.93	2424605.	4.55	-29663.	-.26	232280.	.63	82531.	.09
22.00	-14245907.	-6.11	477885.	2.84	501749.	.93	78115.	.98	-704050.	-2.05	-2669594.	-3.81
23.00	-15517683.	-6.86	-212701.	-1.45	-1938697.	-4.21	70338.	1.51	-1271635.	-3.92	-3902565.	-5.95
24.00	-13967978.	-6.40	-273139.	-2.14	-2098106.	-5.22	33209.	1.57	-1223747.	-4.06	-3398930.	-5.61
25.00	-10785537.	-5.06	-235749.	-2.20	-1737853.	-5.14	3667.	.83	-977544.	-3.48	-2546554.	-4.52
26.00	-5504153.	-2.57	-194704.	-2.13	-1409249.	-4.98	0.	.00	-742127.	-2.82	-1847510.	-3.50
27.00	4015633.	1.86	-159903.	-2.02	-1126494.	-4.78	0.	.00	-509165.	-2.03	-1238604.	-2.46
28.00	13045594.	5.66	-132555.	-1.92	-877829.	-4.48	0.	.00	-69580.	-.25	-249578.	-.48
29.00	16694896.	6.93	-111277.	-1.84	-493980.	-2.67	-693.	-.50	963481.	3.46	2644625.	4.83
30.00	16113445.	6.49	-93926.	-1.75	1043423.	4.02	-69855.	-1.87	1626394.	5.17	4600830.	7.37
31.00	11776429.	4.67	-81106.	-1.70	1924904.	5.55	-176499.	-2.52	1514354.	4.43	4144637.	6.04
32.00	4278481.	1.69	157078.	2.10	2508892.	5.76	-212250.	-2.16	1122138.	3.14	2970821.	4.11
33.00	-5571151.	-2.33	427859.	3.53	2521966.	5.00	-91870.	-.87	478154.	1.32	911110.	1.23
34.00	-13022721.	-5.58	497258.	3.23	1338242.	2.55	63262.	.75	-393946.	-1.15	-1755921.	-2.50
35.00	-15588235.	-6.96	72540.	.46	-1363059.	-2.95	71535.	1.37	-1163359.	-3.54	-3706870.	-5.57
36.00	-15121449.	-6.96	-255114.	-2.04	-2102349.	-5.11	38879.	1.58	-1276354.	-4.18	-3610118.	-5.87
37.00	-12676234.	-6.04	-225154.	-2.14	-1806106.	-5.19	5743.	.99	-1058093.	-3.74	-2781042.	-4.90
38.00	-8621019.	-4.18	-186721.	-2.10	-1469151.	-5.06	0.	.00	-816328.	-3.10	-2032656.	-3.84
39.00	-881941.	-.38	-155562.	-2.00	-1183290.	-4.91	0.	.00	-606042.	-2.45	-1452484.	-2.92
40.00	11026126.	4.97	-129182.	-1.91	-938695.	-4.75	0.	.00	-349963.	-1.46	-845857.	-1.77
41.00	17216832.	7.34	-108609.	-1.83	-697483.	-4.26	0.	.00	504540.	2.01	1132692.	2.31
42.00	18438511.	7.52	-92229.	-1.76	417400.	2.11	-29131.	-2.04	1477091.	5.02	3898532.	6.70
43.00	15810437.	6.28	-78294.	-1.68	1391336.	4.84	-124065.	-2.43	1786834.	5.45	4948606.	7.56
44.00	9650115.	3.79	-54579.	-1.03	2358132.	6.10	-229961.	-2.59	1489093.	4.23	4027442.	5.68
45.00	1125756.	.43	295789.	3.12	2804571.	5.88	-197873.	-1.78	968229.	2.66	2453508.	3.33
46.00	-8670219.	-3.61	574350.	3.93	2424557.	4.55	-29632.	-.26	232162.	.63	82169.	.09
47.00	-14245951.	-6.11	477750.	2.84	501854.	.93	78124.	.98	-704154.	-2.05	-2669650.	-3.81
48.00	-15517799.	-6.86	-213019.	-1.45	-1938851.	-4.21	70338.	1.51	-1271670.	-3.92	-3902656.	-5.95
49.00	-13967909.	-6.40	-273261.	-2.14	-2098113.	-5.22	33207.	1.57	-1223756.	-4.06	-3398965.	-5.61
50.00	-10765354.	-5.06	-235797.	-2.20	-1737643.	-5.14	3666.	.83	-977556.	-3.48	-2546508.	-4.52

2-35-109

Table B-9

Summary of Miscellaneous Computed Hydrodynamic Data

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
WATER YEAR 1972 AVERAGE TRIBUTARY INFLOWS

AVERAGE HEADS FOR A TIDAL CYCLE

	1	2	3	4	5	6	7	8	9	10
1 TO 10	-.131	-.066	-.065	.001	-.002	.034	.115	.187	.403	.252
11 TO 20	.391	.567	.672	.670	.624	.708	.708	.662	.792	.789
21 TO 30	.784	.966	.935	.926	1.030	1.027	1.024	1.104	.000	.000
31 TO 40	1.467	1.458	.000	.000	1.585	1.593	1.757	.000	.000	.000
41 TO 50	.000	.000	1.480	1.765	2.162	2.433	6.864	9.545	10.051	10.077
51 TO 60	.000	2.327	1.844	2.338	2.196	2.495	3.063	3.537	3.778	3.725
61 TO 70	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
71 TO 80	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
81 TO 90	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
91 TO 100	.000	.000	.000	.000	.000	.000	.000	.000	.000	1.130
101 TO 110	1.111	1.449	1.170	1.167	1.324	1.186	1.263	1.413	1.204	1.302
111 TO 120	1.740	1.228	1.212	1.274	1.311	1.327	1.348	1.353	1.352	1.363
121 TO 130	1.364	1.366	1.374	1.386	1.385	1.386	1.408	1.434	.000	.000

AVERAGE VELOCITIES FOR A TIDAL CYCLE

	1	2	3	4	5	6	7	8	9	10
1 TO 10	-.144	-.109	-.038	-.095	-.149	-.027	-.043	-.226	-.084	-.213
11 TO 20	-.246	-.220	-.224	-.064	-.166	-.307	-.139	-.215	-.166	-.013
21 TO 30	-.049	.016	-.087	-.175	.030	.122	-.045	-.116	-.281	.079
31 TO 40	.101	-.239	-.203	-.128	.009	.006	-.103	-.207	-.125	.055
41 TO 50	-.021	-.185	.000	-.249	.000	.000	-.561	.473	.000	.000
51 TO 60	.076	.000	-.347	-.155	-.302	-.069	.000	.000	.000	.000
61 TO 70	.000	.000	.000	.000	.230	-.379	-.545	-.365	-.533	-1.455
71 TO 80	-1.192	-.573	-.185	.000	-.146	-.180	-.350	-.258	-.007	-.520
81 TO 90	-.103	-.434	-.660	-.645	-.434	-.094	.000	.000	-.185	.000
91 TO 100	.000	.000	.000	.000	.000	.000	.000	.000	.000	-.136
101 TO 110	-.223	-.110	-.023	.132	-.056	.056	-.163	-.178	.091	-.022
111 TO 120	.027	.029	-.301	-.238	.031	.003	-.177	-.188	-.410	.293
121 TO 130	-.243	-.147	-.005	-.249	-.287	-.354	-.300	-.322	-.160	.145
131 TO 140	-.377	-.245	-.298	.038	-.035	-.033	-.028	-.162	-.127	-.032
141 TO 150	-.139	-.100	-.042	-.013	-.034	.011	-.099	-.171	-.117	-.252
151 TO 160	-.022	.042	.033	-.121	-.206	-.136	-.182	.000	.000	.000

AVERAGE FLOWS FOR A TIDAL CYCLE

	1	2	3	4	5	6	7	8	9	10
1 TO 10	-251400.	210478.	-459389.	207164.	-249737.	-221684.	427980.	-472089.	422605.	4894.
11 TO 20	4538.	-50213.	-50869.	-291221.	295362.	-337926.	8235.	-41611.	-9413.	-315422.
21 TO 30	-193885.	202008.	79837.	-325024.	130294.	26365.	71584.	183640.	-298844.	273652.
31 TO 40	393498.	-202198.	63646.	94499.	-270363.	-176063.	66058.	-30816.	-81719.	106391.
41 TO 50	-58386.	-38415.	0.	-107199.	0.	0.	-150875.	3157.	0.	0.
51 TO 60	-10601.	0.	-140339.	125404.	-139224.	14549.	0.	0.	0.	0.
61 TO 70	0.	0.	0.	0.	11187.	-2781.	-8443.	-7997.	-2803.	-10855.
71 TO 80	-10896.	-10812.	-10867.	0.	-90085.	-9331.	-50343.	44597.	5165.	-68402.
81 TO 90	68170.	-799.	-870.	-914.	-942.	-978.	0.	0.	63060.	0.
91 TO 100	0.	0.	0.	0.	0.	0.	0.	0.	0.	54700.
101 TO 110	-24452.	103602.	167098.	-39017.	52671.	184767.	11867.	-54564.	47464.	15617.
111 TO 120	137281.	94958.	-51265.	-38965.	232225.	10676.	-61951.	-27701.	-6533.	156813.
121 TO 130	81930.	-89669.	-74635.	-54226.	-53737.	-121832.	-31972.	-31488.	27947.	131940.

Table B-9 - (Cont.)

Summary of Missellaneous Computed Hydrodynamic Data

131 TO 140	-3547.	-14781.	-35241.	30859.	11397.	11770.	-32221.	-33287.	3261.	39723.
141 TO 150	-119.	-20830.	-26045.	-7325.	-7245.	10279.	13205.	777.	14860.	-43137.
151 TO 160	3031.	4190.	33097.	12151.	-13273.	-10043.	-11174.	0.	0.	0.

WATER BALANCE AT EACH JUNCTION (CFS)

	1	2	3	4	5	6	7	8	9	10
1 TO 10	39974.	19.	20.	14.	13.	7.	8.	4.	-1.	1.
11 TO 20	-1.	-3.	-2.	-2.	-3.	-3.	-2.	-3.	-3.	-5.
21 TO 30	-4.	-3.	-4.	-3.	-2.	-3.	0.	-2.	0.	0.
31 TO 40	-2.	-2.	0.	0.	-2.	-2.	5.	0.	0.	0.
41 TO 50	0.	0.	-1.	-0.	0.	3.	4.	4.	7.	2.
51 TO 60	0.	12.	-3.	4.	5.	4.	3.	1.	1.	1.
61 TO 70	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
71 TO 80	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
81 TO 90	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
91 TO 100	0.	0.	0.	0.	0.	0.	0.	0.	0.	-2.
101 TO 110	-1.	2.	-1.	-1.	2.	-0.	-0.	2.	-0.	0.
111 TO 120	-0.	1.	-0.	-0.	-0.	-0.	-0.	-0.	-0.	-0.
121 TO 130	-0.	-0.	0.	-0.	-0.	0.	-0.	-0.	0.	0.

AVERAGE NODAL VOLUME (CU FT)

	1	2	3	4	5	6	7	8	9	10
1 TO 10	.1497+13	.1104+13	.1189+13	.1350+13	.8970+12	.5005+12	.7609+12	.2973+12	.2121+12	.5540+12
11 TO 20	.4618+12	.3134+12	.8483+11	.9765+11	.2218+12	.7525+11	.1157+12	.1397+12	.6713+11	.1542+12
21 TO 30	.1441+12	.6507+11	.1424+12	.1014+12	.6255+11	.9723+11	.2346+11	.4429+11	.0000	.0000
31 TO 40	.3616+11	.2992+11	.0000	.0000	.2081+11	.2180+11	.3362+10	.0000	.0000	.0000
41 TO 50	.0000	.0000	.1447+11	.6339+10	.6962+10	.9752+10	.5649+10	.3151+10	.2994+10	.7560+09
51 TO 60	.0000	.4031+10	.3296+11	.7056+10	.1455+11	.1541+11	.7806+10	.4338+10	.5716+10	.2944+10
61 TO 70	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
71 TO 80	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
81 TO 90	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
91 TO 100	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.4706+11
101 TO 110	.3927+11	.4514+10	.1405+11	.1182+11	.2225+10	.1210+11	.3376+10	.1139+10	.1139+11	.5831+10
111 TO 120	.1406+10	.8764+09	.2495+10	.1679+10	.6983+10	.6309+10	.1900+10	.3436+10	.2235+10	.9409+09
121 TO 130	.3655+10	.1644+10	.1091+10	.2481+10	.2356+10	.1587+10	.9255+10	.7055+10	.0000	.0000

POSITIVE AND NEGATIVE FLOWS FOR EACH CHANNEL

1	14694752.	14946151.	2	16288461.	16077982.	3	2219259.	2678648.	4	11185579.	10978415.
5	16975227.	17224962.	6	894570.	1116254.	7	9561386.	9133405.	8	15659051.	16131139.
9	2844515.	2421911.	10	5958323.	5953429.	11	5010987.	5006449.	12	16905114.	16955329.
13	15517688.	15568558.	14	933132.	1224353.	15	4978468.	4683107.	16	13397142.	13735068.
17	3233275.	3225040.	18	5573923.	5615534.	19	8924408.	8933820.	20	927364.	1242786.
21	282405.	476290.	22	3202413.	3000405.	23	5967253.	5887416.	24	7058861.	7383884.
25	246587.	116293.	26	1056082.	1029717.	27	2457099.	2385515.	28	6633549.	6449910.
29	5306874.	5605718.	30	377529.	103877.	31	1525529.	1132031.	32	1850182.	2052379.
33	6982381.	6918736.	34	3523119.	3428621.	35	1560998.	1831361.	36	1868507.	2044569.
37	2855205.	2787147.	38	6366623.	6397439.	39	801606.	883325.	40	226594.	120203.
41	175945.	234331.	42	2483633.	2522048.	43	0.	0.	44	60522.	167720.
45	0.	0.	46	0.	0.	47	2047464.	2198338.	48	2213933.	2210777.
49	0.	0.	50	0.	0.	51	239665.	250266.	52	0.	0.
53	1733967.	1874305.	54	1658781.	1533377.	55	79314.	218539.	56	172232.	157603.
57	0.	0.	58	0.	0.	59	0.	0.	60	0.	0.
61	0.	0.	62	0.	0.	63	0.	0.	64	0.	0.
65	1144022.	1182036.	66	504487.	503268.	67	423975.	432417.	68	260781.	268778.
69	349142.	350949.	70	292584.	303439.	71	163598.	174493.	72	100542.	111354.

Table B-9 - (Cont.)

Summary of Miscellaneous Computed Hydrodynamic Data

73	17841.	28708.	74	0.	0.	75	33689.	123774.	76	368225.	377556.
77	1150133.	1200476.	78	972499.	927902.	79	305546.	300381.	80	1196218.	1265120.
81	318197.	250027.	82	1141910.	1142709.	83	764702.	765571.	84	528055.	528969.
85	368325.	369266.	86	140776.	141754.	87	0.	0.	88	0.	0.
89	324529.	261469.	90	0.	0.	91	0.	0.	92	0.	0.
93	0.	0.	94	0.	0.	95	0.	0.	96	0.	0.
97	0.	0.	98	0.	0.	99	0.	0.	100	1485991.	1431292.
101	1802330.	1826781.	102	2599198.	2495596.	103	1552659.	1385561.	104	480146.	519162.
105	195958.	143288.	106	1341039.	1156272.	107	1630658.	1618791.	108	35274.	89838.
109	154402.	106938.	110	122797.	107180.	111	1304939.	1167658.	112	899654.	804896.
113	391190.	442455.	114	48400.	87365.	115	2118526.	1886301.	116	37722.	27046.
117	286948.	348899.	118	23724.	91425.	119	104113.	110646.	120	633992.	477179.
121	1294254.	1212325.	122	192635.	282304.	123	66442.	141077.	124	71973.	126199.
125	8789.	62527.	126	114656.	236488.	127	14487.	46459.	128	17066.	46554.
129	338196.	310249.	130	344919.	212979.	131	309007.	312554.	132	409453.	424233.
133	478475.	513716.	134	182024.	151164.	135	218834.	207437.	136	208805.	197035.
137	30970.	63191.	138	124385.	157672.	139	373729.	370468.	140	464395.	444672.
141	388608.	398727.	142	148654.	169483.	143	8215.	34260.	144	57797.	65122.
145	103143.	110388.	146	123064.	112785.	147	275035.	261830.	148	377465.	376668.
149	348665.	333805.	150	225727.	268864.	151	262964.	199933.	152	76705.	72515.
153	73609.	40512.	154	504741.	492590.	155	577317.	590589.	156	258824.	268868.
157	1273506.	1284680.									

MINIMUM HEAD, MAXIMUM HEAD AND TIDAL RANGE

1	-9.02	7.60	16.62	2	-9.24	8.08	17.32	3	-9.27	8.14	17.41	4	-9.68	8.59	18.27
5	-9.57	8.54	18.11	6	-10.13	9.07	19.20	7	-9.65	8.90	18.54	8	-10.14	9.40	19.54
9	-10.14	9.49	19.62	10	-9.69	9.03	18.72	11	-9.96	9.27	19.23	12	-10.35	9.67	20.02
13	-11.08	10.47	21.55	14	-11.04	10.44	21.48	15	-10.98	10.38	21.36	16	-11.77	11.16	22.94
17	-11.75	11.17	22.92	18	-11.67	11.06	22.73	19	-12.55	11.96	24.50	20	-12.50	11.94	24.43
21	-12.44	11.90	24.34	22	-13.50	13.08	26.58	23	-13.35	12.97	26.31	24	-13.25	12.87	26.12
25	-13.93	13.65	27.58	26	-13.88	13.67	27.55	27	-13.84	13.66	27.50	28	-14.30	14.28	28.58
29	.00	.00	.00	30	.00	.00	.00	31	-14.28	15.22	29.51	32	-14.30	15.27	29.57
33	.00	.00	.00	34	.00	.00	.00	35	-14.62	15.70	30.32	36	-14.67	15.76	30.43
37	-11.62	15.57	27.19	38	.00	.00	.00	39	.00	.00	.00	40	.00	.00	.00
41	.00	.00	.00	42	.00	.00	.00	43	-16.49	16.86	33.35	44	-16.03	17.08	33.12
45	-13.86	17.13	30.99	46	-13.62	17.34	30.96	47	-.76	17.22	17.97	48	4.69	16.24	11.55
49	6.60	14.35	7.74	50	6.72	14.57	7.85	51	.00	.00	.00	52	-11.17	15.99	27.16
53	-14.77	16.09	30.86	54	-11.13	16.26	27.39	55	-14.79	16.39	31.18	56	-14.85	16.52	31.37
57	-13.95	16.42	30.37	58	-13.04	16.69	29.73	59	-11.46	17.75	29.21	60	-12.68	18.68	31.36
61	.00	.00	.00	62	.00	.00	.00	63	.00	.00	.00	64	.00	.00	.00
65	.00	.00	.00	66	.00	.00	.00	67	.00	.00	.00	68	.00	.00	.00
69	.00	.00	.00	70	.00	.00	.00	71	.00	.00	.00	72	.00	.00	.00
73	.00	.00	.00	74	.00	.00	.00	75	.00	.00	.00	76	.00	.00	.00
77	.00	.00	.00	78	.00	.00	.00	79	.00	.00	.00	80	.00	.00	.00
81	.00	.00	.00	82	.00	.00	.00	83	.00	.00	.00	84	.00	.00	.00
85	.00	.00	.00	86	.00	.00	.00	87	.00	.00	.00	88	.00	.00	.00
89	.00	.00	.00	90	.00	.00	.00	91	.00	.00	.00	92	.00	.00	.00
93	.00	.00	.00	94	.00	.00	.00	95	.00	.00	.00	96	.00	.00	.00
97	.00	.00	.00	98	.00	.00	.00	99	.00	.00	.00	100	-14.48	14.50	28.98
101	-14.48	14.43	28.91	102	-11.09	14.51	25.60	103	-14.80	14.83	29.64	104	-14.78	14.83	29.61
105	-12.78	14.91	27.68	106	-14.98	15.05	30.03	107	-15.31	15.18	30.49	108	-12.89	15.18	28.07
109	-15.17	15.29	30.46	110	-15.52	15.40	30.92	111	-11.82	15.52	27.34	112	-15.58	15.55	31.14
113	-15.32	15.50	30.81	114	-15.46	15.62	31.08	115	-15.45	15.57	31.02	116	-15.56	15.58	31.14
117	-15.64	15.76	31.40	118	-15.68	15.77	31.45	119	-15.69	15.77	31.46	120	-15.78	15.87	31.65
121	-15.78	15.88	31.66	122	-15.79	15.90	31.69	123	-15.85	15.95	31.80	124	-15.94	16.06	31.99
125	-15.93	16.05	31.98	126	-15.93	16.06	31.98	127	-16.11	16.29	32.40	128	-16.31	16.60	32.91

2-35-112

Table B-9 - (Cont.)

Summary of Miscellaneous Computed Hydrodynamic Data

TIME OF MINIMUM AND MAXIMUM HEAD, HOUR

1	9.64	16.00	2	10.19	16.39	3	10.19	16.44	4	10.75	16.81
5	10.75	16.81	6	11.03	17.11	7	11.33	17.25	8	11.75	17.67
9	12.42	18.90	10	11.92	17.64	11	12.39	18.00	12	12.92	18.69
13	13.28	18.94	14	13.28	18.94	15	13.17	18.92	16	13.47	19.14
17	13.47	19.14	18	13.39	19.17	19	13.75	19.42	20	13.75	19.36
21	13.72	19.31	22	14.17	19.75	23	14.11	19.81	24	14.11	19.86
25	14.33	19.89	26	14.35	19.89	27	14.31	19.86	28	14.47	20.03
29	.00	.00	30	.00	.00	31	15.06	20.36	32	15.03	20.36
33	.00	.00	34	.00	.00	35	15.28	20.47	36	15.31	20.50
37	16.00	20.44	38	.00	.00	39	.00	.00	40	.00	.00
41	.00	.00	42	.00	.00	43	15.31	20.53	44	15.69	20.56
45	16.08	20.58	46	16.33	20.61	47	17.67	20.92	48	18.44	21.39
49	19.14	22.75	50	19.53	22.78	51	.00	.00	52	16.39	20.56
53	15.64	20.56	54	16.42	20.58	55	15.89	20.75	56	16.11	21.14
57	16.47	21.56	58	16.86	22.08	59	17.44	22.39	60	17.81	22.50
61	.00	.00	62	.00	.00	63	.00	.00	64	.00	.00
65	.00	.00	66	.00	.00	67	.00	.00	68	.00	.00
69	.00	.00	70	.00	.00	71	.00	.00	72	.00	.00
73	.00	.00	74	.00	.00	75	.00	.00	76	.00	.00
77	.00	.00	78	.00	.00	79	.00	.00	80	.00	.00
81	.00	.00	82	.00	.00	83	.00	.00	84	.00	.00
85	.00	.00	86	.00	.00	87	.00	.00	88	.00	.00
89	.00	.00	90	.00	.00	91	.00	.00	92	.00	.00
93	.00	.00	94	.00	.00	95	.00	.00	96	.00	.00
97	.00	.00	98	.00	.00	99	.00	.00	100	14.56	20.11
101	14.53	20.14	102	2.67	20.19	103	14.64	20.19	104	14.64	20.19
105	15.42	20.19	106	14.69	20.22	107	14.92	20.33	108	15.75	20.36
109	14.75	20.28	110	15.00	20.39	111	15.72	20.33	112	15.14	20.36
113	14.81	20.33	114	14.92	20.36	115	15.00	20.39	116	15.03	20.42
117	15.06	20.42	118	15.08	20.42	119	15.08	20.42	120	15.11	20.42
121	15.11	20.42	122	15.11	20.42	123	15.11	20.42	124	15.14	20.44
125	15.14	20.44	126	15.14	20.44	127	15.19	20.44	128	15.25	20.50

TOTAL EVAPORATION RATE, CFS	.1080+05
AVERAGE SURFACE AREA, SQ FT	.1131+12
AVERAGE VOLUME, CU FT	.1124+14
AVERAGE DEPTH, FT	.9938+02

2-35-113

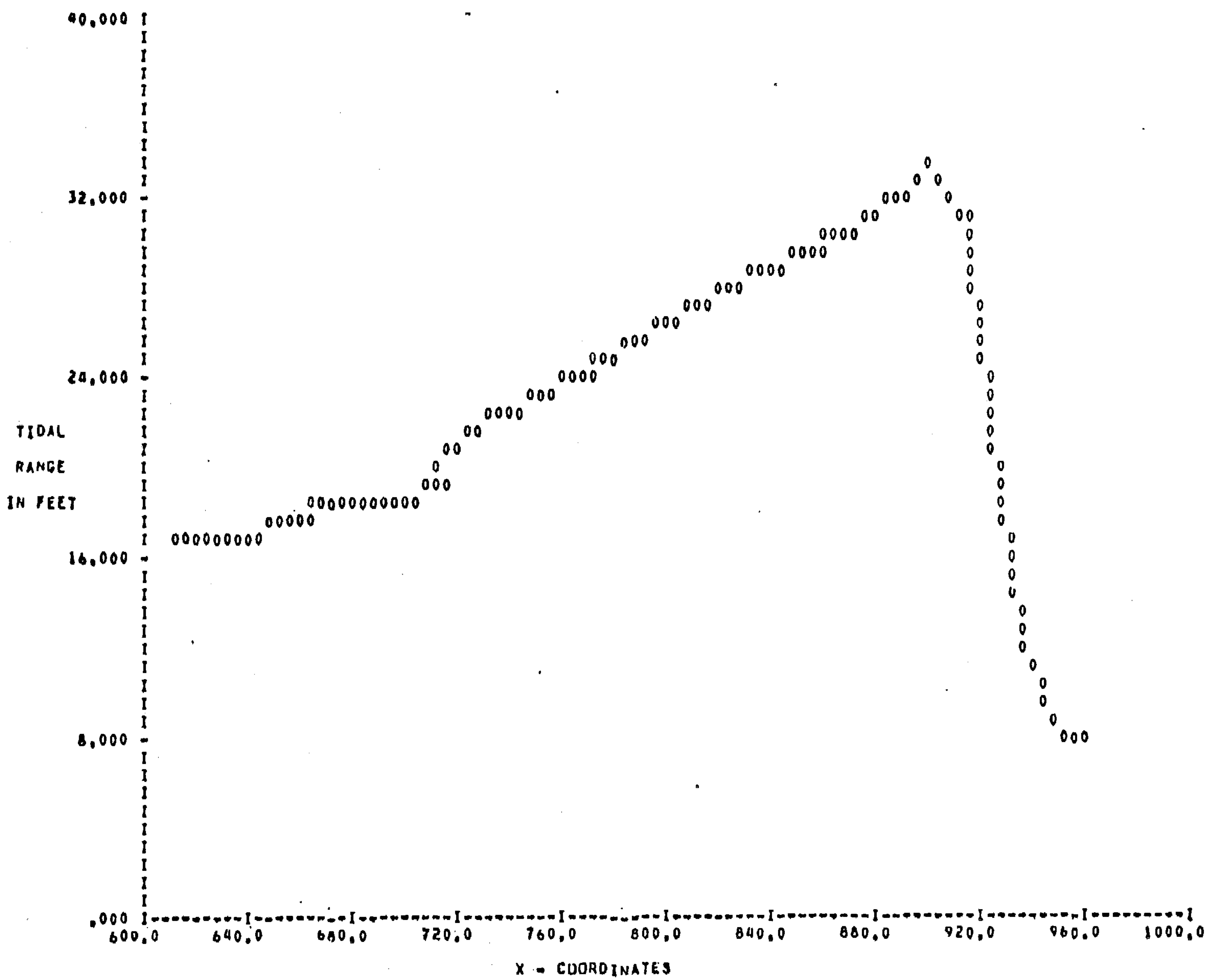


FIGURE B-1 TIDAL RANGE VERSUS X-COORDINATE

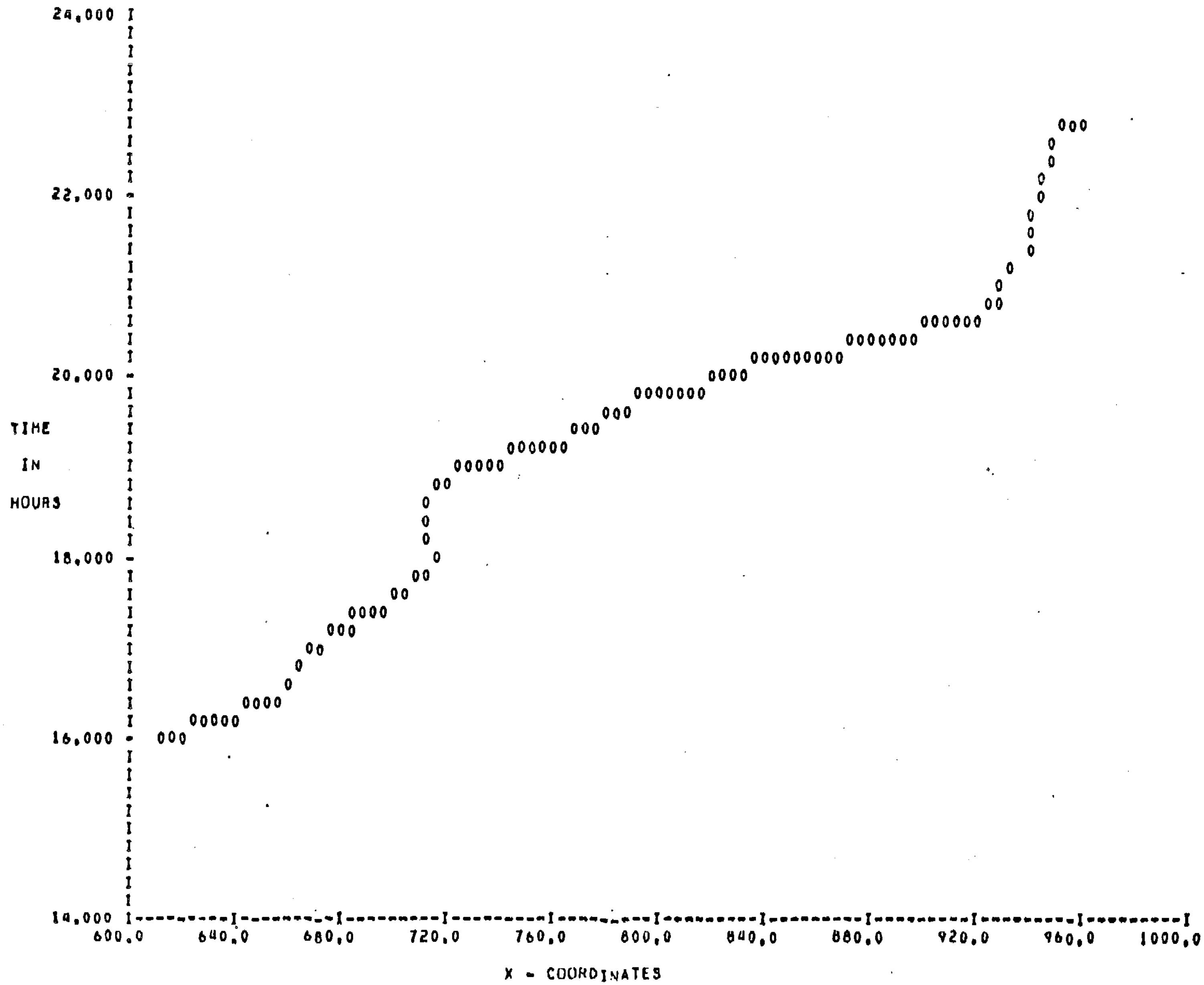


FIGURE B-2 TIME OF HIGH WATER VERSUS X-COORDINATE

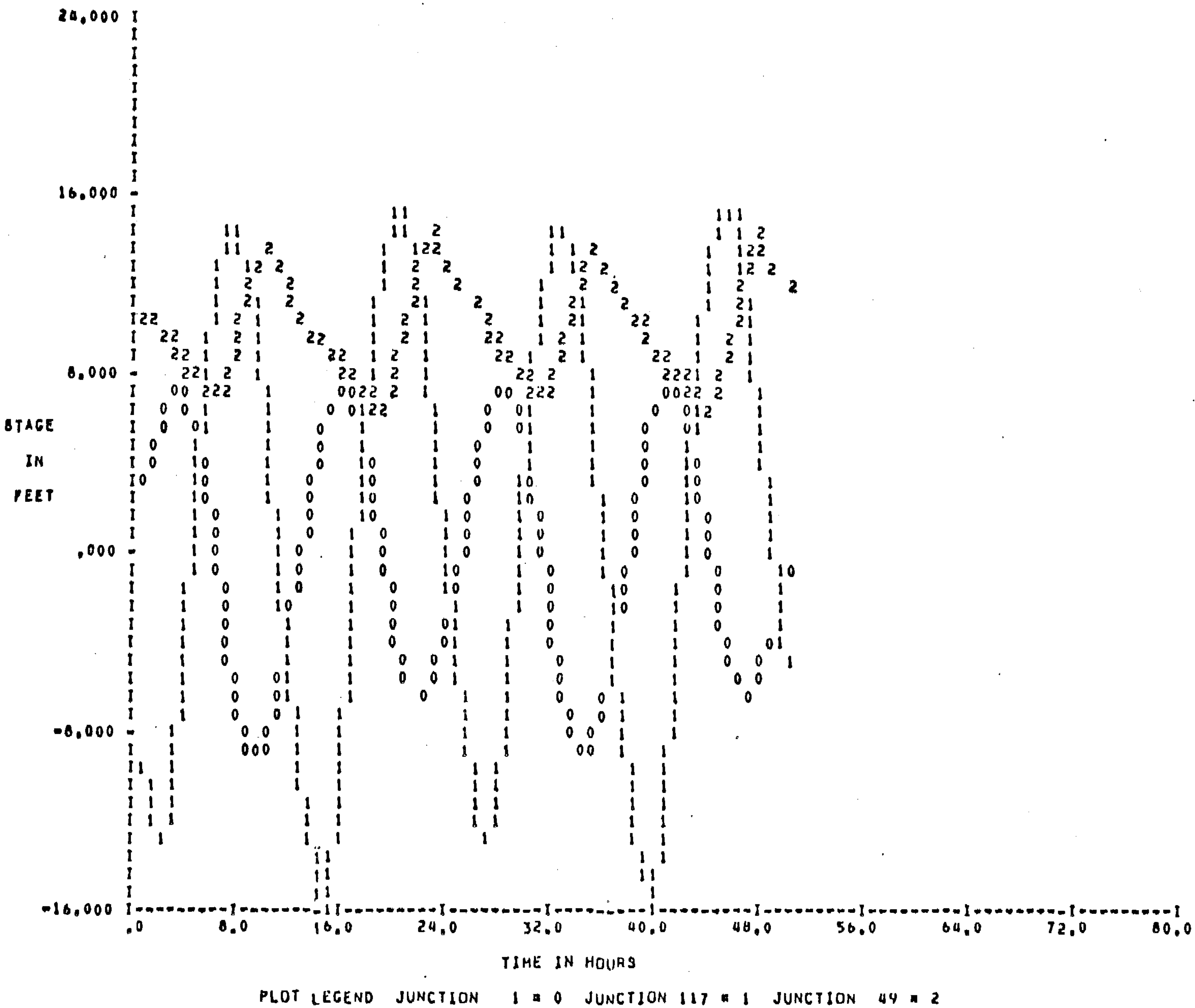


FIGURE B-3 STAGE VERSUS TIME AT SELECTED NODES

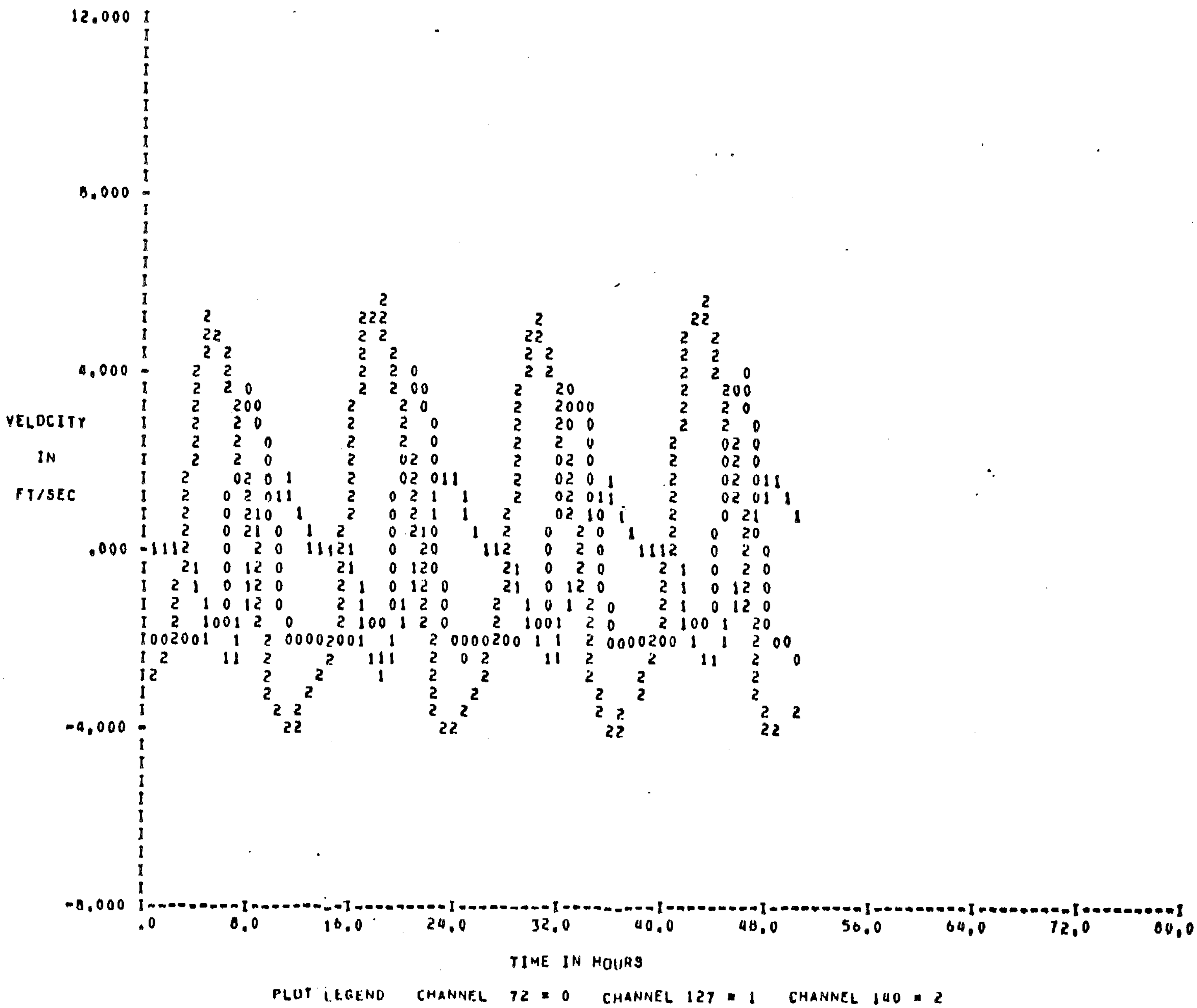


FIGURE B-4 CHANNEL VELOCITY VERSUS TIME IN SELECTED CHANNEL

APPENDIX C

Table C-1

Tidally Averaged Quality Model Input Card Specifications

1a	UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM															
1b	SAMPLE PROBLEM															
2	1	135	24	0	1	0	1	3	12							
3	1	1														
4	[redacted]	0	0	0	1	0	0	0	0	0	0	1	1			
5	NH3-N, MG/L PRIMNO3-N, MG/L PRIM															
7a	1	0	0	0	135											
7b	5	7	10	11	12	14	17	20	23	26	101	107	115	117	121	127
	44	46	48	49	50											
8	1	130									10					
9	1	16	10	3000												
	17	160	5	[redacted]												
10	1	1														
11	AVERAGE RUNOFF CONDITIONS - STEADY STATE															
12	0	0	0	0	1	1	0	0	0	0						
13a	1	.1														
13b	1[redacted]								-1	10						
14	11	4600		.25	.01	0		0	0	-1	10					
	[redacted]			.25	.01	0		0	0	-1	10					
	45	470		.25	.01	0		0	0	-1	10					
	48	120		.25	.01	0		0	0	-1	10					
	5010880			.25	.01	0		0	0	-1	10					
	60	1000		.25	.01	0		0	0	-1	10					
	108	600		.25	.01	0		0	0	-1	10					
	124	110		.25	.01	0		0	0	-1	10					
	117	155		30		335000		120	90	2	15	20	.5			
	45	15.5		25		510000		30	75	6	15	17	.5			
17a	1	0	0	1.08	1.04											
17b	1	130	.2	.1	1	0										
17c	0	0	0	0	0	0	10	.1								
17																
18a	1	135	-1	0	0	0										
18b	1	130	61	150	2											
18c	1	.75	8	2	3	1000										
	25	.75	8	2	3	1000										

APPENDIX D

Table D-1

Computation and Output Control Options

[redacted]

SIMULATION BEGINS ON DAY	135	
TIME STEPS OF	24	HOUR(S)
PRINTOUT EVERY	1	TIME STEP(S)
HYDRAULIC INTERFACE UNIT	12	
QUALITY INTERFACE UNIT	0	
NUMBER OF BOUNDARY CONDITIONS	1	
1 TIME STEPS FOR CONDITION	1	STEADY STATE

THE FOLLOWING CONSTITUENTS ARE BEING MODELED

[redacted]
TOTAL N
TOTAL P
TOTAL COLIF
CARBON BOD
NITRO BOD
OXYGEN
TEMPERATURE
OPP CONST 1   NH3-N, MG/L PRIM
OPP CONST 2   NO3-N, MG/L PRIM

Table D-2

Initial Conditions and Dispersion Parameters

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
SAMPLE PROBLEM

INITIAL QUALITY CONDITIONS

JUN TO JUN		[redacted]	TOT N MG/L	TOT P MG/L	T COL NO/100ML	F COL NO/100ML.	C BOD MG/L	N BOD MG/L	D O MG/L	TEMP C	CONST 1 UNITS	CONST 2 UNITS	CONST 3 UNITS	CONST UNIT.
1	130		.00	.00	.00	.00	.00	.00	.00	10.0	.00	.00	.00	.0

DISPERSION COEFFICIENTS

CHAN	TO CHAN	C1	C4
1	16	10.	3000.
17	160	5.	1500.

Summary of Boundary Conditions and System Coefficients

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
AVERAGE RUNOFF CONDITIONS - STEADY STATE

EXCHANGE CONDITIONS DURING HYDROLOGIC CYCLE 1

JUN	EXCH RATIO	EBB MCFS	FLOOD MCFS	[redacted]	TOT N MG/L	TOT P MG/L	T COL N/100ML	F COL N/100ML	C BOD MG/L	N BOD MG/L	OXY MG/L	TEMP C	CON 1 UNITS	CON 2 UNITS	CON 3 UNITS	CON 4 UNITS
1	.10	31,024	30,983	[redacted]	.00	.00	.00	.00	.00	.00	9.3	10.0	.00	.00	.00	.00

INFLOW CONDITIONS DURING HYDRAULIC CYCLE 1

JUN	INFLOW CFS	TDS MG/L	TOT N MG/L	TOT P MG/L	T COL NO/100ML	F COL NO/100ML	C BOD MG/L	N BOD MG/L	OXY MG/L	TEMP C	CONST 1 UNITS	CONST 2 UNITS	CONST 3 UNITS	CONST 4 UNITS
11	4600.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
[redacted]	33000.00	[redacted]	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
45	470.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
48	120.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
50	10880.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
60	1000.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
108	600.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
124	110.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
117	155.00	0.	30.00	3.00	.35+05	.00	120.00	90.00	2.0	15.0	20.00	.50	.00	.00
45	15.50	0.	25.00	5.00	.10+05	.00	30.00	75.00	6.0	15.0	17.00	.50	.00	.00
AGGREGATED QUALITY														
11	4600.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
27	33000.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
45	470.00	0.	1.07	.17	.33+03	.00	.99	2.47	11.9	10.5	.56	.02	.00	.00
48	120.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
50	10880.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
60	1000.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
108	600.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00
117	75.00	0.	62.00	6.20	.72+05	.00	248.00	186.00	4.1	31.0	41.33	1.03	.00	.00
124	110.00	0.	.25	.01	.00	.00	.00	.00	11.3	10.0	.00	.00	.00	.00

SYSTEM COEFFICIENTS

JUN	TO JUN	BOD DECAY CARB (1/DAY)	BOD DECAY NITR (1/DAY)	COLIF DECAY TOTAL (1/DAY)	COLIF DECAY FECAL (1/DAY)	BENTHIC SINK RATES N (MF/M2/DAY)	BENTHIC SINK RATES P (MF/M2/DAY)	BENTHIC SINK RATES O (MF/M2/DAY)	ALGAL OXYGEN PHOTO (MG/M2/DAY)	ALGAL OXYGEN RESP (MG/M2/DAY)	REAERATION MIN (1/DAY)	REAERATION MAX (1/DAY)	OPP CONST DECAY 1 (1/DAY)	OPP CONST DECAY 2 (1/DAY)	OPP CONST DECAY 3 (1/DAY)	OPP CONST DECAY 4 (1/DAY)	OPP CONST SETTLING 1 (M/DAY)	OPP CONST SETTLING 2 (M/DAY)	OPP CONST SETTLING 3 (M/DAY)	OPP CONST SETTLING 4 (M/DAY)
1	130	.20	.10	1.00	.00	0.	0.	0.	0.	0.	.0	10.0	.10	.00	.00	.00	.00	.00	.00	.00

STOICHIOMETRIC EQUIVALENCE BETWEEN OPTIONAL CONSTITUENTS

CONST NO 1 DECAY TO CONST NO 2. 1.00
CONST NO 2 DECAY TO CONST NO 3. .00
CONST NO 3 DECAY TO CONST NO 4. .00

RATE COEFFICIENT TEMPERATURE ADJUSTMENT CONSTANT FOR

BOD 1.080

2-35-123

Table D-3 - (Cont.)

Summary of Boundary Conditions and System Coefficients

ALL OTHERS 1.040

FLOW AND WIND INDUCED REAERATION COEFFICIENT AND COEFF. USED BY NODES, 1/DAY

1	.015	.037	.037	2	.010	.042	.042	3	.010	.039	.039	4	.012	.036	.036	5	.014	.042	.042
6	.022	.054	.054	7	.028	.055	.055	8	.035	.065	.065	9	.044	.105	.105	10	.028	.067	.067
11	.029	.054	.054	12	.032	.042	.042	13	.027	.077	.077	14	.023	.054	.054	15	.021	.045	.045
16	.031	.101	.101	17	.022	.064	.064	18	.023	.072	.072	19	.042	.110	.110	20	.020	.057	.057
21	.024	.064	.064	22	.050	.096	.096	23	.025	.068	.068	24	.031	.081	.081	25	.028	.077	.077
26	.024	.068	.068	27	.062	.169	.169	28	.054	.083	.083	29	.000	.000	.000	30	.000	.000	.000
31	.070	.105	.105	32	.079	.121	.121	33	.000	.000	.000	34	.000	.000	.000	35	.087	.233	.233
36	.110	.146	.146	37	.458	.360	.458	38	.000	.000	.000	39	.000	.000	.000	40	.000	.000	.000
41	.000	.000	.000	42	.000	.000	.000	43	.141	.143	.143	44	.177	.194	.194	45	.196	.196	.196
46	.285	.292	.292	47	.526	.449	.526	48	.549	.966	.966	49	.430	1.899	1.899	50	.300	1.747	1.747
51	.000	.000	.000	52	.145	.436	.436	53	.120	.169	.169	54	.113	.400	.400	55	.150	.245	.245
56	.140	.265	.265	57	.206	.368	.368	58	.273	.440	.440	59	.283	.476	.476	60	.244	.566	.566
61	.000	.000	.000	62	.000	.000	.000	63	.000	.000	.000	64	.000	.000	.000	65	.000	.000	.000
66	.000	.000	.000	67	.000	.000	.000	68	.000	.000	.000	69	.000	.000	.000	70	.000	.000	.000
71	.000	.000	.000	72	.000	.000	.000	73	.000	.000	.000	74	.000	.000	.000	75	.000	.000	.000
76	.000	.000	.000	77	.000	.000	.000	78	.000	.000	.000	79	.000	.000	.000	80	.000	.000	.000
81	.000	.000	.000	82	.000	.000	.000	83	.000	.000	.000	84	.000	.000	.000	85	.000	.000	.000
86	.000	.000	.000	87	.000	.000	.000	88	.000	.000	.000	89	.000	.000	.000	90	.000	.000	.000
91	.000	.000	.000	92	.000	.000	.000	93	.000	.000	.000	94	.000	.000	.000	95	.000	.000	.000
96	.000	.000	.000	97	.000	.000	.000	98	.000	.000	.000	99	.000	.000	.000	100	.051	.067	.067
101	.057	.072	.072	102	.383	.332	.383	103	.034	.087	.087	104	.063	.107	.107	105	.354	.271	.354
106	.035	.067	.067	107	.153	.175	.175	108	.343	.327	.343	109	.067	.077	.077	110	.097	.149	.149
111	.303	.327	.327	112	.349	.219	.349	113	.107	.118	.118	114	.124	.156	.156	115	.069	.097	.097
116	.066	.115	.115	117	.049	.118	.118	118	.031	.089	.089	119	.043	.138	.138	120	.032	.175	.175
121	.023	.060	.060	122	.034	.107	.107	123	.081	.147	.147	124	.031	.097	.097	125	.022	.077	.077
126	.033	.115	.115	127	.040	.057	.057	128	.054	.103	.103								

Table D-4

Meteorological Conditions

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
AVERAGE RUNOFF CONDITIONS - STEADY STATE

TABLE OF METEOROLOGIC DATA FOR WEATHER ZONE 1, JUNCTION 1 TO 130

LATITUDE = 61.0
LONGITUDE = 150.0

HOUR	WIND SPEED (M/SEC)	CLOUD COVER FRACTION	DRY BULB TEMPERATURE (C)	**** TEMPERATURE (C)	ATMOSPHERIC PRESSURE (MB)	SHORT WAVE SOLAR (KCAL/M2/SEC)	LONG WAVE SOLAR (KCAL/M2/SEC)	VAPOR PRESSURE (MB)
1	3.5	.75	7.0	1.0	1000.	.0000	.0649	7.
2	3.5	.75	7.0	1.0	1000.	.0000	.0649	7.
3	3.5	.75	7.0	1.0	1000.	.0000	.0649	7.
4	3.5	.75	7.0	1.0	1000.	.0000	.0649	7.
5	3.5	.75	7.0	1.0	1000.	.0007	.0649	7.
6	3.5	.75	7.0	1.0	1000.	.0100	.0649	7.
7	3.5	.75	7.0	1.0	1000.	.0263	.0649	7.
8	3.5	.75	7.0	1.0	1000.	.0455	.0649	7.
9	3.5	.75	7.0	1.0	1000.	.0648	.0649	7.
10	3.5	.75	7.0	1.0	1000.	.0820	.0649	7.
11	3.5	.75	7.0	1.0	1000.	.0956	.0649	7.
12	3.5	.75	7.0	1.0	1000.	.1043	.0649	7.
13	3.5	.75	7.0	1.0	1000.	.1072	.0649	7.
14	3.5	.75	7.0	1.0	1000.	.1043	.0649	7.
15	3.5	.75	7.0	1.0	1000.	.0956	.0649	7.
16	3.5	.75	7.0	1.0	1000.	.0820	.0649	7.
17	3.5	.75	7.0	1.0	1000.	.0648	.0649	7.
18	3.5	.75	7.0	1.0	1000.	.0455	.0649	7.
19	3.5	.75	7.0	1.0	1000.	.0263	.0649	7.
20	3.5	.75	7.0	1.0	1000.	.0100	.0649	7.
21	3.5	.75	7.0	1.0	1000.	.0007	.0649	7.
22	3.5	.75	7.0	1.0	1000.	.0000	.0649	7.
23	3.5	.75	7.0	1.0	1000.	.0000	.0649	7.
24	3.5	.75	7.0	1.0	1000.	.0000	.0649	7.

**** DEW POINT

Table D-5

Dispersion Coefficients and Steady-State Salinity

CHANNEL DISPERSION COEFFICIENTS, 80 FT/SEC (LAST TWO ITERATIONS) 3

1	8180.	8184.	2	8934.	8939.	3	1338.	1340.	4	7015.	7018.	5	8589.	8595.
6	548.	554.	7	5900.	5903.	8	7721.	7727.	9	1830.	1839.	10	6752.	6762.
11	5752.	5767.	12	6955.	6965.	13	7378.	7388.	14	945.	951.	15	5588.	5600.
16	11002.	11010.	17	3223.	3229.	18	5446.	5455.	19	6576.	6565.	20	702.	703.
21	215.	219.	22	2826.	2830.	23	5928.	5933.	24	4429.	4436.	25	104.	109.
26	509.	514.	27	1802.	1818.	28	4767.	4776.	29	4390.	4395.	30	127.	133.
31	549.	550.	32	1822.	1832.	33	4827.	4839.	34	2726.	2738.	35	894.	894.
36	862.	867.	37	2249.	2255.	38	3980.	3999.	39	991.	1027.	40	154.	159.
41	286.	326.	42	2705.	2712.	43	0.	0.	44	277.	305.	45	0.	0.
46	0.	0.	47	2851.	2857.	48	3429.	3434.	49	0.	0.	50	0.	0.
51	245.	248.	52	0.	0.	53	1636.	1638.	54	1857.	1857.	55	231.	236.
56	223.	225.	57	0.	0.	58	0.	0.	59	0.	0.	60	0.	0.
61	0.	0.	62	0.	0.	63	0.	0.	64	0.	0.	65	2415.	2449.
66	1165.	1206.	67	1192.	1240.	68	811.	857.	69	1121.	1172.	70	812.	879.
71	526.	584.	72	316.	336.	73	87.	90.	74	0.	0.	75	89.	89.
76	422.	424.	77	1063.	1064.	78	1348.	1349.	79	467.	468.	80	2091.	2093.
81	322.	324.	82	1923.	1928.	83	1697.	1707.	84	1452.	1467.	85	1121.	1142.
86	803.	836.	87	0.	0.	88	0.	0.	89	436.	436.	90	0.	0.
91	0.	0.	92	0.	0.	93	0.	0.	94	0.	0.	95	0.	0.
96	0.	0.	97	0.	0.	98	0.	0.	99	0.	0.	100	2831.	2832.
101	3532.	3534.	102	3306.	3308.	103	1871.	1873.	104	488.	468.	105	300.	313.
106	2163.	2166.	107	2635.	2642.	108	191.	201.	109	247.	254.	110	315.	335.
111	3211.	3217.	112	2878.	2878.	113	1564.	1565.	114	314.	326.	115	3956.	3962.
116	183.	198.	117	1022.	1029.	118	172.	176.	119	654.	660.	120	2774.	2777.
121	3721.	3741.	122	470.	472.	123	683.	686.	124	577.	509.	125	184.	190.
126	767.	767.	127	202.	204.	128	292.	305.	129	2131.	2154.	130	669.	695.
131	2379.	2418.	132	2383.	2409.	133	2631.	2661.	134	1137.	1157.	135	932.	955.
136	531.	539.	137	125.	128.	138	1053.	1078.	139	3030.	3055.	140	2808.	2826.
141	3123.	3152.	142	1192.	1220.	143	69.	71.	144	227.	238.	145	741.	761.
146	988.	1005.	147	2850.	2875.	148	3381.	3409.	149	3302.	3321.	150	1782.	1813.
151	1199.	1225.	152	191.	192.	153	152.	156.	154	3427.	3449.	155	4025.	4052.
156	2272.	2296.	157	3877.	3903.									

[redacted]

1	30.60	2	30.16	3	29.89	4	29.74	5	29.23
6	29.38	7	28.63	8	28.41	9	27.08	10	27.71
11	26.77	12	26.16	13	25.35	14	25.12	15	25.02
16	24.95	17	24.48	18	24.02	19	22.78	20	23.29
21	23.25	22	21.58	23	21.62	24	21.04	25	21.03
26	20.58	[redacted]		28	20.40	29	.01	30	.01
31	19.99	32	19.46	33	.01	34	.01	35	19.86
36	19.84	37	19.58	38	.01	39	.01	40	.01
41	.01	42	.01	43	13.99	44	11.43	45	10.47
46	7.36	47	3.20	48	.75	49	[illegible]	50	.00
51	.01	52	19.72	53	19.73	54	19.74	55	19.61
56	19.18	57	18.36	58	17.24	59	15.55	60	12.02
61	.00	62	.00	63	.00	64	.00	65	.01
66	.01	67	.01	68	.01	69	.01	70	.01
71	.00	72	.00	73	.00	74	.00	75	.01
76	.01	77	.01	78	.01	79	.01	80	.01
81	.01	82	.01	83	.01	84	.01	85	.01
86	.01	87	.00	88	.00	89	.01	90	.00
91	.00	92	.00	93	.00	94	.00	95	.00
96	.00	97	.00	98	.00	99	.00	100	20.30
101	20.34	102	19.72	103	20.16	104	19.94	105	19.12
106	19.96	107	19.05	108	18.67	109	19.77	110	18.84
111	19.59	112	19.46	113	19.67	114	19.06	115	18.94
116	18.79	117	18.14	118	17.95	119	17.87	120	17.64
121	17.60	122	17.20	123	17.27	124	16.78	125	16.81
126	16.70	127	16.05	128	15.20				

2-35-126

Table D-6

Standard Printout Format for Computed Water Quality

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
AVERAGE RUNOFF CONDITIONS - STEADY STATE

QUALITY RESULTS, DAY 15

JUN	[redacted]	TOT N MG/L	TOT P MG/L	T COL NO/100ML	F COL NO/100ML	C BOD MG/L	N BOD MG/L	OXY MG/L	O SAT MG/L	TEMP C	CONST 1 UNITS	CONST 2 UNITS	CONST 3 UNITS	CONST 4 UNITS
1	30596.	.01	.00	.70-10	.00	.00	.00	9.3	9.3	10.0	.00	.00	.00	.00
2	30159.	.01	.00	.11-09	.00	.00	.00	9.3	9.3	10.0	.00	.00	.00	.00
3	29689.	.02	.00	.11-08	.00	.00	.00	9.3	9.3	10.1	.00	.00	.00	.00
4	29736.	.02	.00	.63-09	.00	.00	.00	9.3	9.3	10.1	.00	.00	.00	.00
5	29235.	.02	.00	.96-08	.00	.00	.00	9.4	9.4	10.1	.00	.00	.00	.00
6	29382.	.02	.00	.88-08	.00	.00	.00	9.4	9.3	10.1	.00	.00	.00	.00
7	28533.	.03	.00	.62-07	.00	.00	.00	9.4	9.4	10.1	.00	.01	.00	.00
8	28405.	.04	.00	.14-06	.00	.00	.00	9.4	9.4	10.1	.00	.01	.00	.00
9	27086.	.05	.00	.17-05	.00	.00	.00	9.5	9.5	10.1	.00	.01	.00	.00
10	27713.	.04	.00	.49-06	.00	.00	.00	9.5	9.4	10.1	.00	.01	.00	.00
11	26771.	.05	.00	.31-05	.00	.00	.00	9.5	9.5	10.1	.00	.01	.00	.00
12	26158.	.06	.00	.13-04	.00	.00	.00	9.6	9.5	10.1	.00	.01	.00	.00
13	25356.	.07	.00	.23-04	.00	.00	.00	9.6	9.6	10.1	.00	.01	.00	.00
14	25121.	.08	.00	.65-04	.00	.00	.00	9.6	9.6	10.1	.00	.01	.00	.00
15	25024.	.08	.00	.68-04	.00	.00	.00	9.6	9.6	10.1	.00	.02	.00	.00
16	24953.	.08	.00	.79-04	.00	.00	.00	9.6	9.6	10.1	.00	.02	.00	.00
17	24483.	.08	.01	.22-03	.00	.00	.00	9.7	9.7	10.1	.00	.02	.00	.00
18	24021.	.09	.01	.30-03	.00	.00	.00	9.7	9.7	10.1	.00	.02	.00	.00
19	22780.	.11	.01	.12-02	.00	.00	.00	9.8	9.8	10.1	.00	.02	.00	.00
20	23202.	.10	.01	.12-02	.00	.00	.00	9.7	9.7	10.1	.00	.02	.00	.00
21	23252.	.10	.01	.11-02	.00	.00	.00	9.7	9.7	10.1	.00	.02	.00	.00
22	21582.	.12	.01	.43-02	.00	.00	.00	9.8	9.8	10.1	.00	.02	.00	.00
23	21621.	.12	.01	.89-02	.00	.00	.00	9.6	9.8	10.1	.00	.02	.00	.00
24	21048.	.12	.01	.18-01	.00	.00	.01	9.9	9.9	10.1	.00	.02	.00	.00
25	21032.	.13	.01	.11-01	.00	.00	.01	9.9	9.9	10.1	.00	.03	.00	.00
26	20580.	.13	.01	.37-01	.00	.01	.01	9.9	9.9	10.1	.00	.03	.00	.00
[redacted]	[redacted]	.17	.01	.21+00	.00	.02	.02	10.2	10.2	10.1	.00	.02	.00	.00
28	20378.	.14	.01	.51-01	.00	.01	.01	9.9	9.9	10.1	.00	.03	.00	.00
31	19493.	.15	.01	.10+00	.00	.01	.02	9.9	9.9	10.1	.00	.03	.00	.00
32	19660.	.16	.01	.11+01	.00	.03	.03	9.9	10.0	10.1	.01	.03	.00	.00
35	19857.	.16	.01	.16+00	.00	.02	.02	9.9	10.0	10.1	.00	.04	.00	.00
36	19618.	.16	.01	.53+00	.00	.02	.02	9.9	10.0	10.1	.01	.03	.00	.00
37	19574.	.16	.01	.38+01	.00	.05	.04	10.0	10.0	10.1	.01	.03	.00	.00
43	14015.	.22	.01	.14+01	.00	.05	.06	10.3	10.3	10.1	.01	.04	.00	.00
44	11477.	.23	.01	.39+00	.00	.03	.04	10.5	10.5	10.1	.01	.04	.00	.00
45	10536.	.24	.02	.20+01	.00	.04	.06	10.5	10.6	10.1	.01	.03	.00	.00
46	7456.	.24	.01	.21+00	.00	.02	.03	10.8	10.8	10.1	.01	.03	.00	.00
47	3319.	.25	.01	.26-01	.00	.01	.01	11.0	11.0	10.1	.00	.01	.00	.00
48	812.	.25	.01	.23-02	.00	.00	.00	11.2	11.2	10.1	.00	.00	.00	.00
49	101.	.25	.01	.95-04	.00	.00	.00	11.3	11.2	10.1	.00	.00	.00	.00
50	3.	.25	.01	.20-05	.00	.00	.00	11.3	11.3	10.0	.00	.00	.00	.00
52	19719.	.16	.01	.84+00	.00	.03	.03	10.0	10.0	10.1	.01	.04	.00	.00
53	19733.	.16	.01	.11+00	.00	.01	.02	10.0	10.0	10.1	.00	.04	.00	.00
54	19736.	.16	.01	.18+00	.00	.02	.02	10.0	10.0	10.1	.00	.04	.00	.00
55	19608.	.16	.01	.66-01	.00	.01	.01	10.0	10.0	10.1	.00	.04	.00	.00
56	19175.	.16	.01	.13-01	.00	.01	.01	10.0	10.0	10.1	.00	.04	.00	.00
57	18365.	.17	.01	.28-02	.00	.00	.01	10.1	10.1	10.1	.00	.04	.00	.00
58	17247.	.18	.01	.68-03	.00	.00	.00	10.1	10.1	10.1	.00	.03	.00	.00
59	15569.	.18	.01	.10-03	.00	.00	.00	10.2	10.2	10.1	.00	.03	.00	.00
60	12088.	.20	.01	.12-04	.00	.00	.00	10.5	10.5	10.1	.00	.02	.00	.00

Table D-6 - (Cont.)

Standard Printout Format for Computed Water Quality

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
AVERAGE RUNOFF CONDITIONS - STEADY STATE

TETRA TECH, INC.
LAFAYETTE, CALIF.

QUALITY RESULTS, DAY 136

JUN	TDS MG/L	TOT N MG/L	TOT P MG/L	T COL NO/100ML	F COL NO/100ML	C BOD MG/L	N BOD MG/L	OXY MG/L	O SAT MG/L	TEMP C	CONST 1 UNITS	CONST 2 UNITS	CONST 3 UNITS	CONST 4 UNITS
100	20303.	.14	.01	.16+00	.00	.01	.01	9.9	9.9	10.1	.00	.03	.00	.00
101	20337.	.14	.01	.17+00	.00	.01	.01	9.9	9.9	10.1	.00	.03	.00	.00
102	19717.	.15	.01	.71+00	.00	.03	.03	10.0	10.0	10.1	.01	.03	.00	.00
103	20154.	.15	.01	.44+00	.00	.02	.02	9.9	9.9	10.1	.00	.03	.00	.00
104	19937.	.15	.01	.81+00	.00	.02	.02	9.9	9.9	10.1	.01	.03	.00	.00
105	19125.	.17	.01	.10+01	.00	.05	.04	10.0	10.0	10.1	.01	.04	.00	.00
106	19958.	.15	.01	.11+01	.00	.02	.02	9.9	9.9	10.1	.01	.03	.00	.00
107	19051.	.19	.01	.27+01	.00	.06	.05	10.0	10.0	10.1	.01	.04	.00	.00
108	18672.	.18	.01	.31+01	.00	.06	.06	10.0	10.0	10.1	.01	.04	.00	.00
109	19773.	.16	.01	.22+01	.00	.03	.03	9.9	10.0	10.1	.01	.03	.00	.00
110	19839.	.18	.01	.44+01	.00	.07	.06	10.0	10.0	10.1	.01	.04	.00	.00
111	19500.	.16	.01	.41+01	.00	.05	.04	9.9	10.0	10.1	.01	.03	.00	.00
112	19462.	.17	.01	.61+01	.00	.06	.05	10.0	10.0	10.1	.01	.03	.00	.00
113	19065.	.16	.01	.35+01	.00	.04	.04	9.9	10.0	10.1	.01	.03	.00	.00
114	19063.	.18	.01	.13+02	.00	.09	.08	10.0	10.0	10.1	.02	.04	.00	.00
115	18902.	.18	.01	.87+01	.00	.08	.07	10.0	10.0	10.1	.02	.04	.00	.00
116	18789.	.18	.01	.67+01	.00	.08	.07	10.0	10.0	10.1	.02	.04	.00	.00
117	18146.	.21	.02	.30+02	.00	.17	.14	10.0	10.1	10.1	.03	.04	.00	.00
118	17957.	.20	.01	.11+02	.00	.10	.09	10.0	10.1	10.1	.02	.04	.00	.00
119	17870.	.20	.01	.65+01	.00	.08	.08	10.0	10.1	10.1	.02	.04	.00	.00
120	17650.	.21	.01	.15+02	.00	.12	.11	10.0	10.1	10.1	.02	.04	.00	.00
121	17606.	.20	.01	.13+02	.00	.11	.10	10.0	10.1	10.1	.02	.04	.00	.00
122	17292.	.20	.01	.80+01	.00	.09	.08	10.1	10.1	10.1	.02	.04	.00	.00
123	17281.	.21	.01	.10+02	.00	.10	.09	10.1	10.1	10.1	.02	.04	.00	.00
124	16794.	.21	.01	.74+01	.00	.09	.08	10.1	10.1	10.1	.02	.04	.00	.00
125	15820.	.21	.01	.77+01	.00	.09	.08	10.1	10.1	10.1	.02	.04	.00	.00
126	16707.	.21	.01	.59+01	.00	.08	.09	10.1	10.2	10.1	.02	.04	.00	.00
127	16057.	.21	.01	.43+01	.00	.07	.07	10.1	10.2	10.1	.02	.04	.00	.00
128	15216.	.22	.01	.27+01	.00	.06	.07	10.2	10.3	10.1	.01	.04	.00	.00

Table D-7

Alternative Printout Format for Computed Water Quality
(This printout was not generated by the sample problem)

1 YEAR DYNAMIC SIMULATION OF SALINITY AND STP INFLUENCE

UPPER COOK INLET, KNIK ARM AND TURNAGAIN ARM
JUNE - SEPT RUNOFF CONDITIONS - DYNAMIC

[redacted] [redacted] [redacted]

1	30558.	2	30108.	3	29731.	4	29662.	5	28925.	6	29203.	7	28116.	8	27871.	9	25948.	10	26800.
11	25404.	12	24503.	13	23368.	14	22964.	15	22800.	16	22741.	17	21937.	18	21239.	19	19101.	20	19937.
21	19986.	22	17130.	23	17052.	24	16370.	25	16357.	26	15317.	[redacted]	[redacted]	28	15416.	29	0.	30	0.
31	14964.	32	14399.	33	0.	34	0.	35	14763.	36	14495.	37	13713.	38	0.	39	0.	40	0.
41	0.	42	0.	43	5531.	44	3297.	45	2758.	46	1190.	47	214.	48	18.	49	1.	50	0.
51	0.	52	14372.	53	14711.	54	14684.	55	14643.	56	14214.	57	13005.	58	11227.	59	8772.	60	4700.
61	0.	62	0.	63	0.	64	0.	65	0.	66	0.	67	0.	68	0.	69	0.	70	0.
71	0.	72	0.	73	0.	74	0.	75	0.	76	0.	77	0.	78	0.	79	0.	80	0.
81	0.	82	0.	83	0.	84	0.	85	0.	86	0.	87	0.	88	0.	89	0.	90	0.
91	0.	92	0.	93	0.	94	0.	95	0.	96	0.	97	0.	98	0.	99	0.	100	15167.
101	15011.	102	13953.	103	14859.	104	14344.	105	12869.	106	14445.	107	12743.	108	12030.	109	14086.	110	12354.
111	13731.	112	13477.	113	13873.	114	12711.	115	12493.	116	12242.	117	11163.	118	10830.	119	10677.	120	10342.
121	10255.	122	9778.	123	9755.	124	9008.	125	9037.	126	8877.	127	7948.	128	6879.				

OPP CONST 1 , UNITS FOR DAY 360

1	.04	2	.08	3	.10	4	.12	5	.16	6	.15	7	.20	8	.22	9	.31	10	.27
11	.33	12	.38	13	.43	14	.45	15	.45	16	.46	17	.49	18	.51	19	.60	20	.56
21	.55	22	.66	23	.63	24	.58	25	.76	26	.71	27	.57	28	.85	29	.00	30	.00
31	.97	32	1.02	33	.00	34	.00	35	1.01	36	1.02	37	1.11	38	.00	39	.00	40	.00
41	.00	42	.00	43	.70	44	.42	45	.35	46	.15	47	.03	48	.00	49	.00	50	.00
51	.00	52	1.06	53	1.02	54	1.03	55	1.01	56	.96	57	.86	58	.73	59	.56	60	.30
61	.00	62	.00	63	.00	64	.00	65	.00	66	.00	67	.00	68	.00	69	.00	70	.00
71	.00	72	.00	73	.00	74	.00	75	.00	76	.00	77	.00	78	.00	79	.00	80	.00
81	.00	82	.00	83	.00	84	.00	85	.00	86	.00	87	.00	88	.00	89	.00	90	.00
91	.00	92	.00	93	.00	94	.00	95	.00	96	.00	97	.00	98	.00	99	.00	100	.86
101	.81	102	.94	103	.91	104	.95	105	1.09	106	.96	107	1.18	108	1.17	109	1.02	110	1.24
111	1.10	112	1.16	113	1.07	114	1.33	115	1.25	116	1.25	117	1.69	118	1.32	119	1.24	120	1.42
121	1.34	122	1.21	123	1.29	124	1.17	125	1.15	126	1.12	127	1.02	128	.88				

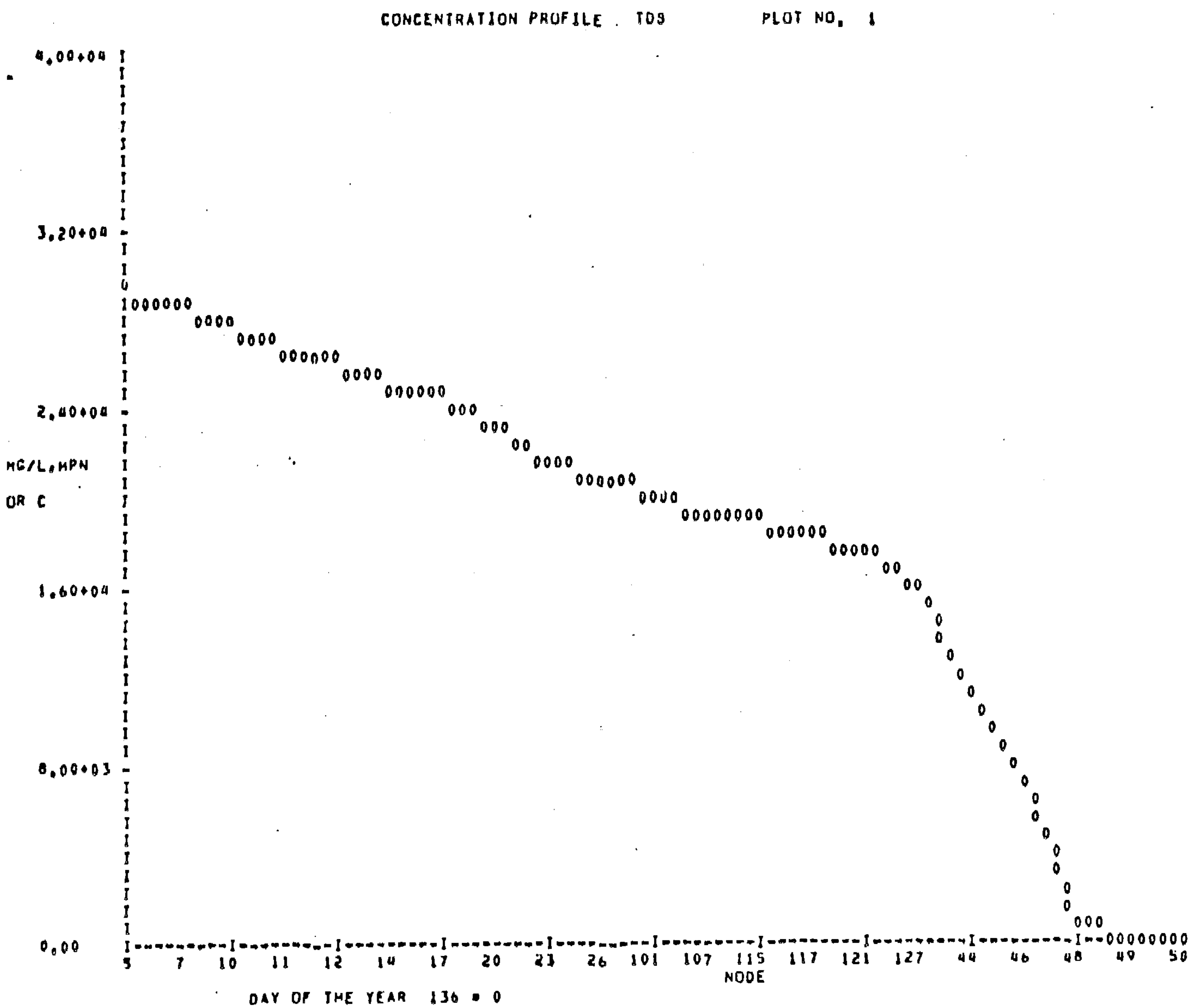


FIGURE D-1 COMPUTED CONCENTRATION VERSUS NODE LOCATION

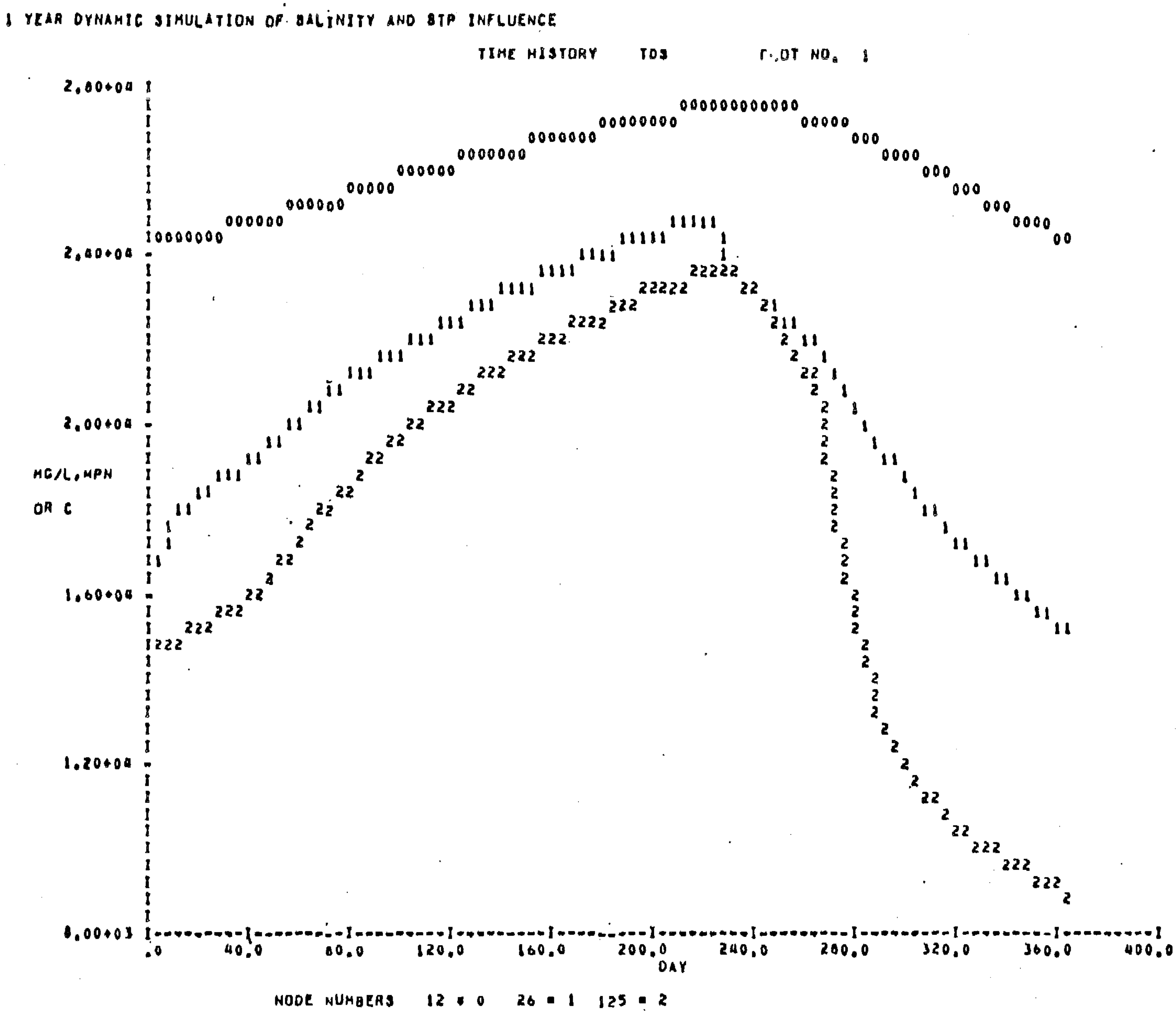


FIGURE D-2 COMPUTED CONCENTRATION VERSUS TIME AT SELECTED NODES
(THIS PRINTOUT WAS NOT GENERATED BY THE SAMPLE PROBLEM)

APPENDIX E

```
C....
C      HYDRO IS A MATHEMATICAL MODEL DEVELOPED TO SIMULATE
C      THE HYDRODYNAMICS OF AN ESTUARY.
C
C      DEVELOPMENT OF THE MODEL WAS DONE UNDER THE SPONSORSHIP
C      OF THE CALIFORNIA DEPARTMENT OF WATER RESOURCES, CALIFORNIA
C      STATE WATER RESOURCES CONTROL BOARD AND THE NASSAU-SUFFOLK
C      REGIONAL PLANNING BOARD, NEW YORK.
C
C      ADDITIONAL MODIFICATIONS WERE MADE UNDER CONTRACT NO.
C      DACW85-76-C-0044, DEPARTMENT OF THE ARMY, ALASKA DISTRICT,
C      ANCHORAGE, ALASKA.
C
C      QUESTIONS REGARDING THE COMPUTER CODE OR THE MODEL APPLICATION
C      SHOULD BE DIRECTED TO DONALD J. SMITH, TETRA TECH, INC.,
C      3700 MT. DIABLO BLVD., LAFAYETTE, CALIF., 94549 (415-283-3771)
C....
      COMMON /TID/ NJEX,JEX(10),AX(7,10),H,TT(50),YY(50),PERIOD,JGH(200)
     1,       RANGE(200,2),TLAG(200,2)
      COMMON/GEOM/ JUN(200),NCHAN(200,8),NJUNC(300,2),NOIN(200)
     1,       QSIN(41,26),QCIN(200),QOU(200),QIN(200),A(300),ACK(300)
     2,       AB(300),EVAP(200),AK(300),AS(200),ASK(200),AT(300),B(300)
     3,       CMN(300),DEPTH(200),H(200),LEN(300),R(300),V(300),X(200)
     4,       VOL(200),Y(200),Q(300),ACAVE(300),ASAVE(200),ASB(200)
     5,       RAVE(300),DEPAVE(200),DEPTHO(200),FWIND(300),HAVE(200)
     6,       HN(200),HT(200),QAVE(300),QH(300),QP(300),RAVL(300),ROH(200)
     7,       RS(300),RSQ(300),SFLOW(200),VABS(300),VAVE(300),QN(300)
     8,       VOLAVE(200),VOLB(200),VS(300),VSQ(300),VT(300),VB(300)
      COMMON/MISC/ NJ,NC,DELT,DELTQ,NHSTEP,NQSTEP,T,T2,DELT2,IDAY
     1,           DMIN,ID,NHPERQ,ITS,NTEMP(8),QERR(10),GFLOOD(10)
      COMMON/IO/ NPRT,KPRT,NQPRT,NHPRT,ICOL(10),JPRT(30),CPRT(30)
     1,       PRTH(50,30),PRTV(50,30),PRTQ(50,30),HOUR(50),NJPLOT(5,3)
     2,       NCPLOT(5,3),TITLE(20),TITL(20),LTIME,JTR(48),NTSL
      DIMENSION WAIND(5,2),WIND(5,25),WDIR(5,25),DVDT(200),IN(25)
      DIMENSION MDAY(48)
      DIMENSION STAR(9)
C     DIMENSION EVAPO(25),WAIND(25),EVAPR(20,25),NEVAP(20,2),SUMEV(200)
      DIMENSION EVAPR(20,25),NEVAP(20,2),SUMEV(200)
      INTEGER CPRT
      REAL LEN
      EQUIVALENCE(HN(1),DVDT(1))
      DATA STAR0/1H /, STAR1/1H*/
C
C**** TITLE INFORMATION
      READ (5,100) TITLE,TITL
  100 FORMAT (20A4)
  110 FORMAT (1H1,20A4,10X,'TETRA TECH INC.',/1X,20A4,10X,'LAFAYETTE, CA
     1LIFORNIA',/,1H 90X,'TIDAL HYDRODYNAMICS PROGRAM'/)
C
C**** GENERAL CONTROL FOR SIMULATION AND PRINT
      READ (5,120) NSESON,NHPRT,NQPRT,NTSL,NSTAGE,NTFLOW,NDYNAM,NSTEAD,N
     1N
      NDYNAM=0
      READ (5,120) (MDAY(I),I=1,NSESON)
      N20=NDYNAM
      N30=NSTEAD
  120 FORMAT (16I5)
```



```
      READ (5,120) (JPRT(I),I=1,NHPRT)
      READ (5,120) (CPRT(I),I=1,NQPRT)
      IF (NSTAGE.GT.0) READ (5,130) ((NJPLOT(I,N),N=1,3),I=1,NSTAGE)
      IF (NTFLOW.GT.0) READ (5,130) ((NCPLOT(I,N),N=1,3),I=1,NTFLOW)
  130 FORMAT (3I5)
      JTR(2)=0
      IF (NTSL.GT.0) READ (5,120) (JTR(I),I=1,NTSL)
      READ (5,140) DELT,DELTQ,PERIOD,DMIN
      DMIN=DMIN/2.
  140 FORMAT (16F5.0)
      NQSTEP=3600.*PERIOD/DELTQ+0.1
      NHSTEP=3600.*PERIOD/DELT+0.1
      NHPERQ=NHSTEP/NQSTEP
      NPRT=NHPERQ
C
C
C.... READ AND PROCESS SYSTEM GEOMETRY DATA
      NEXIT=0
      CALL GEOMET (NEXIT)
      IF (NEXIT.GT.0) GO TO 150
C
C.... CALL RENUMBERING ROUTINE IF STEADY STATE QUALITY TAPE IS SPECIFIED
      IF (NSTEAD.GT.0) CALL NUMBER (NN)
  150 CONTINUE
      IF (NN.EQ.999) NEXIT=1
      WRITE (6,110) TITLE,TITL
      WRITE (6,160) NSESON,(MDAY(I),I=1,NSESON)
      WRITE (6,170) NHSTEP,NQSTEP,NSTAGE,NTFLOW,N20,N30,PERIOD
  160 FORMAT ('0NUMBER OF HYDRAULIC CONDITIONS',T50,I5/,'0NUMBER OF TIDA
     1L CYCLES PER CONDITION',T50,16I5/,(T50,16I5))
  170 FORMAT (,'0NUMBER OF HYDRAULIC TIME STEPS PER CYCLE',T50,I5/,'0NUM
     1BER OF QUALITY TIME STEPS PER CYCLE',T50,I5/,'0NUMBER OF TIDAL STA
     2GE PLOTS              ',T50,I5/,'0NUMBER OF TIDAL VELOCITY PLOTS
     3   ',T50,I5/,'0DYNAMIC HYDRAULIC OUTPUT UNIT          ',T50,I5/,'0S
     4TEADY STATE HYDRAULICS OUTPUT UNIT    ',T50,I5/,'0TIDAL PERIOD, HOU
     5RS',T50,F5.0/)
      WRITE (6,180) NHPRT (JPRT(I),I=1,NHPRT)
  180 FORMAT (' RESULTS PRINTED AT THE FOLLOWING',I3,' JUNCTIONS'//,(10X
     1,16I6))
      WRITE (6,190) NQPRT,(CPRT(I),I=1,NQPRT)
  190 FORMAT (//15X,'AND FOR THE FOLLOWING'I3,' CHANNELS'//(10X,16I6))
      WRITE (6,200)
  200 FORMAT ('0FOLLOWING PLOTS ARE MADE'//)
      DO 220 I=1,NSTAGE
      WRITE (6,210) (NJPLOT(I,N),N=1,3)
  210 FORMAT (15X,' TIDAL STAGE FOR JUNCTIONS',3I5)
  220 CONTINUE
      DO 240 I=1,NTFLOW
      WRITE (6,230) (NCPLOT(I,N),N=1,3)
  230 FORMAT (15X,' TIDAL FLOW FOR CHANNELS  ',3I5)
  240 CONTINUE
C
C.... WRITE INVARIENT GEOMETRY DATA
  250 FORMAT (50X,'INVARIANT CHANNEL DATA'//,' CHANNEL     LENGTH, FT
     1  WIDTH, FT   HYD RAD, FT  MID ELEV, FT   MANNINGS N   END JUNCTIO
     2NS   SIDE SLOPE   MAX TIME, SEC'/)
      II=0
```

```
      DO 300 J=1,NC
      IF (NJUNC(J,1).EQ.0) GO TO 300
      IF (MOD(II,45).NE.0) GO TO 260
      WRITE (6,110) TITLE,TITL
      WRITE (6,250)
  260 II=II+1
      STAR(1)=STARO
      TC=R(J)
      IF (ACK(J).LE.0.0) GO TO 290
      TB=0.9
      DO 270 I=1,10000
      TB=TB+0.1
      TA=B(J)*R(J)-TB*(B(J)+(B(J)-TB*ACK(J)))/2.0
      IF (TA.LE.0.0) GO TO 280
  270 CONTINUE
  280 TC=B(J)/ACK(J)
      TC=AMIN1(TC,TB)
      IF (ABS(TB-TC).GT.0.01.AND.TC.LT.DMIN) STAR(1)=STAR1
  290 CONTINUE
      RS(J)=TC
      WRITE (6,310) J,STAR(1),LEN(J),B(J),R(J),TC,CHN(J),(NJUNC(J,K),K=1
     1,2),ACK(J),VT(J)
      IF (MOD(II,45).EQ.0) WRITE (6,320)
  300 CONTINUE
  310 FORMAT (I7,A1,F13.0,F10.0,F14.1,F14.1,F12.3,I9,I8,F13.0,F14.0)
      IF (MOD(II,45).NE.0) WRITE (6,320)
  320 FORMAT ('0NOTE - - * INDICATES NEGATIVE WIDTH IS POSSIBLE WITH ANT
     1ICIPATED TIDAL STAGE')
  330 FORMAT (50X,'INVARIANT JUNCTION DATA'//' JUNCTION   AREA, MSF    SL
     1OPE, MSF/FT   DEPTH, FT    MIN ELEV, FT     X-CORD      Y-CORD
     2      CHANNELS ENTERING JUNCTION'/)
      II=0
      TD=0.
      TE=0.
      DO 390 J=1,NJ
      IF (NCHAN(J,1).EQ.0) GO TO 390
      IF (MOD(II,45).NE.0) GO TO 340
      WRITE (6,110) TITLE,TITL
      WRITE (6,330)
  340 II=II+1
      TD=TD+VOL(J)
      TE=TE+AS(J)
      TC=DEPTH(J)
      STAR(9)=STARO
      IF (ASK(J).LE.0.0) GO TO 370
      TB=9.0
      DO 350 I=1,10000
      TB=TB+0.1
      TA=VOL(J)-TB*(AS(J)+(AS(J)-TB*ASK(J)))/2.0
      IF (TA.LE.0.0) GO TO 360
  350 CONTINUE
  360 TC=AS(J)/ASK(J)
      TC=AMIN1(TC,TD)
      IF (ABS(TB-TC).GT.0.01.AND.TC.LT.DMIN) STAR(9)=STAR1
  370 CONTINUE
      DO 380 K=1,8
      N=NCHAN(J,K)
```



```
      STAR(K)=STARO
      IF (TC.LT.RS(N)) STAR(K)=STAR1
  380 CONTINUE
      WRITE (6,400) J,STAR(9),STAR(9),AS(J),ASK(J),DEPTH(J),TC,X(J),Y(J)
     1,(NCHAN(J,K),STAR(K),K=1,8)
      IF (MOD(II,45).EQ.0) WRITE (6,410)
  390 CONTINUE
  400 FORMAT (I7,2A1,-6PF10.0,F13.1,0PF15.1,F16.1,F13.1,F11.1,I7,A1,7(I4
     1,A1))
      IF (MOD(II,45).NE.0) WRITE (6,410)
  410 FORMAT ('0NOTE - - * INDICATES THAT DEPTH OF CHANNEL ENTERING JUNC
     1TION IS LARGER THAN JUNCTION DEPTH'/,9X,'** INDICATES NEGATIVE VOL
     2UME OR AREA IS POSSIBLE WITH ANTICIPATED TIDAL STAGE')
      TA=TD/TE
      WRITE (6,420) TD,TE,TA
  420 FORMAT (///20H ESTUARY STATISTICS (AT MSL),/5X,26H TOTAL VOLUME, C
     1U FT          ,E13.4,/5X,26H TOTAL SURFACE AREA, SQ FT,E13.4,/5X,26H M
     2EAN DEPTH, FT             ,E13.4)
C
      IF (N20.LE.0) GO TO 430
      REWIND N20
      WRITE (N20) NJ,NC,((NCHAN(J,I),I=1,8),J=1,NJ),((NJUNC(N,I),I=1,2),
     1LEN(N),N=1,NC)
  430 CONTINUE
C
      IF (N30.LE.0) GO TO 440
      REWIND N30
      WRITE (N30) NJ,NC,IIQ
      WRITE (N30) (JUN(J),(NCHAN(J,I),I=1,8),J=1,NJ),(NJUNC(N,1),NJUNC(N
     1,2),LEN(N),N=1,NC)
  440 CONTINUE
C
C.... HYDRAULIC CONDITIONS LOOP
      DO 1170 IS=1,NSESON
      READ (5,100) TITL
      READ (5,120) NTEMP
      WRITE (6,110) TITLE,TITL
      IF (NTEMP(1).EQ.1) GO TO 460
C
C..... INPUT TIDAL CONDITIONS
      READ (5,120) NJEX
      W=2.*3.14159/PERIOD
      DO 450 N=1,NJEX
      READ (5,120) JEX(N),NI,MAXIT,NCHTID
      READ (5,140) (TT(I),YY(I),I=1,NI)
      CALL TIDCF (NI,MAXIT,NCHTID,N)
  450 CONTINUE
      WRITE (6,110) TITLE,TITL
  460 IF (NTEMP(2).EQ.1) GO TO 530
C
C**** EVAPORATION
      F=1./(12.*30.5*86400.)
      WRITE (6,470)
  470 FORMAT('0JUNCTION TO JUNCTION     EVAPORATION RATE, INCHES/MONTH'/)
C 470 FORMAT ('0HOURLY EVAPORATION AND RAINFALL RATE'/,' JUNCTION TO JUN
C    1CTION   /   EVAPORATION, INCHES/MONTH   /    RAINFALL,INCHES/HOUR')
      DO 480 J=1,NJ
```

```
  480 EVAP(J)=0
      DO 510 I=1,21
      READ (5,700) J1,J2,EVAPA
      IF (J1.LE.0) GO TO 520
C     READ (5,550) (EVAPD(J),RAINO(J),J=1,25)
      WRITE(6,490) J1,J2,EVAPA
  490 FORMAT(I9,I12,F20.2)
C     WRITE (6,490) J1,J2,EVAPO,RAINO
C 490 FORMAT (I9,I12,/(5X,25F5.1))
      NEV=I
      NEVAP(I,1)=J1
      NEVAP(I,2)=J2
      TA=EVAPA*F
      DO 500 J=1,25
  500 EVAPH(I,J)=TA
C 500 EVAPH(I,J)=EVAPD(J)*F-RAINO(J)/43200.
  510 CONTINUE
  520 CONTINUE
  530 IF (NTEMP(3).EQ.1) GO TO 600
C
C.... WIND VELOCITY AND DIRECTION
      WRITE (6,540)
  540 FORMAT ('OHOURLY WIND VELOCITY (MPH) AND DIRECTION (DEGREES CLOCKW
     1ISE FROM NORTH)'/,' CHANNEL TO CHANNEL'/)
      DO 570 I=1,NJ
      READ (5,130) J1,J2
      IF (J1.EQ.0) GO TO 580
      NWIND(I,1)=J1
      NWIND(I,2)=J2
      READ (5,550) (WIND(I,J),WDIR(I,J),J=1,25)
  550 FORMAT (16F5.0)
      IZON=1
      WRITE (6,560) J1,J2,(J,WIND(I,J),WDIR(I,J),J=1,25)
  560 FORMAT (I8,I11,5(I9,F6.1,F6.0)/,(19X,5(I9,F6.1,F6.0)))
  570 CONTINUE
  580 CONTINUE
      IF (NTEMP(4)+NTEMP(5)+NTEMP(6).LT.3) WRITE (6,590)
  590 FORMAT (//,' INFLOW AND OUTFLOW DATA')
  600 IF (NTEMP(4).EQ.1) GO TO 670
C
C.... INFLOW AND OUTFLOW
      DO 610 J=1,NJ
      QIN(J)=0.0
      QOU(J)=0.0
  610 CONTINUE
      WRITE (6,620)
  620 FORMAT ('OJUNCTION      INFLOW, CFS      WITHDRAWL, CFS'/)
      DO 650 J=1,NJ
      READ (5,630) N,QQIN,QQOU
  630 FORMAT (I5,7F10.0)
      IF (N.LE.0) GO TO 660
      WRITE (6,640) N,QQIN,QQOU
  640 FORMAT (I9,F14.2,F18.2)
      QIN(N)=QQIN
      QOU(N)=QQOU
  650 CONTINUE
  660 CONTINUE
```



```
  670 IF (NTEMP(5).EQ.1) GO TO 740
C
C.... GROUND WATER INFLOW
      DO 680 J=1,NJ
  680 QGIN(J)=0
      WRITE (6,690)
  690 FORMAT ('OJUNCTION TO JUNCTION      GROUND WATER INFLOW, CFS')
      DO 720 I=1,NJ
      READ (5,700) J1,J2,GROUND
  700 FORMAT (2I5,F5.0)
      IF (J1.LE.0) GO TO 730
      WRITE (6,710) J1,J2,GROUND
  710 FORMAT (I9,I12,F19.2)
      DO 720 JJ=J1,J2
  720 QGIN(JJ)=GROUND
  730 CONTINUE
  740 IF (NTEMP(6).EQ.1) GO TO 840
C
C.... STORM WATER INFLOW
      DO 750 J=1,26
  750 QSIN(41,J)=0.
      DO 760 J=1,NJ
  760 NQIN(J)=41
      WRITE (6,770)
  770 FORMAT ('OJUNCTION',T27,'STORM WATER INFLOW, HOUR AND FLOW, CFS')
      DO 820 J=1,40
      READ (5,780) N,(TN(I),I=1,12)
  780 FORMAT (I5,12F5.0)
      IF (N.EQ.0) GO TO 830
      READ (5,790) (TN(I),I=13,25)
  790 FORMAT (13F5.0)
      TA=0
      DO 800 I=1,25
      QSIN(J,I)=TN(I)
  800 TA=TA+TN(I)
      QSIN(J,26)=TA/25.
      WRITE (6,810) N,(I,QSIN(J,I),I=1,26)
  810 FORMAT (I9,/(13(I4,F6.1)))
      NQIN(N)=J
  820 CONTINUE
  830 CONTINUE
  840 CONTINUE
      IF (NEXIT.LE.0) GO TO 860
      WRITE (6,850)
  850 FORMAT (///,10(10H    STOP   ),//,30X,' PROGRAM TERMINATION DUE TO
     1PREVIOUS ERROR',//,10(10H   SORRY  ))
      STOP
  860 CONTINUE
C
      T=0.0
      DELT2=DELT/2.0
      W=6.2832/(3600.*PERIOD)
      LTIME=0
      DO 870 I=1,50
      DO 870 J=1,30
      PHIH(I,J)=0.0
      PHIJ(I,J)=0.0
```

2-35-/35

```
  870 PRTY(I,J)=0.0
      DO 890 J=1,NJ
      SUMEV(J)=0.
      JGW(J)=0
      ASAVE(J)=0.0
      RUH(J)=0.0
      DVDT(J)=0.0
      VOLAVE(J)=0.0
      DEPAVE(J)=0.0
      HAVL(J)=0.
      RANGE(J,1)=-1000
      RANGE(J,2)=1000
      DO 880 I=1,2
  880 TLAG(J,I)=0.0
      DO 890 N=1,NC
      VS(N)=0.0
      RS(N)=0.0
      VARD(N)=0.
      ACAVE(N)=0.0
      RSD(N)=0.0
      VSD(N)=0.0
      RAVE(N)=0.0
      QAVE(N)=0.
      BAVE(N)=0
      QP(N)=0
      QM(N)=0
  890 VAVL(N)=0.
      DO 900 N=1,NJEX
      J=JEX(N)
      JGW(J)=N
      QFLOOD(N)=0.0
      QEBB(N)=0.0
  900 CONTINUE
C
C.... DAILY TIME STEP LOOP
      IDAY=NDAY(IS)
      DO 1060 II=1,IDAY
      ID=II
C
C.... QUALITY TIME STEP LOOP
      DO 1050 IQ=1,NQSTEP
      IIQ=IQ
      IF (ID.LT.IDAY) GO TO 940
      KPRT=NPRT
      DO 910 J=1,NJ
      DEPTHB(J)=0.
      VOLB(J)=0.
      ASB(J)=0.0
  910 CONTINUE
      DO 920 I=1,NEV
      J1=NEVAP(I,1)
      J2=NEVAP(I,2)
      DO 920 J=J1,J2
  920 SUMEV(J)=SUMEV(J)+EVAPR(I,IQ)*AS(J)
      DO 930 N=1,NC
      QB(N)=0.
      AB(N)=0.
```

H Y D R O

```
  930 VB(N)=0.0
C
C.... WIND FORCE
  940 DO 950 N=1,NC
  950 FWIND(N)=0.0
      DO 970 I=1,IZON
      IF (WIND(I,IQ).LE.0.0) GO TO 970
      J1=NWIND(I,1)
      J2=NWIND(I,2)
      DO 960 N=J1,J2
      IF (NJUNC(N,1).EQ.0) GO TO 960
      NL=NJUNC(N,1)
      NH=NJUNC(N,2)
      XD=X(NH)-X(NL)
      YD=Y(NH)-Y(NL)
      IF (ABS(XD)+ABS(YD).LE.0.0) GO TO 960
      FWIND(N)=-WIND(I,IQ)**2*COS(WDIR(I,IQ)/57.-ATAN2(XD,YD))*1.5E-6
  960 CONTINUE
  970 CONTINUE
C
C     EVAPORATION
      DO 980 I=1,NEV
      J1=NEVAP(I,1)
      J2=NEVAP(I,2)
      DO 980 J=J1,J2
  980 EVAP(J)=EVAPR(I,IQ)
C
      CALL DYNFLO
      IF (ID.LT.IDAY) GO TO 1050
      F=FLOAT(NHPERQ)
      DO 990 J=1,NJ
      DEPAVE(J)=DEPAVE(J)+DEPTHB(J)
      DEPTHB(J)=DEPTHB(J)/F
      VOLB(J)=VOLB(J)/F
      ASB(J)=ASB(J)/F
  990 CONTINUE
      DO 1000 N=1,NC
      QB(N)=QB(N)/F
      ACAVE(N)=ACAVE(N)+AB(N)
      AB(N)=AB(N)/F
 1000 VB(N)=VB(N)/F
      DO 1030 J=1,NJ
      IF (NCHAN(J,1).EQ.0) GO TO 1030
      TA=0.0
      DO 1010 K=1,8
      IF (NCHAN(J,K).EQ.0) GO TO 1020
      N=NCHAN(J,K)
 1010 TA=TA+ABS(Q(N))
 1020 SFLOW(J)=0.5*TA*DELTQ/VOL(J)
 1030 CONTINUE
C
      IF (N20.LE.0) GO TO 1050
      DO 1040 I=1,NJ
      K=QQ(N(I)
 1040 Q(I)=QQIN(K,IQ)
      WRITE (N20) IQ,(DEPTHB(J),VOL(J),ASB(J),QIN(J),Q(J),QGIN(J),QOU(J)
     1,J=1,NJ),(QB(N),AB(N),VB(N),N=1,NC)
```

2-35-136

```
1050 CONTINUE
1060 CONTINUE
C
      F=FLOAT(NHSTEP)
      DO 1070 J=1,NJ
      IF (NCHAN(J,1).EQ.0) GO TO 1070
      VOLAVE(J)=VOLAVE(J)/F
      HAVE(J)=HAVE(J)/F
      ASAVE(J)=AS(J)+ASK(J)*HAVE(J)
      DEPAVE(J)=DEPAVE(J)/F
1070 CONTINUE
      DO 1080 N=1,NC
      IF (NJUNC(N,1).EQ.0) GO TO 1080
      VS(N)=VSQ(N)-VAVE(N)**2/F
      RS(N)=RSQ(N)-RAVE(N)**2/F
      VS(N)=SQRT(VS(N)/(F-1.0))
      RS(N)=SQRT(RS(N)/(F-1.0))
      RAVE(N)=RAVE(N)/F
      QAVE(N)=QAVE(N)/F
      VABS(N)=VABS(N)/F
      VAVE(N)=VAVE(N)/F
      BAVE(N)=BAVE(N)/F
      ACAVE(N)=ACAVE(N)/F
1080 CONTINUE
      DO 1090 N=1,NJEX
      QFLOOD(N)=QFLOOD(N)/F
1090 QEBB(N)=QEBB(N)/F
      IF (N20+N30.LE.0) GO TO 1160
C
C     CALCULATE REAERATION COEFFICIENTS
      DO 1120 J=1,NJ
      SUMVH=0.
      SUMAC=0.0
      DO 1100 K=1,8
      N=NCHAN(J,K)
      IF (N.LE.0) GO TO 1110
      J1=NJUNC(N,1)
      J2=NJUNC(N,2)
      AREAC=RAVE(N)*LEN(N)
      HCHAN=R(N)-(H(J1)+H(J2))/2.+(HAVE(J1)+HAVE(J2))/2.
      SUMAC=SUMAC+AREAC*HCHAN
      VCHAN=(VABS(N)/HCHAN)**0.5
      SUMVH=SUMVH+VCHAN*AREAC
1100 CONTINUE
1110 CONTINUE
      ROR(J)=SUMVH*12.95/SUMAC
1120 CONTINUE
      IF (N30.LE.0) GO TO 1160
      DO 1130 I=1,NJ
      K=NOIN(I)
      Q(I)=QIN(I)+QSIN(K,26)
1130 VT(I)=QGIN(I)
      EVAP(1)=0.
      DO 1150 J=1,NJ
      IF (NCHAN(J,1).EQ.0) GO TO 1150
      K=NOIN(J)
      SUMEV(J)=SUMEV(J)/FLOAT(NOSTEP)
```

H Y D R O

```
      EVAP(1)=EVAP(1)+SUMEV(J)
      DVDT(J)=QIN(J)+QGIN(J)+QSIN(K,26)-QOU(J)-SUMEV(J)
      DO 1140 K=1,8
      IF (NCHAN(J,K).EQ.0) GO TO 1150
      N=NCHAN(J,K)
      F=1.0
      IF (NJUNC(N,1).EQ.J) F=-1.0
1140 DVDT(J)=DVDT(J)+F*QAVE(N)
1150 CONTINUE
      WRITE (N30) QEBB,QFLOOD,(DVDT(J),DEPAVE(J),ASAVE(J),VOLAVE(J),Q(J)
     1,VT(J),QOU(J),ROR(J),J=1,NJ),(ACAVE(N),QAVE(N),RS(N),HAVE(N),VS(N)
     2,VABS(N),N=1,NC)
1160 CONTINUE
      IF (N20.GT.0) WRITE (N20) (HOR(J),DEPAVE(J),J=1,NJ)
C
      CALL OUTPUT (LTIME,NSTAGE,NIFLOW)
1170 CONTINUE
      IF (N20.GT.0) END FILE N20
      IF (N30.GT.0) END FILE N30
      STOP
C
      END
```

CURVE

```
      SUBROUTINE CURVE (X,Y,NPT,NCV,NPLOT)
C
C     DIMENSION X(NPT,NCV),Y(NPT,NCV)  WHERE
C     NPT=NUMBER OF INPUT POINTS ON EACH CURVE
C     NCV=NUMBER OF CURVES ON EACH GRAPH.
C     NPLOT=PRINTED KEY.
C     IF (NPLOT) = -1, NO PAGE EJECT OR TITLE IS PRINTED.
C     .CURVE. DOES NOT HAVE VARIABLE DIMENTIONS,  CHANGE NEXT CARD
      DIMENSION X(103,1), Y(103,1), NPT(1), DUMX(4), DUMY(4)
      COMMON /LAB/ XLAB(11),YLAB(6),TITLE(12),HORIZ(13),VERT(6),IUNITO
C
C                                    SET UP X AND Y SCALES
C
      XMAX=-1.0E30
      XMIN=1.0E30
      YMAX=-1.0E30
      YMIN=1.0E30
      DO 100 K=1,NCV
      N=NPT(K)
      DO 100 J=1,N
      IF (X(J,K).GT.XMAX) XMAX=X(J,K)
      IF (X(J,K).LT.XMIN) XMIN=X(J,K)
      IF (Y(J,K).GT.YMAX) YMAX=Y(J,K)
      IF (Y(J,K).LT.YMIN) YMIN=Y(J,K)
100   CONTINUE
      DUMX(1)=XMIN
      DUMX(2)=XMAX
      CALL SCALE (DUMX,10.0,2,1)
      DUMY(1)=YMIN
      DUMY(2)=YMAX
      CALL SCALE (DUMY,5.0,2,1)
      DO 105 K=1,NCV
      N=NPT(K)
      X(N+1,K)=DUMX(3)
      X(N+2,K)=DUMX(4)
      Y(N+1,K)=DUMY(3)
      Y(N+2,K)=DUMY(4)
105   CONTINUE
C
C                                    FORM X LABELS AND FACTORS
C
      XMIN=DUMX(3)
      DELTX=DUMX(4)
      XLAB(1)=XMIN
      DO 110 I=1,10
110   XLAB(I+1)=XLAB(I)+DELTX
      XSCAL=100./(XLAB(11)-XMIN)
C
C                                    FORM Y LABELS AND FACTORS
C
      YMIN=DUMY(3)
      DELTY=DUMY(4)
      YLAB(6)=YMIN
      DO 115 I=1,5
115   YLAB(6-I)=YLAB(7-I)+DELTY
      YSCAL=50./(YLAB(1)-YMIN)
C
```

CURVE

```
C
C                                    INITIALIZE PLOT OUTLINE
      NCD=100
      CALL PPLOT (0,0,NCD,NPLOT)
      K=1
C
C                                    DRAW IN EACH CURVE
C
      DO 130 L=1,NCV
      IF (NPT(L).EQ.0) GO TO 125
C
C                                    JOINING XO YO AND XT YT
C
      XO=XSCAL*(X(1,L)-XMIN)
      YO=YSCAL*(Y(1,L)-YMIN)
      NPOINT=NPT(L)
      DO 120 N=2,NPOINT
      XT=XSCAL*(X(N,L)-XMIN)
      YT=YSCAL*(Y(N,L)-YMIN)
      CALL PINE (XO,YO,XT,YT,K,NPLOT)
      XO=XT
      YO=YT
120   CONTINUE
125   K=K+1
130   CONTINUE
C
C                                    OUTPUT FINAL PLOT
C
      NC=99
      CALL PPLOT (0,0,NC,NPLOT)
      RETURN
      END
```

2-35-138

```
      SUBROUTINE DYNFLO
      COMMON /TID/ NJEX,JEX(10),AK(7,10),W,TT(50),YY(50),PERIOD,JGW(200)
     ..      RANGE(200,2),TLAG(200,2)
      COMMON/GEOM/ JUN(200),NCHAN(200,8),NJUNC(300,2),NQIN(200)
     ..      QSIN(41,26),QGIN(200),QOU(200),QIN(200),A(300),ACK(300)
     ..      AB(300),EVAP(200),AK(300),AS(200),ASK(200),AT(300),B(300)
     ..      CMN(300),DEPTH(200),H(200),LEN(300),R(300),V(300),X(200)
     ..      VOL(200),Y(200),Q(300),ACAVE(300),ASAVE(200),ASU(200)
     ..      BAVE(300),DEPAVE(200),DEPTHB(200),FWIND(300),HAVE(200)
     ..      HN(200),HT(200),QAVE(300),QB(300),QP(300),RAVE(300),RUR(200)
     ..      PS(300),RSQ(300),SFLOW(200),VABS(300),VAVE(300),QN(300)
     ..      VOLAVE(200),VOLB(200),VS(300),VSQ(300),VT(300),VB(300)
      COMMON/MISC/ NJ,NC,DELT,DELTQ,NHSTEP,NQSTEP,T,T2,DELT2,IDAY
     ..         DMIN,IQ,NHPERD,ITU,NTEMP(8),DLRB(10),UFLOOD(10)
      COMMON/IO/ NPRT,KPRT,NQPRT,NHPRT,ICOL(10),JPRT(30),CPRT(30)
     ..      PRTH(50,30),PRTV(50,30),PRTQ(50,30),HOUR(50),NJPLOT(5,3)
     ..      NCPLOT(5,3),TITLE(20),TITL(20),LTIME,JTH(48),NTSL
C
      INTEGER CPRT
      REAL LEN
      DATA ISTOP /0/
      DATA TIME/0.0/
      DT=DELT/3600.
      TH=1/3600.
C
      DO 270 IH=1,NHPERD
      T2=T+DELT2
      T=T+DELT
C
C**** VELOCITIES3 AT T+DELT/2
C**** FLO-S AT T+DELT/4
C
      DO 105 N=1,NC
      IF (NJUNC(N,1).LE.0) GO TO 105
C
C******** CHECK FOR DRY (R.LT.0.5 FT) CHANNEL
      RNT=A(N)/B(N)
      IF (RNT.GT.0.5) GO TO 100
      VT(N)=0.0
      Q(N)=0.0
      GO TO 105
100   CONTINUE
      NL=NJUNC(N,1)
      NH=NJUNC(N,2)
      DELV2=V(N)*(1.-AT(N)/A(N))+DELT2*((V(N)**2/RNT)-32.1739)*(H(NH)-H(
     1NL))/LEN(N)
      V2=V(N)+DELV2
      TEMP=DELT2*AK(N)/RNT**1.3333333
      DELV1=0.5*((1./TEMP+2.*ABS(V2))-SQRT((1./TEMP+ABS(2.*V2))**2-4.*V2
     1**2))
      DELV1=-SIGN(DELV1,V2)
      VT(N)=V(N)+DELV1+DELV2+DELT2*FWIND(N)/RNT
      Q(N)=VT(N)*A(N)
105   CONTINUE
C
C**** HEADS AT T+DELT/2
      DO 135 J=1,NJ
      IF (NCHAN(J,1).LE.0) GO TO 135
      IF (JGW(J).EQ.0) GO TO 115
      N=JGW(J)
      TA=W*T2
      HT(J)=AX(1,N)
      DO 110 I=2,4
      TB=I-1
110   HT(J)=HT(J)+AX(I,N)*SIN(TA*TB)+AX(I+3,N)*COS(TA*TB)
      GO TO 135
115   CONTINUE
      L=NQIN(J)
      SUMQ=QOU(J)-QIN(J)-QGIN(J)-QSIN(L,IIQ)+EVAP(J)*AS(J)
      DO 125 K=1,8
      IF (NCHAN(J,K).LE.0) GO TO 130
      N=NCHAN(J,K)
      IF (J.NE.NJUNC(N,1)) GO TO 120
      SUMQ=SUMQ+Q(N)
      GO TO 125
120   SUMQ=SUMQ-Q(N)
125   CONTINUE
130   HT(J)=H(J)-DELT2*SUMQ/AS(J)
135   CONTINUE
C
C**** CHANNEL AREAS AT T+DELT/2
C**** VELOCITIES AT T +DELT
C**** FLOWS AT T+DELT/2
C
      DO 145 N=1,NC
      IF (NJUNC(N,1).LE.0) GO TO 145
      NL=NJUNC(N,1)
      NH=NJUNC(N,2)
      DELH=0.5*(HT(NH)-H(NH)+HT(NL)-H(NL))
      TA=B(N)+ACK(N)*DELH
      AT(N)=A(N)+0.5*(B(N)+TA)*DELH
      RNT=AT(N)/TA
C
C******** CHECK FOR DRY (R.LT.0.5 FT) CHANNEL
      IF (RNT.GT.0.50) GO TO 140
      V(N)=0.0
      Q(N)=0.
      GO TO 145
140   CONTINUE
      DELV2=2.*VT(N)*(1.-A(N)/AT(N))+DELT*((VT(N)**2/RNT)-32.1739)*(HT(N
     1H)-HT(NL))/LEN(N)
      V2=V(N)+DELV2
      TEMP=DELT*AK(N)/RNT**1.3333333
      DELV1=0.5*((1./TEMP+2.*ABS(V2))-SQRT((1./TEMP+2.*ABS(V2))**2-4.*V2
     1**2))
      DELV1=-SIGN(DELV1,V2)
      V(N)=V(N)+DELV1+DELV2+DELT*FWIND(N)/RNT
      Q(N)=0.5*(Q(N)+V(N)*AT(N))
145   CONTINUE
C
C**** HEADS AT T+DELT (TEMPORARILY STORED IN HN)
      DO 175 J=1,NJ
      IF (NCHAN(J,1).LE.0) GO TO 175
      IF (JGW(J).EQ.0) GO TO 155
```

```
      N=JGN(J)
      TA=W*T
      HN(J)=AX(1,N)
      DO 150 I=2,4
      TB=I-1
150   HN(J)=HN(J)+AX(I,N)*SIN(TA*TB)+AX(I+3,N)*COS(TA*TB)
      GO TO 175
155   CONTINUE
      ASAJ=AS(J)+ASK(J)*(HT(J)-H(J))
      L=NJIN(J)
      SUMQ=QOU(J)-QIN(J)-QGIN(J)-QSIN(L,IIQ)+EVAP(J)*AS(J)
      DO 165 K=1,8
      IF (NCHAN(J,K).LE.0) GO TO 170
      N=NCHAN(J,K)
      IF (J.NE.NJUNC(N,1)) GO TO 160
      SUMQ=SUMQ+Q(N)
      GO TO 165
160   SUMQ=SUMQ-Q(N)
165   CONTINUE
170   HN(J)=H(J)-DELT*SUMQ/ASAJ
175   CONTINUE
C
C**** HYDRAULIC RADIUS AT T+DELT
C**** CHANNEL AREAS AT T+DELT
C
      DO 180 N=1,NC
      IF (NJUNC(N,1).LE.0) GO TO 180
      NL=NJUNC(N,1)
      NH=NJUNC(N,2)
      DELH=0.5*(HN(NH)-H(NH)+HN(NL)-H(NL))
      R(N)=R(N)+DELH
      TA=B(N)+ACK(N)*DELH
      A(N)=A(N)+0.5*(B(N)+TA)*DELH
      B(N)=TA
180   CONTINUE
C**** COMPUTE NEW SURFACE AREAS, VOLUME, DEPTH
C**** SHIFT HEADS AT T+1 TO H ARRAY
C
      IF(ID.EQ.IDAY) TIME=TIME+DT
      DO 200 J=1,NJ
      IF (NCHAN(J,1).EQ.0) GO TO 200
      DELH=HN(J)-H(J)
      DEPTH(J)=DEPTH(J)+DELH
      ASAJ=AS(J)+ASK(J)*DELH
      VOL(J)=VOL(J)+0.5*(ASAJ+AS(J))*DELH
      AS(J)=ASAJ
      IF(VOL(J).GT.0.0) GO TO 181
      ISTOP=ISTOP+1
      WRITE(6,182) IH,J,H(J),VOL(J)
  182 FORMAT('0NEGATIVE VOLUME ENCOUNTERED AT HOUR',F7.2,' AT NODE'
     *,     I4,', HEAD =',F7.1,' FEET, VOLUME =',E9.2,' CU FT')
  181 CONTINUE
      IF(AS(J).GT.0.0) GO TO 195
      WRITE(6,190) IH,J,H(J),AS(J)
  190 FORMAT('0NEGATIVE SURFACE AREA ENCOUNTERED AT HOUR',F7.2
     *,   ' AT NODE',I4,', HEAD =',F7.1,' FEET, AREA =',E9.2,' SQ FT')
      ISTOP=ISTOP+1
```



```
      IF(ISTOP.GT.50) GO TO 282
195   CONTINUE
      H(J)=HN(J)
      IF(ID.NE.IDAY) GO TO 200
      IF(H(J).LT.RANGE(J,1)) GO TO 202
      RANGE(J,1)=H(J)
      TLAG(J,1)=TIME
      GO TO 200
  202 IF(H(J).GT.RANGE(J,2)) GO TO 200
      RANGE(J,2)=H(J)
      TLAG(J,2)=TIME
200   CONTINUE
C
C                   CHECK FOR ABNORMAL VELOCITIES
C
      DO 210 N=1,NC
      IF(NJUNC(N,1).LE.0) GO TO 210
      IF (ABS(V(N)).LE.20.0) GO TO 210
      ISTOP=ISTOP+1
      WRITE (6,205) IH,N,Q(N),R(N),V(N)
  205 FORMAT('0HYDRODYNAMIC SOLUTION WAS UNSTABLE AT HOUR',F7.2
     *,  ' IN CHANNEL',I4,', FLOW =',E9.2,' CFS, DEPTH =',F7.1
     *,  ' FEET, VELOCITY =',F7.0,' FT/SEC')
      IF(ISTOP.GT.50) GO TO 282
210   CONTINUE
C
      IF ((ID.EQ.IDAY-1).AND.(IH.EQ.NHPERD)) GO TO 255
      IF (ID.LT.IDAY) GO TO 270
C
C                   SUM FOR LATER AVERAGING
C
      DO 215 J=1,NJ
      DEPTHB(J)=DEPTHB(J)+DEPTH(J)
      VOLB(J)=VOLB(J)+VOL(J)
      ASB(J)=ASB(J)+AS(J)
      VOLAVE(J)=VOLAVE(J)+VOL(J)
      HAVE(J)=HAVE(J)+H(J)
215   CONTINUE
      DO 230 N=1,NC
C
C      SUM FLOWS IN EACH CHANNEL
C
      IF ((Q(N)).GT.0.0) GO TO 220
      QN(N)=QN(N)-Q(N)
      GO TO 225
220   QP(N)=QP(N)+Q(N)
225   CONTINUE
C
      QAVE(N)=QAVE(N)+Q(N)
      VAVE(N)=VAVE(N)+V(N)
      RSQ(N)=RSQ(N)+R(N)**2
      VSQ(N)=VSQ(N)+V(N)**2
      RAVE(N)=RAVE(N)+R(N)
      QB(N)=QB(N)+Q(N)
      AB(N)=AB(N)+A(N)
      RAVE(N)=RAVE(N)+R(N)
      VABS(N)=VABS(N)+ABS(V(N))
```

2-35-140

```
 230    VB(N)=VB(N)+V(N)
 C
 C      SUM TIDAL EBB AND FLOOD
 C
        DO 250 J=1,NJEX
        I=JEX(J)
        DO 240 K=1,8
        N=NCHAN(I,K)
        IF (N.EQ.0) GO TO 245
        F=1.
        IF (NJUNC(N,2).EQ.I) F=-1.
        IF (F*Q(N).LE.0.) GO TO 235
        QFLOOD(J)=QFLOOD(J)+ABS(Q(N))
        GO TO 240
 235    QEBB(J)=QEBB(J)+ABS(Q(N))
 240    CONTINUE
 245    CONTINUE
 250    CONTINUE
 C
 C                     STORE OUPUT DATA FOR SUBSEQUENT PRINTOUT
 C
        IF (IH.NE.KPRT) GO TO 270
        KPRT=KPRT+NPRT
 255    LTIME=LTIME+1
 C
 C**** STORE HEADS TO BE PRINTED
        DO 260 I=1,NHPRT
        MJPRT=JPRT(I)
        PRTH(LTIME,I)=H(MJPRT)
 260    CONTINUE
 C
 C**** STORE FLOWS AND VELOCITIES TO BE PRINTED
        DO 265 I=1,NQPRT
        MCPRT=CPRT(I)
        PRTQ(LTIME,I)=Q(MCPRT)
        PRTV(LTIME,I)=V(MCPRT)
 265    CONTINUE
 270    CONTINUE
        IF(ISTOP.EQ.0) RETURN
   282 WRITE(6,283)
   283 FORMAT('0CHANNEL DEPTH AND VELOCITY'/)
       WRITE(6,284) (I,R(I),V(I),I=1,NC)
   284 FORMAT(5(I6,2F10.1))
       WRITE(6,285)
   285 FORMAT('0NODAL DEPTH'/)
       WRITE(6,286) (I,H(I),I=1,NJ)
   286 FORMAT(10(I6,F7.1))
       STOP
       END
```

```
      SUBROUTINE GEOMET(NEXIT)
      COMMON/GEOM/ JUN(200),NCHAN(200,8),NJUNC(300,2),NQIN(200)
     *,      QSIN(41,26),QGIN(200),QOU(200),QIN(200),A(300),ACK(300)
     *,      AB(300),EVAP(200),AK(300),AS(200),ASK(200),AT(300),B(300)
     *,      CMN(300),DEPTH(200),H(200),LEN(300),R(300),V(300),X(200)
     *,      VOL(200),Y(200),Q(300),ACAVE(300),ASAVE(200),ASH(200)
     *,      RAVE(300),DEPAVE(200),DEPTHB(200),FWIND(300),HAVE(200)
     *,      HN(200),HT(200),QAVE(300),QB(300),QP(300),RAVE(300),HUR(200)
     *,      RS(300),RSQ(300),SFLOW(200),VABS(300),VAVE(300),UN(300)
     *,      VOLAVE(200),VOLB(200),VS(300),VSQ(300),VT(300),VH(300)
      COMMON/MISC/ NJ,NC,DELT,DELTQ,NHSTEP,NQSTEP,T,T2,DELT2,IDAY
     *,            QMIN,IO,NHPERQ,ITQ,NTEMP(8),QEBB(10),QFLOOD(10)
      REAL LEN
      DIMENSION BIG(1)
      EQUIVALENCE (JUN(1),BIG(1))
C
      NCHAN=300
      NJUN=200
      N=32*NJUN+29*NCHAN+41*26
      DO 10 J=1,N
   10 BIG(J)=0.0
C
C**** JUNCTION DATA
C
      NJ=0
      DO 100 I=1,NJUN
      H(I)=0.
      DO 100 J=1,8
      NCHAN(I,J)=0
100   CONTINUE
      DO 120 I=1,NJUN
      READ (5,105) J,AREA,SLOPE,DEP,X1,Y1,(NTEMP(K),K=1,8)
105   FORMAT (I5,2F10.0,3F5.0,8I5)
      IF (J.LE.0) GO TO 125
      IF (J.LE.NJUN) GO TO 115
      WRITE (6,110) J
110   FORMAT ('0 *** ERROR ***   JUNCTION NUMBER',I6,' IS LARGER THAN PR
     1OGRAM DIMENSIONS')
      STOP
115   CONTINUE
      IF (J.GT.NJ) NJ=J
      AS(J)=AREA
      ASK(J)=SLOPE
      DEPTH(J)=DEP
      X(J)=X1
      Y(J)=Y1
      DO 120 K=1,8
      NCHAN(J,K)=NTEMP(K)
120   CONTINUE
125   CONTINUE
C
C**** CHANNEL DATA
C
      NC=0
      DO 130 I=1,NCHAN
      DO 130 J=1,2
      NJUNC(I,J)=0
```



```
130   CONTINUE
      DO 150 I=1,NCHAN
      READ(5,135) N,ALEN,WIDTH,RAD,COEF,(NTEMP(K),K=1,2),SLOPE
135   FORMAT(I5,4F10.0,2I5,F10.0)
      IF (N.LE.0) GO TO 155
      IF (N.LE.NCHAN) GO TO 145
      WRITE (6,140) N
140   FORMAT ('0 *** ERROR ***  CHANNEL NUMBER',I6,' IS LARGER THAN PROG
     1RAM DIMENSIONS')
      STOP
145   CONTINUE
      IF (N.GT.NC) NC=N
      CMN(N)=COEF
      LEN(N)=ALEN
      B(N)=WIDTH
      R(N)=RAD
      AK(N)=COEF
      V(N)=0.0
      ACK(N)=SLOPE
      NJUNC(N,1)=MIN0(NTEMP(1),NTEMP(2))
150   NJUNC(N,2)=MAX0(NTEMP(1),NTEMP(2))
155   CONTINUE
C
C**** COMPATIBILITY CHECK
C
      DO 170 N=1,NC
      DO 170 I=1,2
      IF (NJUNC(N,I).LE.0) GO TO 170
      J=NJUNC(N,I)
      DO 160 K=1,8
      IF (N.EQ.NCHAN(J,K)) GO TO 170
160   CONTINUE
      NEXIT=NEXIT+1
      WRITE (6,165) N,J
165   FORMAT ('0CHANNEL CARD COMPATIBILITY CHECK, CHANNEL ',I3,' AND JUN
     1CTION ',I3)
170   CONTINUE
      DO 190 J=1,NJ
      DO 185 K=1,8
      IF (NCHAN(J,K).LE.0) GO TO 190
      N=NCHAN(J,K)
      DO 175 I=1,2
      IF (J.EQ.NJUNC(N,I)) GO TO 185
175   CONTINUE
      NEXIT=NEXIT+1
      WRITE (6,180) J,N
180   FORMAT ('0JUNCTION CARD COMPATIBILITY CHECK, JUNCTION ',I3,' AND C
     1HANNEL ',I3)
185   CONTINUE
190   CONTINUE
C
C**** DERIVED CHANNEL DATA
C
      DO 195 N=1,NC
      IF (NJUNC(N,1).LE.0) GO TO 195
      AK(N)=32.1739*AK(N)**2/2.208196
      A(N)=B(N)*R(N)
```

```
      AT(N)=A(N)
195   CONTINUE
C
C**** DERIVED JUNCTION DATA
C
      DO 205 J=1,NJ
      IF (NCHAN(J,1).EQ.0) GO TO 205
      VOL(J)=AS(J)*DEPTH(J)
      IF (DEPTH(J).GT.0.) GO TO 205
      VOL(J)=0.
      IF (AS(J).LE.0.0) GO TO 205
      AREA=0.
      VOLUME=0.
      DO 200 K=1,8
      N=NCHAN(J,K)
      IF (N.LE.0) GO TO 200
      AREA=AREA+B(N)*LEN(N)
      VOLUME=VOLUME+B(N)*LEN(N)*R(N)
200   CONTINUE
      DEPTH(J)=VOLUME/AREA
      VOL(J)=DEPTH(J)*AS(J)
205   CONTINUE
      G=SQRT(32.2)
      TP=0
      DO 225 N=1,NC
      IF (NJUNC(N,1).EQ.0) GO TO 225
      DG=SQRT(R(N)+DMIN)*G
      TT=LEN(N)/DG
      VT(N)=TT
225   CONTINUE
      IF(NEXIT.GT.0) WRITE(6,227)
  227 FORMAT('0PROGRAM EXECUTION WILL TERMINATE LATER DUE TO CHANNEL- N
     .ODE INCOMPATIBILITY')
      RETURN
C
      END
```

```
      SUBROUTINE NUMBER(NN)
      COMMON/GEOM/ JUN(200),NCHAN(200,8),NJUNC(300,2),SPACE(11156)
     *,      IBOOK(200,8),JHOLD(100,2),JIN(200),NSTART(10),FILL(600)
      COMMON/MISC/ NJ,NC,DELT,DELTO,NHSTEP,NQSTEP,T,T2,DELT2,IDAY
     *,           QMIN,ID,NHPERQ,IIQ,NTEMP(8),QEBB(10),QFLOOD(10)
      ISTOP=0
      ISUMH=0
      ISUML=0
      NSTAR=NN
      JUN(1)=NSTAR
      I=1
      DO 130 L=1,8
      N=NCHAN(NSTAR,L)
      IF (N.LE.0) GO TO 135
      JOPP=NJUNC(N,1)
      IF (NSTAR.EQ.JOPP) GO TO 105
      GO TO 110
105   JOPP=NJUNC(N,2)
110   JHOLD(I,1)=JOPP
      I=I+1
      DO 120 KK=1,8
      NN=NCHAN(JOPP,KK)
      IF (NN.LE.0) GO TO 125
      JJOPP=IABS(NJUNC(NN,1))
      IF (JJOPP.EQ.JOPP) GO TO 115
      NJUNC(NN,2)=-IABS(NJUNC(NN,2))
      GO TO 120
115   NJUNC(NN,1)=-IABS(NJUNC(NN,1))
120   CONTINUE
125   CONTINUE
      NJUNC(N,1)=-IABS(NJUNC(N,1))
      NJUNC(N,2)=-IABS(NJUNC(N,2))
130   CONTINUE
135   CONTINUE
      K=1
C
C        MAIN LOOP
C
      DO 190 MAIN=1,NJ
      M=1
      DO 175 I=1,200
      J=JHOLD(I,1)
      IF (J.LE.0) GO TO 180
      K=K+1
      JUN(K)=J
      DO 170 L=1,8
      N=NCHAN(J,L)
      IF (N.LE.0) GO TO 170
      JOPP=IABS(NJUNC(N,1))
      IF (J.EQ.JOPP) GO TO 140
      JOPP=NJUNC(N,1)
      IF (JOPP.LE.0) GO TO 165
      GO TO 145
140   JOPP=NJUNC(N,2)
      IF (JOPP.LE.0) GO TO 165
145   JHOLD(M,2)=JOPP
      M=M+1
```



```
      DO 155 KK=1,8
      NN=NCHAN(JOPP,KK)
      IF (NN.LE.0) GO TO 160
      JJOPP=IABS(NJUNC(NN,1))
      IF (JJOPP.EQ.JOPP) GO TO 150
      NJUNC(NN,2)=-IABS(NJUNC(NN,2))
      GO TO 155
150   NJUNC(NN,1)=-IABS(NJUNC(NN,1))
155   CONTINUE
160   CONTINUE
165   CONTINUE
      NJUNC(N,1)=-IABS(NJUNC(N,1))
      NJUNC(N,2)=-IABS(NJUNC(N,2))
170   CONTINUE
175   CONTINUE
180   CONTINUE
      DO 185 I=1,200
      JHOLD(I,1)=JHOLD(I,2)
185   JHOLD(I,2)=0
      IF (JHOLD(1,1).EQ.0) GO TO 195
C
C        END OF MAIN LOOP
C
190   CONTINUE
195   CONTINUE
      NP=K
      WRITE(6,204)
  204 FORMAT('1CROSS REFERENCE - - INTERNAL NODE NUMBER VS. EXTERNAL NODE
     *E NUMBER (USED IN QUALITY PROGRAM AQUAL)'/)
      DO 200 N=1,NC
      DO 200 KK=1,2
200   NJUNC(N,KK)=IABS(NJUNC(N,KK))
      WRITE (6,205) (J,JUN(J),J=1,NP)
  205 FORMAT(10(I7,I5))
      DO 210 K=1,NP
      J=JUN(K)
210   JIN(J)=K
      DO 230 K=1,NP
      J=JUN(K)
      DO 220 M=1,8
      N=NCHAN(J,M)
      IF (N.LE.0) GO TO 225
      JOPP=NJUNC(N,1)
      IF (J.NE.JOPP) GO TO 215
      JOPP=NJUNC(N,2)
215   CONTINUE
      IBOOK(K,M)=JIN(JOPP)
220   CONTINUE
225   CONTINUE
230   CONTINUE
      DO 250 J=1,NP
      IMIN=J
      IMAX=J
      DO 240 K=1,8
      IF (IBOOK(J,K).LE.0) GO TO 240
      IMIN=MIN0(IBOOK(J,K),IMIN)
      IMAX=MAX0(IBOOK(J,K),IMAX)
```

N U M B E R

```
200   CONTINUE
      IDIF=IMAX-IMIN
      IDIF1=IMAX-J
      IDIF2=J-IMIN
      IF (ISUMH.LT.IDIF1) ISUMH=IDIF1
      IF (ISUML.LT.IDIF2) ISUML=IDIF2
      K=MAX0(IDIF1,IDIF2)
      IF(K.LE.10) GO TO 250
      NN=999
      WRITE(6,245) K,J,JUN(J)
  245 FORMAT('0THE HALF BAND WIDTH OF',I4,' FOR EQUATION NUMBER',I4
     ., ', NODE',I4,' EXCEEDS THE DIMENSION LIMITS IN PROGRAM AQUAL'
     .,/'       PROGRAM EXECUTION WILL TERMINATE LATER')
250   CONTINUE
      ISUMT=ISUMH+ISUML
      WRITE (6,255) ISUMT,ISUMH,ISUML
255   FORMAT('0THE WIDEST TOTAL BAND WIDTH IS'I5,' , THE HIGH SIDE MAXIM
     +UM WIDTH IS'I5,' , AND THE LOW SIDE MAXIMUM WIDTH IS'I5,///)
C
260   CONTINUE
      IIQ=MAX0(ISUMH,ISUML)
      RETURN
      END
```

```
      SUBROUTINE OUTPUT (NPOINT,NSTAGE,NTFLOW)
      COMMON /TID/ NJEX,JEX(10),AK(7,10),W,TT(50),YY(50),PERIOD,JGW(200)
     *,       RANGE(200,2),TLAG(200,2)
      COMMON/GEOM/ JUN(200),NCHAN(200,8),NJUNC(300,2),NOIN(200)
     *,       QSIN(41,26),OGIN(200),QOU(200),UIN(200),A(300),ACK(300)
     *,       AB(300),EVAP(200),AK(300),AS(200),ASK(200),AT(300),B(300)
     *,       CMN(300),DEPTH(200),H(200),LEN(300),R(300),V(300),X(200)
     *,       VOL(200),Y(200),Q(300),ACAVE(300),ASAVE(200),ASB(200)
     *,       RAVE(300),DEPAVE(200),DEPTHH(200),FWIND(300),HAVE(200)
     *,       HN(200),HT(200),QAVE(300),QN(300),QP(300),RAVE(300),HOR(200)
     *,       RS(300),RSQ(300),SFLOW(200),VABS(300),VAVE(300),QN(300)
     *,       VOLAVE(200),VOLH(200),SPALE(579),XC(103,3),YC(103,3),NPT(3)
      COMMON/MISC/ NJ,NC,DELT,DELT0,NOSTEP,NUSTEP,T,T2,DELT2,IDAY
     *,          DMIN,ID,NMPLPO,IIO,NTEMP(8),QEND(10),QFLOOD(10)
      COMMON/IO/ NPHT,NPRT,NOPRT,NHPRT,ICOL(10),JPRT(30),CPRT(30)
     *,       PRTH(50,30),PRTV(50,30),PRTQ(50,30),HOUR(50),NJPLOT(5,3)
     *,       NCPLOT(5,3)              ,TITL(40),LTIME,JTH(48) ,NTSL
      COMMON /LAB/ XLAB(11),YLAB(6),TITLE(12),HORIZ(13),VERT(6),IUNITO
      INTEGER CPRT
      REAL LEN
      DIMENSION VERT1(6,2),VERT2(6,2),HORIZ1(13,2)
      DATA HORIZ1/6*4H    ,4HTIME,4H IN ,4HHOUR,4HS     ,3*4H
     *,            6*4H    ,4HX - ,4HCOOR,4HDINA,4HTES   ,3*4H        /
      DATA       VERT1/4HVELO,4HCITY,4H    I,4HN    ,4H FT/,4HSEC
     *,                 4H STA,4HGE  ,4H    I,4HN    ,4H  FE,4HET  /
      DATA       VERT2/4H TID,4HAL   ,4H RAN,4HGE  ,4HIN F,4HEET
     *,                4H  TI,4HME  ,4H    I,4HN    ,4H  HO,4HURS /
C
      DO 105 I=1,NHPRT,6
      WRITE(6,10) TITL
   10 FORMAT   (1H1,20A4,10X,'TETRA TECH INC.',/1X,20A4,10X,'LAFAYETTE,
     1CALIFORNIA',/,1H 90X,'TIDAL HYDRODYNAMICS PROGRAM')
      WRITE (6,100) JPRT(I),JPRT(I+1),JPRT(I+2),JPRT(I+3),JPRT(I+4),JPRT
     1(I+5)
100   FORMAT ('0'23X,'JUNCTION'I5,'      JUNCTION'I5,'      JUNCTION'I5,'
     1    JUNCTION'I5,'      JUNCTION'I5,'      JUNCTION'I5,/'
     2   HOUR        HEAD(FEET)          HEAD(FEET)          HEAD(FEET)
     3  HEAD(FEET)          HEAD(FEET)          HEAD(FEET)'/)
      T=0.0
      DO 105 L=1,LTIME
      T=T+DELT*FLOAT(NPRT)
      HOUR(L)=T/3600.
105   WRITE (6,110) HOUR(L),PRTH(L,I),PRTH(L,I+1),PRTH(L,I+2),PRTH(L,I+3
     1),PRTH(L,I+4),PRTH(L,I+5)
110   FORMAT (11X,F6.2,F14.2,5F18.2)
C
C**** PRINT FLOWS AND VELOCITIES
      DO 120 I=1,NOPRT,6
      WRITE(6,10) TITL
      WRITE (6,115) CPRT(I),CPRT(I+1),CPRT(I+2),CPRT(I+3),CPRT(I+4),CPRT
     1(I+5)
115   FORMAT ('0'23X,'CHANNEL'I5,'       CHANNEL'I5,'       CHANNEL'I5,'
     1 CHANNEL'I5,'       CHANNEL'I5,'       CHANNEL'I5,/'            HOU
     2R         FLOW   VEL.          FLOW   VEL.          FLOW   VEL.          FLOW   VE
     3L.         FLOW   VEL.          FLOW   VEL.'/25X,'(CFS) (FPS)        (CFS)
     4(FPS)        (CFS) (FPS)        (CFS) (FPS)        (CFS) (FPS)        (CFS
     5) (FPS)')
      DO 120 L=1,LTIME
120   WRITE (6,125) HOUR(L),PRTQ(L,I),PRTV(L,I),PRTQ(L,I+1),PRTV(L,I+1),
     1PRTQ(L,I+2),PRTV(L,I+2),PRTQ(L,I+3),PRTV(L,I+3),PRTQ(L,I+4),PRTV(L
     2,I+4),PRTQ(L,I+5),PRTV(L,I+5)
125   FORMAT (11X,F8.2,F10.0,F7.2,F10.0,F7.2,F10.0,F7.2,F10.0,F7.2,F10.0
     1,F7.2,F10.0,F7.2)
C
      WRITE(6,10) TITL
      DO 130 I=1,10
130   ICOL(I)=I
      WRITE (6,135) (ICOL(I),I=1,10)
135   FORMAT ('0AVERAGE HEADS FOR A  TIDAL CYCLE'//11X,I9,9I11)
      DO 145 I=1,NJ,10
      L=I+9
      WRITE (6,140) I,L,(HAVE(J),J=I,L)
140   FORMAT (I4,' TO 'I3,10F11.3)
145   CONTINUE
C
      WRITE (6,150) (ICOL(I),I=1,10)
150   FORMAT ('0AVERAGE VELOCITIES FOR A  TIDAL CYCLE'//11X,I9,9I11)
      DO 160 I=1,NC,10
      L=I+9
      WRITE (6,155) I,L,(VAVE(J),J=I,L)
155   FORMAT (I4,' TO 'I3,10F11.3)
160   CONTINUE
C
      WRITE (6,165) (ICOL(I),I=1,10)
165   FORMAT ('0AVERAGE FLOWS FOR A  TIDAL CYCLE'//11X,I9,9I11)
      DO 175 I=1,NC,10
      L=I+9
      WRITE (6,170) I,L,(QAVE(J),J=I,L)
170   FORMAT (I4,' TO 'I3,10F11.0)
175   CONTINUE
C
      WRITE (6,190) (ICOL(I),I=1,10)
190   FORMAT ('0WATER BALANCE AT EACH JUNCTION (CFS)'//11X,I9,9I11)
      DO 200 I=1,NJ,10
      L=I+9
      WRITE (6,195) I,L,(HN(J),J=I,L)
195   FORMAT (I4,'  TO  ',I3,10F11.0)
200   CONTINUE
C
      WRITE (6,205) (ICOL(I),I=1,10)
205   FORMAT ('0AVERAGE NODAL VOLUME (CU FT)',//11X,I9,9I11)
      DO 215 I=1,NJ,10
      L=I+9
      WRITE (6,210) I,L,(VOLAVE(J),J=I,L)
210   FORMAT (I4,'  TO  ',I4,10E11.4)
215   CONTINUE
C
C
      TA=DELT/(3600.*PERIOD)
      DO 220 N=1,NC
      QP(N)=QP(N)*TA
220   QN(N)=QN(N)*TA
      WRITE (6,225) ((NA,QP(NA),QN(NA)),NA=1,NC)
225   FORMAT ('0POSITIVE AND NEGATIVE FLOWS FOR EACH CHANNEL',/,(4(I10
```

OUTPUT

```
      1,2F11.6)))
C
      DO 295 I=1,NJ
      IF(NCHAN(I,1).GT.0) GO TO 295                                      *NEW
      RANGE(I,1)=0.                                                      *NEW
      RANGE(I,2)=0.                                                      *NEW
  295 SPACE(I)=RANGE(I,1)-RANGE(I,2)
      WRITE(6,290) (I,RANGE(I,2),RANGE(I,1),SPACE(I),I=1,NJ)
  290 FORMAT('0MINIMUM HEAD, MAXIMUM HEAD AND TIDAL RANGE'
     ..      /(4(I10,3F7.2)))
      WRITE(6,337) (I,TLAG(I,2),TLAG(I,1),I=1,NJ)
  337 FORMAT('0TIME OF MINIMUM AND MAXIMUM HEAD, HOUR',/(4(I10,2F8.2)))
C
C.... TOTAL EVAPORATION RATE
      TA=0.
      ATOTAL=0.
      DO 310 J=1,NJ
      TA=TA+VOLAVE(J)
310   ATOTAL=ATOTAL+ASAVE(J)
      TB=TA/ATOTAL                                                       *NEW
      WRITE(6,312) EVAP(1),ATOTAL,TA,TB                                  *NEW
  312 FORMAT(//29H TOTAL EVAPORATION RATE, CFS   ,E12.4                  *NEW
     ..       /29H AVERAGE SURFACE AREA, SQ FT   ,E12.4                  *NEW
     ..       /29H AVERAGE VOLUME, CU FT         ,E12.4                  *NEW
     ..       /29H AVERAGE DEPTH, FT             ,E12.4  )               *NEW
C                                                                        **-5
C.... TIDAL RANGE PLOT
      IF(JTR(2).EQ.0) GO TO 410
      DO 412 I=1,6
  412 VERT(I)=VERT2(I,1)
      DO 420 I=1,13
  420 HORIZ(I)=HORIZ1(I,2)
      DO 414 M=1,NTSL
      J=JTR(M)
      YC(M,1)=SPACE(J)
      XC(M,1)=X(J)
  414 NPT(1)=M
      I=1
      CALL CURVE(XC,YC,NPT,I,I)
      DO 432 I=1,6
  432 VERT(I)=VERT2(I,2)
      DO 434 M=1,NTSL
      J=JTR(M)
  434 YC(M,1)=TLAG(J,1)
      I=1
      CALL CURVE(XC,YC,NPT,I,I)
  410 CONTINUE
C
      NCV=3
      DO 230 I=1,NCV
      NPT(I)=NPOINT
      DO 230 J=1,NPOINT
      XC(J,I)=HOUR(J)
230   YC(J,I)=0.0
C
C.... TIDAL STAGE PLOT
      DO 422 I=1,13
```

OUTPUT

```
  422 HORIZ(I)=HORIZ1(I,1)
      DO 256 I=1,6
  256 VERT(I)=VERT1(I,2)
      DO 255 K=1,NSTAGE
      DO 245 N=1,3
      DO 235 L=1,30
      IF (NJPLOT(K,N).EQ.JPRT(L)) GO TO 240
235   CONTINUE
240   DO 245 M=1,NPOINT
      YC(M,N)=PRTH(M,L)
245   CONTINUE
      CALL CURVE (XC,YC,NPT,NCV,K)
      WRITE (6,250) (NJPLOT(K,N),N=1,3)
250   FORMAT (1H0,30X,21HPLOT LEGEND  JUNCTION,I4,4H = 0,10H  JUNCTION,I
     .4,4H = 1,10H  JUNCTION,I4,4H = 2)
255   CONTINUE
C
C.... TIDAL FLOW PLOT
      DO 281 I=1,6
  281 VERT(I)=VERT1(I,1)
      DO 280 K=1,NTFLOW
      DO 270 N=1,3
      DO 260 L=1,30
      IF (NCPLOT(K,N).EQ.CPRT(L)) GO TO 265
260   CONTINUE
265   DO 270 M=1,NPOINT
      YC(M,N)=PRTV(M,L)
270   CONTINUE
      CALL CURVE (XC,YC,NPT,NCV,K)
      WRITE (6,275) (NCPLOT(K,N),N=1,3)
275   FORMAT (1H0,30X,21HPLOT LEGEND   CHANNEL,I4,4H = 0,10H   CHANNEL,I
     .4,4H = 1,10H   CHANNEL,I4,4H = 2)
280   CONTINUE
      RETURN
      END
```

2-35-147

```
      SUBROUTINE PINE (X1,Y1,X2,Y2,NSYM,NCT)
      COMMON/GEOM/ SPACE(10315),A(51,101),FILL(700)
      DIMENSION SYM(3)
      DATA   SYM /1H0,1H1,1H2/
      AXA=X1
      AXB=X2
      AYA=Y1
      AYB=Y2
      N=1
      IF (ABS(AXB-AXA),LT,ABS(AYB-AYA)) GO TO 115
C
C     SET PARAMETERS FOR X DIRECTION
C
      IF (AXB,GT,AXA) GO TO 100
      AXA=X2
      AXB=X1
      AYA=Y2
      AYB=Y1
100   CONTINUE
      IXA=AXA+,5
      IXB=AXB+,5
      IYA=AYA+,5
      IYB=AYB+,5
105   CONTINUE
      IF (IXA,LT,0,OR,IXA,GT,100) GO TO 110
      IF (IYA,LT,0,OR,IYA,GT,50) GO TO 110
      A(51-IYA,IXA+1)=SYM(NSYM)
110   CONTINUE
      IXA=IXA+1
      YA=(N*(AYB-AYA))/(AXB-AXA)
      IYA=AYA+YA+0,5
      N=N+1
      IF (IXA,LE,IXB) GO TO 105
      GO TO 140
C
C     SET PARAMETERS FOR Y DIRECTION
C
115   CONTINUE
      IF (AYB,GT,AYA) GO TO 120
      AYB=Y1
      AYA=Y2
      AXB=X1
      AXA=X2
120   CONTINUE
      IXA=AXA+,5
      IXB=AXB+,5
      IYA=AYA+,5
      IYB=AYB+,5
125   CONTINUE
      IF (IXA,LT,0,OR,IXA,GT,100) GO TO 130
      IF (IYA,LT,0,OR,IYA,GT,50) GO TO 130
      A(51-IYA,IXA+1)=SYM(NSYM)
130   CONTINUE
      IYA=IYA+1
      XA=(N*(AXB-AXA))/(AYB-AYA)
      IXA=XA+AXA+0,5
      N=N+1
```



```
      IF (IYA-IYB) 125,135,140
135   IXA=IXB
      GO TO 125
140   RETURN
      END
```

2-35-148

P P L O T

```
      SUBROUTINE PPLOT (IX,IY,K,NCT)
      COMMON/GEOM/ SPACE(10315),A(51,101),FILL(700)
      DIMENSION SYM(9)
      COMMON /LAB/ XLAB(11),YLAB(6),TITLE(12),HORIZ(13),VERT(6),IUNITO
      DATA SYM/7*1H ,1HI,1H-/
      IF(K.GT.99) GO TO 170
      I=0
      WRITE(6,200)
200   FORMAT(1H1)
      DO 135 II=1,6
      I=I+1
      WRITE(6,150) YLAB(II),(A(I,J),J=1,101)
      IF (II.EQ.6) GO TO 140
      DO 130 JJ=1,9
      I=I+1
      IF (I.NE.20) GO TO 115
      WRITE(6,165) VERT(5),VERT(6),(A(I,J),J=1,101)
      GO TO 130
115   IF (I.NE.24) GO TO 120
      WRITE(6,165) VERT(1),VERT(2),(A(I,J),J=1,101)
      GO TO 130
120   IF (I.NE.26) GO TO 125
      WRITE(6,165) VERT(3),VERT(4),(A(I,J),J=1,101)
      GO TO 130
125   WRITE(6,145) (A(I,J),J=1,101)
130   CONTINUE
135   CONTINUE
140   CONTINUE
      WRITE(6,155) XLAB
      WRITE(6,160) HORIZ
145   FORMAT (18X,101A1)
150   FORMAT (F17.3,1X,101A1)
155   FORMAT (F20.1,10F10.1)
160   FORMAT (/30X,13A4)
  165 FORMAT(5X, 2A4,5X,101A1)
170   DO 180 I=1,50
      DO 175 J=1,101
175   A(I,J)=SYM(7)
      A(I,1)=SYM(8)
180   CONTINUE
      DO 185 J=1,101
185   A(51,J)=SYM(9)
      DO 190 I=1,101,10
190   A(51,I)=SYM(8)
      DO 195 I=11,41,10
      A(I,1)=SYM(9)
195   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SCALE (ARRAY,AXLEN,NPTS,INC)
      DIMENSION ARRAY(NPTS), INT(5)
      DATA INT  /2,4,5,8,10/
      INCT=IABS(INC)
C
C                                     SCAN FOR MAX AND MIN
C
      AMAX=ARRAY(1)
      AMIN=ARRAY(1)
      DO 100 N=1,NPTS,INCT
      IF (AMAX.LT.ARRAY(N)) AMAX=ARRAY(N)
      IF (AMIN.GT.ARRAY(N)) AMIN=ARRAY(N)
100   CONTINUE
      IF (AMAX-AMIN) 120,105,120
C
C
105   IF (AMIN) 115,150,110
110   AMIN=0.0
      AMAX=2.0*AMAX
      GO TO 120
115   AMAX=0.0
      AMIN=2.0*AMIN
120   CONTINUE
C
C                                     COMPUTE UNITS/INCH
C
      RATE=(AMAX-AMIN)/AXLEN
C
C                                                 SCALE INTERVAL TO
C                                                 LESS THAN 10
      A=ALOG10(RATE)
      N=A
      IF (A.LT.0) N=A-0.9999
      RATE=RATE/(10.**N)
      L=RATE+1.00
C
C                                     FIND NEXT HIGHER INTERVAL
C
125   DO 130 I=1,5
      IF (L-INT(I)) 135,135,130
130   CONTINUE
C
C                                     L IS NEXT HIGHER INTERVAL
C                                     RANGE IS SCALED BACK TO FULL SET
C
135   L=INT(I)
      RANGE=FLOAT(L)*10.**N
      IF (INC.LT.0) GO TO 145
C
C                                     SET UP POSITIVE STEPS
C
      K=AMIN/RANGE
      IF (AMIN.LT.0.) K=K-1
C
C                                     CHECK FOR MAX VALUE IN RANGE
C
      IF (AMAX.GT.(K+AXLEN)*RANGE) GO TO 140
```



```
      I=NPTS*INCT+1
      ARRAY(I)=K*RANGE
      I=I+INCT
      ARRAY(I)=RANGE
      RETURN
C
C
C                                     IF OUTSIDE RANGE RESET L AND N
140   L=L+1
      IF (L.LT.11) GO TO 125
      L=2
      N=N+1
      GO TO 125
C
C
C                                     SET UP NEGATIVE STEPS
145   K=AMAX/RANGE
      IF (AMAX.GT.0.) K=K+1
      IF (AMIN.LT.(K+AXLEN)*RANGE) GO TO 140
      I=INCT*NPTS+1
      ARRAY(I)=K*RANGE
      I=I+INCT
      ARRAY(I)=-RANGE
      RETURN
150   WRITE (6,155)
155   FORMAT (//10X,'RANGE AND SCALE ARE ZERO ON PLOT ATTEMPT')
      RETURN
      END
```

TIDCF

```
      SUBROUTINE TIDCF (NI,MAXIT,NCHTID,NN)
      COMMON /TID/ NJEX,JEX(10),AX(7,10),W,TT(50),YY(50),PERIOD,JGW(200)
     *,     RANGE(200,2),TLAG(200,2)
      DIMENSION AA(10), XX(10), SXX(10,10), SXY(10),HN(26)
      DATA DELTA,NTT,N6 /0.005,7,6/
C
      IF (NI.NE.6) GO TO 105
      DO 100 I=1,5
      J=I+1
      NI=NI+1
      TT(NI)=(3.*TT(I)+TT(J))/4.
      YY(NI)=0.8535*YY(I)+0.1465*YY(J)
      NI=NI+1
      TT(NI)=(TT(I)+TT(J))/2.
      YY(NI)=(YY(I)+YY(J))/2.
      NI=NI+1
      TT(NI)=(TT(I)+3.*TT(J))/4.
      YY(NI)=0.1465*YY(I)+0.8535*YY(J)
100   CONTINUE
105   CONTINUE
      DO 115 J=1,NTT
      DO 110 K=1,NTT
110   SXX(K,J)=0.
      AA(J)=0.
115   SXY(J)=0.
      NJ2=NTT/2+1
      DO 135 I=1,NI
      DO 125 J=1,NTT
      FJ1=FLOAT(J-1)
      FJ3=FLOAT(J-NJ2)
      IF (J.LE.NJ2) GO TO 120
      XX(J)=COS(FJ3*W*TT(I))
      GO TO 125
120   XX(J)=SIN(FJ1*W*TT(I))
      IF (J.EQ.1) XX(J)=1.
125   SXY(J)=SXY(J)+XX(J)*YY(I)
      DO 130 J=1,NTT
      DO 130 K=1,NTT
130   SXX(K,J)=SXX(K,J)+XX(K)*XX(J)
135   CONTINUE
      IT=0
140   IT=IT+1
      DELMAX=0.
      DO 150 K=1,NTT
      SUM=0.
      DO 145 J=1,NTT
      IF (J.EQ.K) GO TO 145
      SUM=SUM-AA(J)*SXX(K,J)
145   CONTINUE
      SUM=(SUM+SXY(K))/SXX(K,K)
      DEL=ABS(SUM-AA(K))
      IF (DEL.GT.DELMAX) DELMAX=DEL
150   AA(K)=SUM
      IF (IT.GE.MAXIT) GO TO 155
      IF (DELMAX.GT.DELTA) GO TO 140
  155 CONTINUE
C
```

TIDCF

```
      DO 170 J=1,7
170   AX(J,NN)=AA(J)
      IF (NCHTID.NE.1) GO TO 210
      WRITE (6,175) JEX(NN),(AX(I,NN),I=1,7)
175   FORMAT ('0 TIDAL COEFFICIENTS FOR JUNCTION',I8,/7F13.4)
      WRITE (N6,180)
  180 FORMAT(48H0        TIME    OBSERVED    COMPUTED      DIFF)
      RES=0.
      DO 195 I=1,NI
      SUM=0.
      DO 190 J=2,NTT
      FJ1=FLOAT(J-1)
      FJ3=FLOAT(J-NJ2)
      IF (J.LE.NJ2) GO TO 185
      SUM=SUM+AA(J)*COS(FJ3*W*TT(I))
      GO TO 190
185   SUM=SUM+AA(J)*SIN(FJ1*W*TT(I))
190   CONTINUE
      SUM=SUM+AA(1)
      DIFF=SUM-YY(I)
      RES=RES+ABS(DIFF)
195   WRITE (N6,200) TT(I),YY(I),SUM,DIFF
200   FORMAT (4F12.4)
      WRITE (N6,205) RES
205   FORMAT (6H0TOTAL,30X,F12.4)
      DO 702 J=1,26
      TA=FLOAT(J)*W
      HN(J)=AX(1,NN)
      DO 702 I=2,4
      TB=I-1
  702 HN(J)=HN(J)+AX(I,NN)*SIN(TA*TB)+AX(I+3,NN)*COS(TA*TB)
      WRITE(6,69)
69    FORMAT(/,20X,'SUMMARY BY HOUR')
      WRITE(6,707) (I, HN(I),I=1,26)
707   FORMAT(10(I3,F8,2))
210   CONTINUE
C
      RETURN
      END
```

APPENDIX F

```
C....
C     AQUAL IS A MATHEMATICAL MODEL DEVELOPED TO SIMULATE
C     THE WATER QUALITY OF AN ESTUARY.
C
C     DEVELOPMENT OF THE MODEL WAS DONE UNDER THE SPONSORSHIP OF
C     THE CALIFORNIA STATE WATER RESOURCES CONTROL BOARD AND THE
C     NASSAU-SUFFOLK REGIONAL PLANNING BOARD, NEW YORK.
C
C     ADDITIONAL MODIFICATIONS WERE MADE UNDER CONTRACT NO.
C     DACW85-76-C-0044, DEPARTMENT OF THE ARMY, ALASKA DISTRICT,
C     ANCHORAGE, ALASKA.
C
C     QUESTIONS REGARDING THE COMPUTER CODE OR THE MODEL APPLICATION
C     SHOULD BE DIRECTED TO DONALD J. SMITH, TETRA TECH, INC.,
C     3700 MT. DIABLO BLVD., LAFAYETTE, CALIF., 94549 (415-283-3771)
C....
      COMMON TF(200,3),CTOC(200)
      COMMON/BIG/ NCHAN(200,8),NJUNC(300,2),JUN(200),XLEN(300)
     1,      ALPH(200),ALPHI(200),AA(200),BB(200),BETA(200)
     2,      ASAVE(200,21),A(200,21),ALPHA(200,21),AC(300),AS(200)
     3,      DIF(300),Q(300),VS(300) ,COU(200),ZZ(300)   ,VOL(200),Z(300)
     4,      CC1(300),CC4(300),DEP(200),RAVE(300),RS(300),VABS(300)
      COMMON/QUAL/ JUNIN(200),JUNGIN(200),JUNA(200),QIN(200),QGIN(200)
     1,      TDSIN(150),TOTNIN(150),TOTPIN(150),COLTIN(150),COLFIN(150)
     2,       BODCIN(150),BODNIN(150),OXYIN(150),TEMPIN(150)
     3,      TYPEIN(150,4),SALTIN(150)
     4,      TDS(200),TOTN(200),TOTP(200),COLT(200),COLF(200),BODC(200)
     5,      BODN(200),OXY(200),TEMP(200),TYPE(200,4),TYPEDK(200,4)
     6,      DALG(200),DSEN(200),DRON(200),BODCDK(200),BODNDK(200)
     7,      COLTDK(200),COLFDK(200),OSAT(200),BENN(200),BENP(200)
      COMMON/ACD/TYPEEQ(4),TYSETL(200,4),OTEN(2)
      COMMON/BACK/ INTAKE(20,5),FACTOR(20,5)
      COMMON/MISC/NJ,NC,NP,NDYN,NHHO,METH,DELT,IPAGE,NHYD,IDAY,IDELT
     1,      NJP,IEE,KPLOT,ISKIP(16),ALL(20),IDYN(52),TITLE(20),TITL(20)
     2,      NGPERH(52),IPCYC,LDAY,NCYCH,INQUAL
      COMMON/EXC/ NBOUND,JBOUND(10),DEPB(10),UFLOOD(10),XH(10),TDSEX(10)
     1,      TOTNEX(10),TOTPEX(10),COLTEX(10),COLFEX(10),BODCEX(10)
     2,      BODNEX(10),OXYEX(10),TEMPEX(10),TYPEEX(10,4),SALTEX(10)
      COMMON/PLOT/ IPLOT(4),CP(101,6,4),DAY(101),NPOINT,JPLOT(6)
     1,       IPP,NPP,IPDAY(3),NODEP(21,2),PROFA(21,3,4),NCONP(4)
     2,      PROFB(21,3,4)
      COMMON/MET/NAZONE,JWZONE(6,2),FONE(200),FTWO(200)
     1,      EV(200),QWS(24,6),WINDA(200)
      DIMENSION EESAVE (1),EE(1),TEMPT(1),SALT(1),CON(200,1)
      EQUIVALENCE (EESAVE(1),VABS(1)),(EE(1),VS(1))
     1,      (TEMPT(1),RAVE(1)),(SALT(1),RS(1)),(CON(1,1),TDS(1))
C
      SATOXY(X,Y)=14.5532-0.38217*X+5.4258E-3*X*X-0.555*Y*(1.665E-4-5.86
     16E-6*X+9.796E-8*X*X)
      CALL INPUT (0)
      IPERD=24/IDELT
      IF (IPERD.LT.1) IPERD=1
      IDEL=IDELT/24
      IF (IDEL.LT.1) IDEL=1
C
      DO 760 NCYCT=1,NHYD
      NCYCH=NCYCT
```



```
C
      CALL INPUT (1)
C
C.... DISPERSION COEFF
      IF (IEE.LT.0) GO TO 190
      NDYN=1
      DO 100 N=1,NC
      IF (NJUNC(N,1).LE.0) GO TO 100
      Z(N)=CC1(N)*(VABS(N)+VS(N))*(RAVE(N)+RS(N))
      EE(N)=Z(N)
      DIF(N)=EE(N)*AC(N)/XLEN(N)
  100 CONTINUE
      DO 110 J=1,NP
      K=JUN(J)
      SALT(K)=TDS(K)
      AA(J)=0.0
  110 BB(J)=0.0
      DO 170 NN=1,IEE
      CALL SETUP
      CALL FORM (SALT,SALTIN,SALTEX)
      CALL SOLVIT (SALT)
      DO 120 N=1,NC
      J1=NJUNC(N,1)
      IF (J1.EQ.0) GO TO 120
      J2=NJUNC(N,2)
      J1=JUN(J1)
      J2=JUN(J2)
      SX=ABS(SALT(J1)-SALT(J2))
      ZZ(N)=Z(N)+CC4(N)*SX/XLEN(N)
      EESAVE(N)=EE(N)
      EE(N)=(EE(N)+ZZ(N))*0.5
      DIF(N)=EE(N)*AC(N)/XLEN(N)
  120 CONTINUE
      IF (NN.NE.IEE) GO TO 170
      WRITE (6,130) NN
  130 FORMAT (1H1,10X,' CHANNEL DISPERSION COEFFICIENTS, SQ FT/SEC (LAST
     1 TWO ITERATIONS)')
      WRITE (6,140) (N,EESAVE(N),ZZ(N),N=1,NC)
  140 FORMAT (5(I10,2F8.0))
      WRITE (6,150)
  150 FORMAT (//,10X,'STEADY STATE SALINITY, PPT')
      WRITE (6,160) (J,SALT(J),J=1,NJ)
  160 FORMAT (5(I13,-3PF8.2))
  170 CONTINUE
C.... ESTIMATE CHLORICITY
      DO 180 JJ=1,NP
      J=JUN(JJ)
      T=TEMP(J)-19.5
      TF(JJ,1)=OTEN(2)**T
      TF(JJ,2)=OTEN(1)**T
  180 OSAT(J)=SATOXY(TEMP(J),SALT(J))
  190 CONTINUE
      NDYN=IDYN(NCYCH)
C
C.... SET UP FINAL ALPHA MATRIX
C
      CALL SETUP
```

2-35-153

```
C
C.... QUALITY LOOP, CONSTANT HYDRAULICS
C
      NOM=NOPERH(NCYCH)
      DO 750 NCYCO=1,NOM
      KPLOT=KPLOT+1
      LDAY=LDAY+IDEL
C
      DO 670 NCYCD=1,IPERD
C
C.... TDS
      IF (ISKIP(1).EQ.1) GO TO 210
      DO 200 J=1,NP
      AA(J)=0.0
      BB(J)=0.0
  200 CONTINUE
      CALL FORM (TDS,TDSIN,TDSEX)
      CALL SOLVIT (TDS)
  210 CONTINUE
C
C....TEMPERATURE
      IF (ISKIP(9).EQ.1) GO TO 290
      IF (NDYN.EQ.1) GO TO 230
      CALL METDAT (1,TEMP)
      DO 220 J=1,NP
      JJ=JUN(J)
      AA(J)=0.003281*AS(JJ)*FTWO(JJ)*ALPH1(J)
      BB(J)=0.003281*AS(JJ)*(FONE(JJ)-FTWO(JJ)*TEMP(JJ)*ALPH(J))
  220 CONTINUE
      CALL FORM (TEMP,TEMPIN,TEMPEX)
      CALL SOLVIT (TEMP)
      GO TO 270
  230 CONTINUE
      LL=6/IPERD
      IF (LL.LT.2) LL=2
      DO 260 L=1,LL
      CALL METDAT (1,TEMP)
      DO 240 J=1,NP
      JJ=JUN(J)
      AA(J)=0.003281*AS(JJ)*FTWO(JJ)
      BB(J)=0.003281*AS(JJ)*FONE(JJ)
  240 CONTINUE
      CALL FORM (TEMP,TEMPIN,TEMPEX)
      CALL SOLVIT (TEMPT)
      IF (L.EQ.LL) GO TO 260
      DO 250 J=1,NJ
  250 TEMP(J)=(TEMP(J)+2.0*TEMPT(J))/3.0
  260 CONTINUE
  270 CONTINUE
      DO 280 JJ=1,NP
      J=JUN(JJ)
      T=TEMP(J)-19.5
      TF(JJ,1)=1.02**T
      TF(JJ,1)=QTEN(2)**T
      TF(JJ,2)=QTEN(1)**T
      CTOC(JJ)=0.0
  280 DSAT(J)=SATOXY(TEMP(J),TDS(J))
```

A Q U A L

```
  290 CONTINUE
C
C.... OPTIONAL CONSTITUENTS
      DO 370 I=1,4
      IF (ISKIP(I+9).EQ.1) GO TO 370
      IF (NDYN.EQ.1) GO TO 310
      DO 300 J=1,NP
      JJ=JUN(J)
      AA(J)=(TYPEDK(JJ,I)+TYSETL(JJ,I))*VOL(JJ)*ALPH1(J)*TF(J,1)
  300 BB(J)=-(TYPEDK(JJ,I)+TYSETL(JJ,I))*VOL(JJ)*ALPH(J)*TYPE(JJ,I)*TF(J
     1,1)+CTOC(J)
      GO TO 330
  310 DO 320 J=1,NP
      JJ=JUN(J)
      AA(J)=(TYPEDK(JJ,I)+TYSETL(JJ,I))*VOL(JJ)*TF(J,1)
  320 BB(J)=CTOC(J)
  330 CONTINUE
      CALL FORM (TYPE(1,I),TYPEIN(1,I),TYPEEX(1,I))
      CALL SOLVIT (TYPE(1,I))
      IF (TYPEEQ(I).LE.0.0) GO TO 350
      DO 340 J=1,NP
      JJ=JUN(J)
  340 CTOC(J)=TYPEDK(JJ,I)*TF(J,1)*TYPE(JJ,I)*TYPEEQ(I)*VOL(JJ)
      GO TO 370
  350 IF (I.EQ.4) GO TO 370
      DO 360 J=1,NP
  360 CTOC(J)=0.
  370 CONTINUE
C
C.... TOTAL NITROGEN
      IF (ISKIP(2).EQ.1) GO TO 390
      DO 380 J=1,NP
      JJ=JUN(J)
      AA(J)=0.
  380 BB(J)=-VOL(JJ)*BENN(JJ)
      CALL FORM (TOTN,TOTNIN,TOTNEX)
      CALL SOLVIT (TOTN)
  390 CONTINUE
C
C.... TOTAL PHOSPHORUS
      IF (ISKIP(3).EQ.1) GO TO 410
      DO 400 J=1,NP
      JJ=JUN(J)
      AA(J)=0.
  400 BB(J)=-VOL(JJ)*BENP(JJ)
      CALL FORM (TOTP,TOTPIN,TOTPEX)
      CALL SOLVIT (TOTP)
  410 CONTINUE
C
C.... TOTAL COLIFORM BACTERIA
      IF (ISKIP(4).EQ.1) GO TO 460
      IF (NDYN.EQ.1) GO TO 430
      DO 420 J=1,NP
      JJ=JUN(J)
      AA(J)=COLTDK(JJ)*VOL(JJ)*ALPH1(J)*TF(J,1)
      BB(J)=-COLTDK(JJ)*VOL(JJ)*ALPH(J)*COLT(JJ)*TF(J,1)
  420 CONTINUE
```

2-35-154

```
      GO TO 450
  430 CONTINUE
      DO 440 J=1,NP
      JJ=JUN(J)
      AA(J)=COLTOK(JJ)*VOL(JJ)*TF(J,1)
  440 BB(J)=0.0
  450 CONTINUE
      CALL FORM (COLT,COLTIN,COLTEX)
      CALL SOLVIT (COLT)
  460 CONTINUE
C
C.... FECAL COLIFORM BACTERIA
      IF (ISKIP(5).EQ.1) GO TO 510
      IF (NDYN.EQ.1) GO TO 480
      DO 470 J=1,NP
      JJ=JUN(J)
      AA(J)=COLFOK(JJ)*VOL(JJ)*ALPH1(J)*TF(J,1)
      BB(J)=-COLFOK(JJ)*VOL(JJ)*ALPH(J)*COLF(JJ)*TF(J,1)
  470 CONTINUE
      GO TO 500
  480 CONTINUE
      DO 490 J=1,NP
      JJ=JUN(J)
      AA(J)=COLFOK(JJ)*VOL(JJ)*TF(J,1)
  490 BB(J)=0.0
  500 CONTINUE
      CALL FORM (COLF,COLFIN,COLFEX)
      CALL SOLVIT (COLF)
  510 CONTINUE
C
C.... CARBONACEOUS BOD
      IF (ISKIP(6).EQ.1) GO TO 560
      IF (NDYN.EQ.1) GO TO 530
      DO 520 J=1,NP
      JJ=JUN(J)
      AA(J)=BODCOK(JJ)*VOL(JJ)*ALPH1(J)*TF(J,2)
      BB(J)=-BODCOK(JJ)*VOL(JJ)*ALPH(J)*BODC(JJ)*TF(J,2)
  520 CONTINUE
      GO TO 550
  530 CONTINUE
      DO 540 J=1,NP
      JJ=JUN(J)
      AA(J)=BODCOK(JJ)*VOL(JJ)*TF(J,2)
  540 BB(J)=0.0
  550 CONTINUE
      CALL FORM (BODC,BODCIN,BODCEX)
      CALL SOLVIT (BODC)
  560 CONTINUE
C
C.... NITROGENOUS BOD
      IF (ISKIP(7).EQ.1) GO TO 610
      IF (NDYN.EQ.1) GO TO 580
      DO 570 J=1,NP
      JJ=JUN(J)
      AA(J)=BODNOK(JJ)*VOL(JJ)*ALPH1(J)*TF(J,1)
      BB(J)=-BODNOK(JJ)*VOL(JJ)*ALPH(J)*BODN(JJ)*TF(J,1)
  570 CONTINUE
```

A Q U A L

```
      GO TO 600
  580 CONTINUE
      DO 590 J=1,NP
      JJ=JUN(J)
      AA(J)=BODNOK(JJ)*VOL(JJ)*TF(J,1)
  590 BB(J)=0.0
  600 CONTINUE
      CALL FORM (BODN,BODNIN,BODNEX)
      CALL SOLVIT (BODN)
  610 CONTINUE
C
C.... DISSOLVED OXYGEN
      IF (ISKIP(8).EQ.1) GO TO 660
      IF (NDYN.EQ.1) GO TO 630
      DO 620 J=1,NP
      JJ=JUN(J)
      AA(J)=VOL(JJ)*OROR(JJ)*ALPH1(J)
      BB(J)=VOL(JJ)*(-BODC(JJ)*BODCOK(JJ)*TF(J,2)+(-BODN(JJ)*BODNOK(JJ)-
     1ODEN(JJ)+OALG(JJ))*TF(J,1)+OROR(JJ)*(OSAT(JJ)-ALPH(J)*OXY(JJ)))
  620 CONTINUE
      GO TO 650
  630 CONTINUE
      DO 640 J=1,NP
      JJ=JUN(J)
      AA(J)=VOL(JJ)*OROR(JJ)
      BB(J)=VOL(JJ)*(-BODC(JJ)*BODCOK(JJ)*TF(J,2)+(-BODN(JJ)*BODNOK(JJ)-
     1ODEN(JJ)+OALG(JJ))*TF(J,1)+OROR(JJ)*OSAT(JJ))
  640 CONTINUE
  650 CONTINUE
      CALL FORM (OXY,OXYIN,OXYEX)
      CALL SOLVIT (OXY)
  660 CONTINUE
  670 CONTINUE
C
      IF (MOD(KPLOT,IPCYC).EQ.0) CALL OUTPUT (LDAY)
      IF (NDYN.EQ.0.AND.IPDAY(IPP).NE.LDAY) GO TO 720
      IPDAY(IPP)=LDAY
C
C.... STORE PROFILE PLOT DATA
      IF (IPP.EQ.4) GO TO 720
      DO 710 II=1,4
      IF (NCOMP(II).EQ.0) GO TO 710
      I=NCOMP(II)
      DO 700 K=1,NPP
      DO 690 LL=1,21
      L=NODEP(LL,K)
      IF (L.EQ.0) GO TO 710
      IF (K.EQ.2) GO TO 680
      PROFA(LL,IPP,II)=CON(L,I)
      GO TO 690
  680 PROFB(LL,IPP,II)=CON(L,I)
  690 CONTINUE
  700 CONTINUE
  710 CONTINUE
      IPP=IPP+1
  720 CONTINUE
C
```

A Q U A L

```
C.... STORE TIME HISTORY PLOT DATA
      IF (KPLOT.GT.100) GO TO 750
      DAY(KPLOT)=LDAY
      DO 740 K=1,4
      IF (IPLOT(K).EQ.0) GO TO 740
      I=IPLOT(K)
      DO 730 II=1,NJP
      J=JPLOT(II)
      CP(KPLOT,II,K)=CON(J,I)
  730 CONTINUE
  740 CONTINUE
  750 CONTINUE
      IF (INQUAL.GT.0) WRITE (INQUAL) ((CON(J,K),K=1,13),J=1,NJ)
  760 CONTINUE
      IPP=IPP-1
      IF (NPP.GT.0.AND.IPP.GT.0) CALL OUTPUT (-1)
      NPOINT=KPLOT
      IF (NPOINT.GT.100) NPOINT=100
      IF (NJP.GT.0) CALL OUTPUT (0)
C
      END
```

C U R V E

```
      SUBROUTINE CURVE(X,Y,NPT,NCV,NPLOT)
C
C  CURVE FINDS THE MAX AND MIN X AND Y VALUES, AS WELL AS X AND Y LABELS
C  IT CALLS SCALE,PPLOT, AND PINE
C
C     DIMENSION X(NPT,NCV),Y(NPT,NCV)  WHERE
C     NPT=NUMBER OF INPUT POINTS ON EACH CURVE
C     NCV=NUMBER OF CURVES ON EACH GRAPH.
C     NPLOT=PRINTED KEY.
C
      DIMENSION X(103,1),Y(103,1),NPT(1)
     *          ,DUMX(4),DUMY(4)
      COMMON/LAB/XLAB(11),YLAB(6),TITLE(12),HORIZ(13),VERT(6),IUNITO
      COMMON/XAXE/NXPTS
C
C                                          SET UP X AND Y SCALES
C
      XMAX = -1.0E30
      XMIN = 1.0E30
      YMAX = -1.0E30
      YMIN = 1.0E30
      DO 150 K = 1, NCV
      N = NPT(K)
      DO 150 J = 1, N
      IF( X(J,K) .GT. XMAX ) XMAX = X(J,K)
      IF( X(J,K) .LT. XMIN ) XMIN = X(J,K)
      IF( Y(J,K) .GT. YMAX ) YMAX = Y(J,K)
      IF( Y(J,K) .LT. YMIN ) YMIN = Y(J,K)
  150 CONTINUE
      IF(NXPTS.EQ.21) XMIN=1.0
      IF(NXPTS.EQ.21) XMAX=21.0
      DUMX(1) = XMIN
      DUMX(2) = XMAX
      CALL SCALE(DUMX,10.0,2,1)
      DUMY(1) = YMIN
      DUMY(2) = YMAX
      CALL SCALE(DUMY,5.0,2,1)
      DO 160 K = 1, NCV
      N = NPT(K)
      X(N+1,K) = DUMX(3)
      X(N+2,K) = DUMX(4)
      Y(N+1,K) = DUMY(3)
      Y(N+2,K) = DUMY(4)
  160 CONTINUE
C
C                                          FORM X LABELS AND FACTORS
C
      XMIN= DUMX(3)
      DELTX= DUMX(4)
      XLAB(1)=XMIN
      DO 260 I=1,10
  260 XLAB(I+1)=XLAB(I)+DELTX
C  XSCAL IS THE NUMBER OF SPACES PER UNIT ALUNG THE X-AXIS (5 FOR PROFILES)
      XSCAL=100./(XLAB(11)-XMIN)
      IF(NXPTS.EQ.21) XSCAL=5.0
C
C                                          FORM Y LABELS AND FACTORS
```

C U R V E

```
C
      YMIN= DUMY(3)
      DELTY= DUMY(4)
      YLAB(6)=YMIN
      DO 270 I=1,5
  270 YLAB(6-I)=YLAB(7-I)+DELTY
      YSCAL=50./(YLAB(1)-YMIN)
C
C                                          INITIALIZE PLOT OUTLINE
C
      CALL PPLOT(0,0,100,NPLOT)
      K = 1
C
C                                          DRAW IN EACH CURVE
C
      DO 450 L=1,NCV
       IF(NPT(L).EQ.0) GO TO 440
C
C                                          JOINING XO YO AND XT YT
C
C  FOR PROFILES THE ORIGTN IS THE FIRST DATA POINT
      IF(NXPTS.EQ.21) XMIN=1.0
      XO=XSCAL*(X(1,L)-XMIN)
      YO=YSCAL*(Y(1,L)-YMIN)
      NPOINT = NPT(L)
      DO 400 N = 2,NPOINT
      XT = XSCAL*(X(N,L) - XMIN)
      YT = YSCAL*(Y(N,L) - YMIN)
      CALL PINE(XO,YO,XT,YT,K,NPLOT)
      XO = XT
      YO = YT
  400 CONTINUE
  440 K = K + 1
  450 CONTINUE
C
C                                          OUTPUT FINAL PLOT
C
      CALL PPLOT(0,0,99,NPLOT)
      RETURN
      END
```

2-35-157

```
      SUBROUTINE FORM(CON,CIN,CEX)
      COMMON/MISC/NJ,NC,NP,NDYN,NBND,MLIM,DELT,IPAGE,NHYD,IDAY,IDELT
     *,      NJP,IEE,KPLOT,ISKIP(16),ALL(20),IDYN(52),TITLE(20),TITL(20)
     *,      NOPERM(52),IPCYC,LDAY,NCYCM,INQUAL
      COMMON/BACK/ INTAKE(20,5),FACTOR(20,5)
      COMMON/EXC/ NBOUND,JBOUND(10),QEBB(10),QFLOOD(10),XR(10),FILL(140)
      COMMON/BIG/ NCHAN(200,8),NJUNC(300,2),JUN(200),XLEN(300)
     *,      ALPH(200),ALPH1(200),AA(200),BB(200),BETA(200)
     *,      ASAVE(200,21),A(200,21),ALPHA(200,21),AC(300),AS(200)
     *,      DIF(300),U(300),VS(300) ,QOU(200),ZZ(300)   ,VOL(200),Z(300)
     *,      CC1(300),CC4(300),DEP(200),RAVE(300),RS(300),VABS(300)
      COMMON/QUAL/ JUNIN(200),JUNGIN(200),JUNA(200),QIN(200),QGIN(200)
     *,      SPACE(7500)
      DIMENSION CON(1),CIN(1),CEX(1)
C
C.... FORM FINAL COEFFICIENT MATRIX AND CONSTANT VECTOR
      M=NBND+1
      DO 92 J=1,NP
      BETA(J)=0.0
      DO 92 K=1,MLIM
   92 ALPHA(J,K)=ASAVE(J,K)
      IF(NDYN.EQ.1) GO TO 150
      II=M
      DO 100 J=1,NP
      II=II-1
      KK=J-NBND
      LL=J+NBND
      IF(KK.LE.0) KK=1
      IF(II.LT.0) II=0
      IF(LL.GT.NP) LL=NP
      I=II
      DO 110 K=KK,LL
      I=I+1
      JJ=JUN(K)
  110 BETA(J)=BETA(J)+CON(JJ)*A(J,I)
      BETA(J)=BETA(J)+BB(J)
      ALPHA(J,M)=ALPHA(J,M)+AA(J)
  100 CONTINUE
      GO TO 120
  150 CONTINUE
      DO 160 J=1,NP
      ALPHA(J,M)=ALPHA(J,M)+AA(J)
      BETA(J)=BETA(J)+BB(J)
  160 CONTINUE
  120 CONTINUE
C..
C.... INFLOWS
      DO 200 J=1,NP
      JJ=JUN(J)
      J1=JUNIN(JJ)
      J2=JUNGIN(JJ)
      BETA(J)=BETA(J)+CIN(J1)*QIN(JJ)+CIN(J2)*QGIN(JJ)
      IF(JUNA(JJ).EQ.0) GO TO 200
      KK=JUNA(JJ)
      DO 220 I=1,5
      K=INTAKE(KK,I)
      IF(K.EQ.0) GO TO 220
```



```
      BETA(J)=BETA(J)+(CON(K)+CIN(100+KK))*QOU(K)*FACTOR(KK,I)
  220 CONTINUE
  200 CONTINUE
C
C.... BOUNDARY EXCHANGE
      IF(NDYN.EQ.1) GO TO 408
      DO 400 L=1,NBOUND
      J=JBOUND(L)
      JJ=JUN(J)
      TA=QFLOOD(L)*(1.0-XR(L))-QEBB(L)
      ALPHA(J,M)=ALPHA(J,M)-TA*ALPH1(J)
      BETA(J)=BETA(J)+TA*ALPH(J)*CON(JJ)+CEX(L)*QFLOOD(L)*XR(L)
  400 CONTINUE
      GO TO 418
  408 CONTINUE
      DO 420 L=1,NBOUND
C     KEQ=JBOUND(L)
C     CONE=XR(L)*(QEBB(L)+QFLOOD(L))/(2.-XR(L))
C     CTWO=2.0*CEX(L)*(QFLOOD(L)-(1.0-XR(L))*QEBB(L))/(2.-XR(L))
C     ALPHA(KEQ,M)=ALPHA(KEQ,M)+CONE
C     BETA(KEQ)=BETA(KEQ)+CTWO
      J=JBOUND(L)
      TA=QFLOOD(L)*(1.0-XR(L))-QEBB(L)
      ALPHA(J,M)=ALPHA(J,M)-TA
      BETA(J)=BETA(J)+CEX(L)*QFLOOD(L)*XR(L)
  420 CONTINUE
  418 CONTINUE
      RETURN
      END
```

INPUT

```
      SUBROUTINE INPUT (KK)
      COMMON HORM(200)
      COMMON/BIG/ NCHAN(200,8),NJUNC(300,2),JUN(200),XLEN(300)
     1,      ALPH(200),ALPH1(200),AA(200),BB(200),BETA(200)
     2,      ASAVE(200,21),A(200,21),ALPHA(200,21),AC(300),AS(200)
     3,      DIF(300),Q(300),VS(300) ,QOU(200),ZZ(300)   ,VOL(200),Z(300)
     4,      CC1(300),CC4(300),DEP(200),RAVE(300),RS(300),YABS(300)
      COMMON/QUAL/ JUNIN(200),JUNGIN(200),JUNA(200),QIN(200),UGIN(200)
     1,      TDSIN(150),TOTNIN(150),TOTPIN(150),COLTIN(150),COLFIN(150)
     2,       BODCIN(150),BODNIN(150),OXYIN(150),TEMPIN(150)
     3,      TYPEIN(150,4),SALTIN(150)
     4,      TDS(200),TOTN(200),TOTP(200),COLT(200),COLF(200),BODC(200)
     5,      BODN(200),OXY(200),TEMP(200),TYPE(200,4),TYPEDK(200,4)
     6,      DALG(200),DBEN(200),DHUM(200),BODCDK(200),BODNDK(200)
     7,      COLTOK(200),COLFOK(200),OSAT(200),BENN(200),BENP(200)
      COMMON/ACD/TYPEEQ(4),TYSETL(200,4),QTEN(2)
      COMMON/BACK/ INTAKE(20,5),FACTOR(20,5)
      COMMON/MISC/NJ,NC,NP,NDYN,NBND,NLIM,DELT,IPAGE,NHYD,IDAY,IDELT
     1,      NJP,IEE,KPLOT,ISKIP(16),ALT(20),IDYN(52),TITLE(20),TITL(20)
     2,      NOPERM(52),IPCYC,LDAY,NCYCH,INQUAL
      COMMON/EXC/ NBOUND,JBOUND(10),QEBB(10),QFLOOD(10),XH(10),TDSEX(10)
     1,      TOTNEX(10),TOTPEX(10),COLTEX(10),COLFEX(10),BODCEX(10)
     2,      BODNEX(10),OXYEX(10),TEMPEX(10),TYPLEX(10,4),SALTEX(10)
      COMMON/PLOT/ IPLOT(4),CP(101,6,4),DAY(101),NPOINT,JPLOT(6)
     1,       IPP,NPP,IPDAY(3),NODEP(21,2),PROFA(21,3,4),NCOMP(4)
     2,      PROFB(21,3,4)
      COMMON/HET/NAZONE,JAZONE(6,2),FONE(200),FIND(200)
     1,      FY(200),ONS(24,6),WINDA(200)
      DIMENSION CON(200,1),CIN(150,1),CEX(10,1)
      DIMENSION QVDT(200),AGAM(200)
      EQUIVALENCE (CON(1,1),TDS(1))
     1,      (CEX(1,1),TDSEX(1)),(CIN(1,1),TDSIN(1))
      DIMENSION NAME(3,13),NTEMP(10),CNAME(4,4)
      DATA NAME/4HTDS ,2*4H    ,4HTOTA,4HL N ,4H    ,4HTOTA,4HL P
     1,      4H    ,4HTOTA,4HL CO,4HLIF ,4HFECA,4HL CO,4HLIF ,4HCARB
     2,      4HON B,4HOD  ,4HNITR,4HO BO,4HD   ,4HOXYG,4HEN  ,4H
     3,      4HTEMP,4HERAT,4HURE ,4HOPP ,4HCONS,4HT 1 ,4HOPP ,4HCONS
     4,      4HT 2 ,4HOPP ,4HCONS,4HT 3 ,4HOPP ,4HCONS,4HT 4  /
      DATA NJMAX/200/
      SATOXY(X,Y)=14.5532-0.38217*X+5.4258E-3*X*X-0.555*Y*(1.665E-4-5.86
     16E-6*X+9.796E-8*X*X)
      RATE(X)=X/86400.
C
      IF (KK.EQ.1) GO TO 520
      QTEN(1)=1.0
      QTEN(2)=1.0
      DO 100 J=1,300
  100 NJUNC(J,1)=0
      DO 110 J=1,200
  110 NCHAN(J,1)=0
      DO 120 I=1,4
      NCOMP(I)=0
  120 IPLOT(I)=0
      DO 130 I=1,3
  130 IPDAY(I)=0
      DO 140 I=1,6
  140 JPLOT(I)=0
```

INPUT

```
      DO 160 I=1,21
      DO 150 J=1,3
      DO 150 K=1,4
      PROFA(I,J,K)=0.0
  150 PROFB(I,J,K)=0.0
      NODEP(I,1)=0
  160 NODEP(I,2)=0
      READ (5,170) TITLE,TITL
  170 FORMAT (20A4)
      READ (5,180) NHYD,IDAY,IDELT,IALT,IPCYC,NJP,NPP,IEE,NFILE,INQUAL
      INQUAL=0
  180 FORMAT (16I5)
      REWIND NFILE
      READ (NFILE) NJ,NC,NBND
      READ (NFILE) (JUN(J),(NCHAN(J,I),I=1,8),J=1,NJ),(NJUNC(N,1),NJUNC(
     1N,2),XLEN(N),N=1,NC)
      NLIM=2*NBND+1
      IPP=1
      NP=0
      KPLOT=0
      DO 190 J=1,NJ
  190 WINDA(J)=0.
      DO 200 I=1,14
  200 CIN(150,I)=0.
      DO 210 J=1,NJ
      JUNA(J)=0
      JUNIN(J)=150
      JUNGIN(J)=150
      IF (JUN(J).LE.0) GO TO 210
      NP=NP+1
  210 CONTINUE
C
      DO 220 J=1,NP
      DO 220 N=1,NC
      IF (JUN(J).EQ.NJUNC(N,1)) NJUNC(N,1)=-J
      IF (JUN(J).EQ.NJUNC(N,2)) NJUNC(N,2)=-J
  220 CONTINUE
      DO 230 N=1,NC
      NJUNC(N,1)=IABS(NJUNC(N,1))
      NJUNC(N,2)=IABS(NJUNC(N,2))
  230 CONTINUE
C
      IF (IEE.EQ.0) IEE=10
      IF (NJP.GT.6) NJP=6
      IF (NPP.GT.2) NPP=2
      IF (INQUAL.GT.0) REWIND INQUAL
      KEEPP=IPCYC
      LDAY=IDAY
      DELT=FLOAT(IDELT)*3600.
      READ (5,180) (NOPERM(I),IDYN(I),I=1,NHYD)
      NDYN=IDYN(1)
      READ (5,180) (ISKIP(I),I=1,16)
      READ (5,200) CNAME
  240 FORMAT (16A4)
      ISKIP(16)=IALT
      IF (NJP.EQ.0) GO TO 250
      READ (5,180) (IPLOT(K),K=1,4),(JPLOT(K),K=1,6)
```

2-35-159

```
  250 CONTINUE
      IF (NPP.EQ.0) GO TO 270
      READ (5,180) (NCONP(K),K=1,4),(IPDAY(I),I=1,3)
      DO 260 I=1,NPP
  260 READ (5,180) (NODEP(J,I),J=1,21)
  270 CONTINUE
      WRITE (6,280) TITLE,TITL
  280 FORMAT (1H1,10X,20A4,'      TETRA TECH, INC.'/,11X,20A4,'      LAFAY
     1ETTE, CALIF.'/)
      WRITE (6,290) IDAY,IDELT,IPCYC,NFILE,INQUAL,NHYD
  290 FORMAT (///,20X,'SIMULATION BEGINS ON DAY                ',I4,//,20X,'
     1TIME STEPS OF                          ',I4,' HOUR(S)',//,20X,'PRINTO
     2UT EVERY                          ',I4,' TIME STEP(S)',//,20X,'HYDRAUL
     3IC INTERFACE UNIT',T57,I4,//,20X,'QUALITY INTERFACE UNIT',T57,I4,/
     4/,20X,'NUMBER OF BOUNDARY CONDITIONS          ',I4/)
      DO 330 I=1,NHYD
      IF (IDELT.GT.24) NOPERH(I)=NOPERH(I)*24/IDELT
      IF (NOPERH(I).LE.0) NOPERH(I)=1
      IF (IDYN(I).EQ.0) GO TO 310
      WRITE (6,300) NOPERH(I),I
  300 FORMAT (23X,I3,'  TIME STEPS FOR CONDITION   ',I5,'    STEADY STATE
     1')
      GO TO 330
  310 WRITE (6,320) NOPERH(I),I
  320 FORMAT (23X,I3,'  TIME STEPS FOR CONDITION   ',I5,'    DYNAMIC')
  330 CONTINUE
      WRITE (6,340)
  340 FORMAT (///,20X,'THE FOLLOWING CONSTITUENTS ARE BEING MODELED'/)
      DO 350 K=1,9
      IF (ISKIP(K).EQ.0) WRITE (6,360) (NAME(J,K),J=1,3)
  350 CONTINUE
  360 FORMAT (25X,3A4)
      I=0
      DO 370 K=10,13
      I=I+1
      IF (ISKIP(K).EQ.0) WRITE (6,380) (NAME(J,K),J=1,3),(CNAME(J,I),J=1
     1,4)
  370 CONTINUE
  380 FORMAT (25X,3A4,2X,4A4)
C
C.... INITIAL QUALITY CONDITIONS
      WRITE (6,280) TITLE,TITL
      WRITE (6,390)
  390 FORMAT (//,30X,'INITIAL QUALITY CONDITIONS'/,' JUN TO JUN       TDS
     1     TOT N     TOT P     T COL     F COL     C BOD     N BOD      D O
     2  TEMP  CONST 1  CONST 2  CONST 3  CONST 4'/,11X,3(5X,'MG/L'),2('
     3NO/100ML'),3(5X,'MG/L'),7X,'C ',4('     UNITS')/)
      DO 440 JJ=1,NJ
      READ (5,400) J1,J2,(ALL(I),I=1,13)
  400 FORMAT (2I5,14F5.0)
      IF (J1.EQ.0) GO TO 450
      IF (J1.GT.J2.OR.J2.GT.NJMAX) WRITE (6,410)
  410 FORMAT ('0* ERROR * THE FOLLOWING NODE LIMITS ARE IN ERROR')
      IF (ALL(8).LT.0.0) ALL(8)=-ALL(8)*SATOXY(ALL(9),ALL(1))
      WRITE (6,420) J1,J2,(ALL(J),J=1,13)
  420 FORMAT (I4,I7,F9.0,2F9.2,2F9.2,3F9.2,F9.1,4F9.2)
      DO 430 J=J1,J2
```

INPUT

```
      DO 430 I=1,13
      CON(J,I)=ALL(I)
  430 CONTINUE
  440 CONTINUE
  450 CONTINUE
C
C.... DISPERSION COEFFICIENTS
      WRITE (6,460)
  460 FORMAT (///,10X,'DISPERSION COEFFICIENTS'/,5X,'CHAN TO CHAN
     1     C1              C4')
  470 FORMAT (I9,I8,2F12.0)
      DO 490 N=1,NC
      READ (5,400) J1,J2,C1,C4
      IF (J1.EQ.0) GO TO 490
      WRITE (6,470) J1,J2,C1,C4
      DO 480 J=J1,J2
      CC1(J)=C1
  480 CC4(J)=C4
  490 CONTINUE
C
C.... SEAWARD BOUNDARY
      READ (5,180) NBOUND,(JBOUND(J),J=1,10)
      DO 510 L=1,NBOUND
      DO 500 K=1,NP
      IF (JBOUND(L).NE.JUN(K)) GO TO 500
      JBOUND(L)=K
      GO TO 510
  500 CONTINUE
  510 CONTINUE
      RETURN
C
C
  520 CONTINUE
      NDYN=IDYN(NCYCH)
      IPCYC=KEEPP
      IF (NDYN.EQ.1) IPCYC=1
      READ (5,170) TITL
      READ (5,180) (NTEMP(I),I=1,10)
      I=0
      DO 530 J=2,9
  530 I=I+NTEMP(J)
      IF (I.LT.8) WRITE (6,280) TITLE,TITL
      IEE=-IABS(IEE)
      IF (NTEMP(1).EQ.1) GO TO 590
C
C.... HYDRODYNAMICS
      IF (NTEMP(10)) 540,580,560
  540 I=-NTEMP(10)
      DO 550 K=1,I
  550 BACKSPACE NFILE
      GO TO 580
  560 I=NTEMP(10)
      DO 570 K=1,I
  570 READ (NFILE)
  580 CONTINUE
      READ (NFILE) QEBB,QFLOOD,(DVDT(J),DEP(J),AS(J),VOL(J),QIN(J),QOIN(
     1J),QOU(J),RORH(J),J=1,NJ),(AC(N),Q(N),RS(N),RAVE(N),VS(N),VABS(N),
```

```
     2N=1,NC)
      TEE=-IFE
  590 CONTINUE
C
C.... TIDAL CONDITIONS
      IF (NTEMP(2).EQ.1) GO TO 650
      READ (5,610) (XR(J),J=1,NBOUND)
      IPAGE=IPAGE+1
      WRITE (6,600) NCYCH
  600 FORMAT (//,30X,'EXCHANGE CONDITIONS DURING HYDROLOGIC CYCLE',I4,/'
     1 JUN  EXCH      EBB      FLOOD      TDS    TOT N    TOT P    T COL    F CO
     2L     C BOD    N BOD      OXY      TEMP    CON 1    CON 2    CON 3    CON 4'
     3/,5X,'RATIO     MCFS     MCFS ',3(4X,'MG/L'),2(' N/100ML'),3('      MG
     4/L'),5X,'C',2X,4('    UNITS')/)
      DO 630 K=1,NBOUND
      READ (5,610) (CEX(K,I),I=1,14)
  610 FORMAT (5X,14F5.0)
      J=JBOUND(K)
      J=JUN(J)
      IF (SALTEX(K).LE.0.0) SALTEX(K)=TDSEX(K)
      IF (OXYEX(K).LT.0.0) OXYEX(K)=-OXYEX(K)*SATOXY(TEMPEX(K),TDSEX(K))
      WRITE (6,620) J,XR(K),QEBB(K),QFLOOD(K),(CEX(K,I),I=1,13)
  620 FORMAT (I4,F5.2,-6P2F9.3,0PF8.0,F8.2,F7.2,2E9.2,F7.2,F8.2,2F8.1,4F
     18.2)
  630 CONTINUE
  640 FORMAT (///,30X,'INFLOW CONDITIONS DURING HYDRAULIC CYCLE',I4,/' J
     1UN    INFLOW        TDS      TOT N     TOT P     T COL     F COL     C BOD
     2    N BOD       OXY      TEMP   CONST 1  CONST 2  CONST 3  CONST 4'/9X
     3,'CFS ',3(5X,'MG/L'),2(' NO/100ML'),3(5X,'MG/L'),7X,'C ',4('     UN
     4ITS')/)
C
C.... INFLOW WATER QUALITY
  650 IF (NTEMP(3).EQ.1) GO TO 810
      WRITE (6,640) NCYCH
      DO 660 J=1,NJ
  660 JUNIN(J)=150
      DO 670 J=1,100
      DO 670 K=1,14
  670 CIN(J,K)=0.0
      L=1
      DO 730 LI=1,500
      READ (5,690) JJ,QQ,(ALL(K),K=1,14)
  680 FORMAT ('0* ERROR * RETURN WATER IS ALLOWED AT 20 NODES MAXIMUM')
  690 FORMAT (I5,15F5.0)
      IF (JJ.EQ.0) GO TO 740
      IF (ALL(14).LE.0.0) ALL(14)=ALL(1)
      IF (ALL(8).LT.0.0) ALL(8)=-ALL(8)*SATOXY(ALL(9),ALL(1))
      WRITE (6,800) JJ,QQ,(ALL(K),K=1,13)
      IF (LL.EQ.1) JUNIN(JJ)=1
      DO 700 K=1,L
      J=K
      IF (JUNIN(JJ).EQ.K) GO TO 710
  700 CONTINUE
      L=L+1
      J=L
      JUNIN(JJ)=J
  710 CONTINUE
```



```
      TA=-45*000.*35.314/(.864E+8*QQ)
      DO 720 K=1,14
      F=1.
      IF (ALL(K).LT.0.0) F=TA
  720 CIN(J,K)=CIN(J,K)+ALL(K)*QQ*F
  730 CONTINUE
  740 CONTINUE
      IF (J.GT.100) WRITE (6,750)
  750 FORMAT ('0WARNING * * THE MAXIMUM OF 100 INFLOW LOCATIONS HAS BEEN
     1 EXCEEDED * *')
      IF (NTEMP(4).EQ.1) GO TO 810
      WRITE (6,760)
  760 FORMAT (/,10X,'AGGREGATED QUALITY')
      DO 790 J=1,NJ
      JJ=JUNIN(J)
      IF (JJ.EQ.150) GO TO 780
      IF (QIN(J).LE.0) QIN(J)=1.0
      DO 770 K=1,14
  770 CIN(JJ,K)=CIN(JJ,K)/QIN(J)
      IF (SALTIN(JJ).LE.0.) SALTIN(JJ)=TDSIN(JJ)
  780 IF (QIN(J).LE.0.0) GO TO 790
      WRITE (6,800) J,QIN(J),(CIN(JJ,K),K=1,13)
  790 CONTINUE
  800 FORMAT (I4,F9.2,F9.0,2F9.2,2E9.2,2F9.2,2F9.1,4F9.2)
C
C.... GROUND WATER INFLOW
  810 IF (NTEMP(5).EQ.1) GO TO 900
      WRITE (6,820)
  820 FORMAT (/,10X,'GROUND WATER INFLOW QUALITY',/'   JUN TO JUN')
      DO 830 J=1,NJ
  830 JUNGIN(J)=150
      DO 880 JJ=1,30
      READ (5,800) J1,J2,(ALL(I),I=1,14)
      IF (J1.EQ.0) GO TO 890
      IF (ALL(14).LE.0.0) ALL(14)=ALL(1)
      IF (ALL(8).LT.0.0) ALL(8)=-ALL(8)*SATOXY(ALL(9),ALL(1))
      WRITE (6,840) J1,J2,(ALL(I),I=1,13)
  840 FORMAT (I6,I7,F9.0,2F9.2,2E9.2,2F9.2,2F9.1,4F9.2)
      IF (JJ.EQ.30) WRITE (6,850)
  850 FORMAT ('0* ERROR * A MAXIMUM OF 29 GROUND WATER TYPES ARE ALLOWED'
     1)
      DO 860 I=1,14
  860 CIN(120+JJ,I)=ALL(I)
      DO 870 I=J1,J2
  870 JUNGIN(I)=JJ+120
  880 CONTINUE
  890 CONTINUE
C
C.... RETURN WATER
  900 IF (NTEMP(6).EQ.1) GO TO 1010
      WRITE (6,910)
  910 FORMAT (///,10X,'RETURN WATER'/,' WITHDRAWAL JUNCTION AND FRACTION
     1 RETURNED',/' DISCHARGE JUNCTION AND CONCENTRATION INCREMENT'/)
      DO 920 J=1,NJ
  920 JUNA(J)=0
      DO 930 J=1,20
      DO 930 K=1,5
```

2-35-161

```
      INTAKE(J,K)=0
  930 FACTOR(J,K)=0.0
      DO 990 J=1,21
      READ (5,940) J1,(NTEMP(I),ALL(I),I=1,5)
  940 FORMAT (I5,5(I5,F5.0))
      IF (J1.EQ.0) GO TO 1000
      IF (J.EQ.21) WRITE (6,660)
      JUNA(J1)=J
      DO 950 I=1,5
      INTAKE(J,I)=NTEMP(I)
  950 FACTOR(J,I)=ALL(I)
      READ (5,960) (ALL(I),I=1,14)
      IF (ALL(14).LE.0.0) ALL(14)=ALL(1)
  960 FORMAT (16F5.0)
      DO 970 I=1,14
  970 CIN(100+J,I)=ALL(I)
      WRITE (6,980) (INTAKE(J,I),FACTOR(J,I),I=1,5),J1,(ALL(I),I=1,13)
  980 FORMAT (5(I5,F5.2),/I4,F18.0,2F9.2,2E9.2,2F9.2,2F9.1,4F9.2)
  990 CONTINUE
 1000 CONTINUE
      IPAGE=IPAGE+1
C
C.... SYSTEM COEFFICIENTS
 1010 IF (NTEMP(7).EQ.1) GO TO 1110
      WRITE (6,1020)
 1020 FORMAT (///,30X,'SYSTEM COEFFICIENTS',/' JUN TO JUN   BOD DECAY
     1COLIF DECAY   BENTHIC SINK RATES   ALGAL OXYGEN   REAERATION      O
     2PP CONST DECAY     OPP CONST SETTLING',/13X,'CARB  NITR   TOTAL FEC
     3AL       N       P       O   PHOTO   RESP   MIN    MAX     1     2
     43    4     1     2     3     4',/16X,'1/DAY             1/DAY           MF
     5/M2/DAY           MG/M2/DAY          1/DAY              1/DAY
     6      M/DAY'/)
      READ (5,960) (TYPEEQ(I),I=1,3),(QTEN(I),I=1,2)
      IF (QTEN(1).LE.0.0) QTEN(1)=1.05
      IF (QTEN(2).LE.0.0) QTEN(2)=1.03
      TYPEEQ(4)=0.0
      DO 1080 JJ=1,NJ
      READ (5,400) J1,J2,(ALL(I),I=2,9)
      IF (J1.EQ.0) GO TO 1090
      READ (5,1030) (ALL(I),I=6,20)
 1030 FORMAT (16F5.0)
      IF (J1.GT.J2.OR.J2.GT.NJMAX) WRITE (6,410)
      WRITE (6,1040) J1,J2,(ALL(I),I=2,7),ALL(10),ALL(8),ALL(9),(ALL(I),
     1I=11,20)
 1040 FORMAT (I4,I7,2F6.2,F8.2,F6.2,3F7.0,F8.0,F7.0,F6.1,F7.1,F6.2,3F5.2
     1,F7.2,3F5.2)
      TA=1.
      TB=1.
      ALL(2)=RATE(TB*ALL(2))
      ALL(3)=RATE(TA*ALL(3))
      ALL(4)=RATE(TA*ALL(4))
      ALL(5)=RATE(TA*ALL(5))
      DO 1050 I=13,16
 1050 ALL(I)=RATE(TA*ALL(I))
      DO 1080 J=J1,J2
      IF (NCHAN(J,1).EQ.0) GO TO 1080
      BODCDK(J)=ALL(2)
```



```
      BODNDK(J)=ALL(3)
      COLTDK(J)=ALL(4)
      COLFDK(J)=ALL(5)
      DO 1060 I=1,4
      K=12+I
 1060 TYPEDK(J,I)=ALL(K)
      TC=0.003281*AS(J)/VOL(J)/86400.
      BENN(J)=TA*TC*ALL(6)
      BENP(J)=TA*TC*ALL(7)
      OALG(J)=TA*TC*(ALL(8)-ALL(9))
      OBEN(J)=TA*TC*ALL(10)
      TC=TC*1000.
      DO 1070 I=1,4
      K=16+I
 1070 TYSETL(J,I)=ALL(K)*TC
      AA(J)=ALL(11)
      BB(J)=ALL(12)
 1080 CONTINUE
 1090 CONTINUE
      WRITE (6,1100) (TYPEEQ(I),I=1,3),(QTEN(I),I=1,2)
 1100 FORMAT ('0STOICHIOMETRIC EQUIVALENCE BETWEEN OPTIONAL CONSTITUENTS
     1'/,' CONST NO 1 DECAY TO CONST NO 2,',F8.2,/' CONST NO 2 DECAY TO
     2 CONST NO 3,',F8.2,/' CONST NO 3 DECAY TO CONST NO 4,',F8.2,//' RA
     3TE COEFFICIENT TEMPERATURE ADJUSTMENT CONSTANT FOR',//' BOD
     4',F10.3,/' ALL OTHERS',F10.3)
 1110 CONTINUE
C
C.... METEROLOGICAL CONDITIONS
      IF (NTEMP(8).NE.1) CALL METDAT (-1,TEMP)
      IF (NTEMP(7).EQ.1.AND.NTEMP(8).EQ.1) GO TO 1170
      IF (NTEMP(7).NE.1) GO TO 1130
      DO 1120 J=1,NJ
      AA(J)=0.0
 1120 BB(J)=10000.
 1130 CONTINUE
      DO 1140 J=1,NJ
      RORW(J)=0.
      OROR(J)=0.
      IF (NCHAN(J,1).EQ.0) GO TO 1140
      RORW(J)=0.40+0.0974*WINDA(J)**2
      RORW(J)=RORW(J)*AS(J)*3.281/VOL(J)
      OROR(J)=AMAX1(RORW(J),RORH(J))
      OROR(J)=AMAX1(OROR(J),AA(J))
      OROR(J)=AMIN1(OROR(J),BB(J))
 1140 CONTINUE
      WRITE (6,1150) (J,RORH(J),RORW(J),OROR(J),J=1,NJ)
 1150 FORMAT ('0 FLOW AND WIND INDUCED REAERATION COEFFICIENT AND COEFF.
     1 USED BY NODES, 1/DAY'/(5(I8,3F6.3)))
      TA=1.
      DO 1160 J=1,NJ
      IF (NCHAN(J,1).EQ.0) GO TO 1160
      OROR(J)=RATE(TA*OROR(J))
 1160 CONTINUE
      IF (NTEMP(9).NE.1) CALL METDAT (0,TEMP)
 1170 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE METDAT (JSKIP,TW)
C*****
C     THIS ROUTINE USES ARC SIN AND ARC COS LIBRARY FUNCTIONS.
C     THESE FUNCTIONS ARE SPELLED ASIN AND ACOS IN THIS CODE.
C*****
      COMMON/MISC/NJ,NO,NP,NDYN,NHND,MLIM,DELT,IPAGE,NHYD,IDAY,IDELT
     1,       NJP,ILE,KPLOT,ISKIP(16),ALL(20),IDYN(52),TITLE(20),TITL(20)
     2,       NOPERH(52),IPCYC,LDAY,NCYCH,INDUAL
      COMMON/AT/XLAT(6),XLON(6),TURB(6),CLOUD(25,6),DBT(25,6),WBT(25,6)
     1,       APR(25,6),WIND(25,6),QNA(25,6),EA(25,6)
      COMMON/MET/NWZONE,JWZONE(6,2),FONE(200),FTWO(200)
     1,       FY(200),QNS(24,6),WINDA(200)
      DIMENSION ALPH(8), BETA(8), A(4), B(4) ,TW(200)
C
      DATA ALPH/6.05,5.10,2.65,-2.04,-9.94,-22.29,-40.63,-66.90/
      DATA BETA/0.522,0.710,0.954,1.265,1.659,2.151,2.761,3.511/
      DATA A/1.18,2.20,0.95,0.35/
      DATA B/-0.77,-0.97,-0.75,-0.45/
      DATA PI/3.14159/, WBO/0.3333333/, DTOR/0.01745/
C
      RO(X)=1000.-(((X-3.98)**2*(X+283.))/(503.57*(X+67.26)))
C
      IF (JSKIP) 100,210,290
  100 CONTINUE
      READ (5,110) NWZONE,DAY,EPS,AA,BB,DEW
  110 FORMAT (I5,10F5.0)
      IF (BB.LE.0.0) BB=1.5E-9
      DO 200 L=1,NWZONE
C
C READ NUMBERS OF JUNCTIONS DELIMITING THE WEATHER ZONE, THE LATITUDE
C AND LONGITUDE, AND ATMOSPHERIC TURBIDITY (2 FOR CLEAR, UP TO 5 FOR SMO
      READ (5,120) (JWZONE(L,J),J=1,2),XLAT(L),XLON(L),TURB(L)
  120 FORMAT (2I5,10F5.0)
C
      J1=1
      DO 140 J=1,25
C
C READ CLOUD COVER FRACTION(PCT), DRY BULB(C),WET BULB(C),ATMOSPHERIC PR
C (MB), AND WIND SPEED(M/SEC)
C
      READ (5,110) J2,(ALL(I),I=1,5)
      CLOUD(J2,L)=ALL(1)
      DBT(J2,L)=ALL(2)
      WBT(J2,L)=ALL(3)
      APR(J2,L)=ALL(5)
      WIND(J2,L)=ALL(4)
      IF (J2.EQ.1) GO TO 140
      NN=J2-J1-1
      IF (NN.LE.0) GO TO 140
      DO 130 N=1,NN
      JJ=J1+N
      TA=FLOAT(N)/FLOAT(NN+1)
      TB=1.0-TA
      CLOUD(JJ,L)=CLOUD(J2,L)*TA+CLOUD(J1,L)*TB
      DBT(JJ,L)=DBT(J2,L)*TA+DBT(J1,L)*TB
      WBT(JJ,L)=WBT(J2,L)*TA+WBT(J1,L)*TB
      APR(JJ,L)=APR(J2,L)*TA+APR(J1,L)*TB
  130 WIND(JJ,L)=WIND(J2,L)*TA+WIND(J1,L)*TB
      IF (J2.EQ.25) GO TO 150
  140 J1=J2
  150 CONTINUE
C
      SMERD=15*IFIX(XLON(L)/15.0)
      DELTS=EPS*(SMERD-XLON(L))/15.0
C....                          COMPUTE DECLINATION,SUNUP, SUNSET, AND
C                              CONSTANTS USED IN RADIATION COMPUTATION
C
      DECL=0.4092*COS(0.01721*(172.0-DAY))
      TA=TAN(XLAT(L)*DTOR)*TAN(DECL)
C*****
      HSR=12.0*ACOS(-TA)/PI
C*****
      SUNUP=12.0-HSR+DELTS
      SUNSET=12.0+HSR+DELTS
      T1=SIN(DECL)*SIN(XLAT(L)*DTOR)
      T2=COS(DECL)*COS(XLAT(L)*DTOR)
C
C....                          RADIATION AT GIVEN INTERVALS THROUGHOUT A D
C
C....                          COMPUTE LONGWAVE ATMOSPHER. RADIATION
C
      DO 180 NN=1,24
      TA=1.21E-16*(1.0+0.17*CLOUD(NN,L)**2)
      QNA(NN,L)=TA*(DBT(NN,L)+273.0)**6
C
C....                          SHORTWAVE SOLAR RADIATION
C
      QNS(NN,L)=0.0
      TIME=NN-1
      IF (TIME.LE.SUNUP.OR.TIME.GE.SUNSET) GO TO 170
      CLD=CLOUD(NN,L)
      HA=PI*(TIME-12.0-DELTS)/12.0
      SINA=T1+T2*COS(HA)
      RAD=WBO*SINA
      A1=0.128-0.054*ALOG10(1.0/ABS(SINA))
      TA=TURB(L)*A1/SINA
      RAD=RAD/EXP(TA)
      RAD=RAD*(1.0-.65*CLD**2)
      NC=2.0*(CLD+1.0)
      IF (CLD.GT.0.05.AND.CLD.LT.0.95) GO TO 160
      NC=1
      IF (CLD.GT.0.95) NC=4
C*****
  160 ALBEDO=A(NC)*(57.3*ASIN(SINA))**B(NC)
C*****
      QNS(NN,L)=RAD*(1.-ALBEDO)
      IF (QNS(NN,L).LT.0.) QNS(NN,L)=0.
  170 CONTINUE
  180 CONTINUE
C
      TA=0.
      DO 190 JJ=1,24
      EA(JJ,L)=2.1718E8*EXP(-4157.0/(WBT(JJ,L)+239.09))
      IF (DEW.GT.0.01) EA(JJ,L)=EA(JJ,L)-APR(JJ,L)*(DBT(JJ,L)-WBT(JJ,L))
```

2-35-163

```
      1*(6.6E-4+7.59E-7*WBT(JJ,L))
      TA=TA+WIND(JJ,L)
  190 CONTINUE
      TA=TA/24.
      J1=JWZONE(L,1)
      J2=JWZONE(L,2)
      DO 200 J=J1,J2
  200 WINDA(J)=TA
      RETURN
  210 CONTINUE
      DO 280 L=1,NWZONE
      IPAGE=IPAGE+1
      WRITE (6,220) TITLE,TITL
  220 FORMAT (1H1,10X,20A4,'      TETRA TECH, INC.'/,11X,20A4,'      LAFAY
     1ETTE, CALIF.'/)
      WRITE (6,230) L,(JWZONE(L,J),J=1,2),XLAT(L),XLON(L)
  230 FORMAT (///,20X,44HTABLE OF METEOROLOGIC DATA FOR WEATHER ZONE ,I2
     1,10H, JUNCTION,I4,3H TO,I4/,T99,12HLATITUDE =  ,F5.1/,T99,12HLONGI
     2TUDE = ,F5.1//,120H       HOUR              WIND      CLOUD     DRY BULB
     3        ****        ATMOSPHERIC  SHORT WAVE        LONG WAVE          VAPOR
     4        /120H                          SPEED       COVER  TEMPERATURE  TEMPE
     5RATURE       PRESSURE        SOLAR              SOLAR          PRESSURE
     6/120H                       (M/SEC)    FRACTION      (C)              (C)
     7          (MB)    (KCAL/M2/SEC)    (KCAL/M2/SEC)       (MB)         /)
      DO 240 I=1,24
      WRITE (6,270) I,WIND(I,L),CLOUD(I,L),DBT(I,L),WBT(I,L),APR(I,L),QN
     1S(I,L),QNA(I,L),EA(I,L)
  240 CONTINUE
      IF (DEW.LE..01) WRITE (6,250)
  250 FORMAT ('0**** DEW POINT')
      IF (DEW.GT..01) WRITE (6,260)
  260 FORMAT ('0**** WET BULB')
  270 FORMAT (I10,F13.1,F10.2,F10.1,F13.1,F16.0,F12.4,F16.4,F12.0)
  280 CONTINUE
      RETURN
C                              COMPUTE HEAT TRANSFER PARAMETERS...
  290 CONTINUE
      DO 310 L=1,NWZONE
      J1=JWZONE(L,1)
      J2=JWZONE(L,2)
      DO 310 J=J1,J2
      EV(J)=0.0
      FONE(J)=0.0
      FTWO(J)=0.0
      IF (TW(J).LE.0.0) GO TO 310
      DO 300 I=1,24
      PF=6.1E-4*APR(I,L)
      NN=TW(J)/5.0+1.0
      IF (NN.GT.8) NN=8
      IF (NN.LT.1) NN=1
C
C**   LONGWAVE BACK RADIATION
      ROL=RO(TW(J))*(597.0-0.57*TW(J))*(AA+BB*WIND(I,L))
      F=0.00693+ROL*(ALPH(NN)-EA(I,L)-PF*DBT(I,L))
      FONE(J)=QNS(I,L)+QNA(I,L)-F+FONE(J)
      FTWO(J)=ROL*(BETA(NN)+PF)+0.00147+FTWO(J)
      FS=ALPH(NN)+BETA(NN)*TW(J)
```



```
      EV(J)=(WIND(I,L)*BB+AA)*(ES-EA(I,L))+EV(J)
  300 CONTINUE
  310 CONTINUE
      DO 320 J=1,NJ
      FONE(J)=FONE(J)/24.
      FTWO(J)=FTWO(J)/24.
      IF (EV(J).LT.0.0) EV(J)=0.0
  320 EV(J)=EV(J)/24.
      RETURN
C
      END
```

```
      SUBROUTINE OUTPUT (JSKIP)
C
      COMMON/LAB/XLAB(11),YLAB(6),TITLE(12),HORIZ(13),VERT(6),IUNITO
      COMMON/PLOT/ IPLOT(4),CP(101,6,4),DAY(101),NPOINT,JPLOT(6)
     1,       IPP,NPP,IPDAY(3),NODEP(21,2),PROFA(21,3,4),NCONP(4)
     2,      PROFB(21,3,4)
      COMMON/MISC/NJ,NC,NP,NDYN,NBND,MLIM,DELT,IPAGE,NHYD,IDAY,IDELT
     1,      NJP,ILF,KPLOT,ISKIP(16),ALL(20),IDYN(52),TITL1(20),TITL(20)
     2,      NGPERH(52),IPCYC,LDAY,NCYCH,INQUAL
      COMMON/BIG/NCHAN(200,8),FILL(18800)
      COMMON/QUAL/ JUNIN(200),JUNGIN(200),JUNA(200),DIN(200),UGIN(200)
     1,      TDSIN(150),TOTNIN(150),TOTPIN(150),COLTIN(150),COLFIN(150)
     2,       BODCIN(150),BODNIN(150),OXYIN(150),TEMPIN(150)
     3,      TYPEIN(150,4),SALTIN(150)
     4,      TDS(200),TOTN(200),TOTP(200),COLT(200),COLF(200),BODC(200)
     5,      BODN(200),OXY(200),TEMP(200),TYPE(200,4),TYPEDK(200,4)
     6,      DALG(200),DBEN(200),DRDR(200),BODCOK(200),BODNOK(200)
     7,      COLTOK(200),COLFOK(200),OSAT(200),BENN(200),BENP(200)
      COMMON/XAAF/NAPIS
      DIMENSION X(103,3),Y(103,3),NPT(3),CON(200,1)
      DOUBLE PRECISION UNITS
      DIMENSION UNITS(13)
      DIMENSION TITLE1(9,2),HORIZ1(13,2),VERT1(6)
      EQUIVALENCE (CON(1,1),TDS(1))
      REAL NAME(3,13)
      DATA NAME/4HTDS ,2*4H    ,4HTOTA,4HL N ,4H    ,4HTOTA,4HL P
     1,      4H    ,4HTOTA,4HL CO,4HLIF ,4HFECA,4HL CO,4HLIF ,4HCARB
     2,      4HON B,4HOD  ,4HNITR,4HO BO,4HD   ,4HOXYG,4HEN  ,4H
     3,      4HTEMP,4HERAT,4HURE ,4HOPP ,4HCONS,4HT 1 ,4HOPP ,4HCONS
     4,      4HT 2 ,4HOPP ,4HCONS,4HT 3 ,4HOPP ,4HCONS,4HT 4  /
      DATA UNITS
     1 /3*8HMG/L    ,2*8HNO/100ML,3*8HMG/L    ,8HDEG C   ,4*8HUNITS   /
      DATA TITLE1/2*4H    ,4HTIME,4H HIS,4HTORY,4*4H    ,4HCONC
     1,      4HENTR,4HATIO,4HN PR,4HOFIL,4HE   ,3*4H     /
     2,      HORIZ1/7*4H    ,4H DAY,12*4H    ,4HNODE,5*4H    /
     3,      VERT1/4HMG/L,4H,MPN,4HOR C,3*4H    /
C
      IF (JSKIP) 470,360,100
  100 CONTINUE
  110 FORMAT (1H1,10X,20A4,'      TETRA TECH, INC.'/,11X,20A4,'      LAFAY
     1ETTE, CALIF,'/)
  120 FORMAT (50X,'QUALITY RESULTS, DAY',I4,/'   JUN       TDS     TOT N
     1  TOT P    T COL     F COL     C BOD     N BOD        OXY     O SAT
     2TEMP  CONST 1  CONST 2  CONST 3  CONST 4'/,6X,3(5X,'MG/L'),2(' NO/
     3100ML'),4(5X,'MG/L'),7X,'C ',4(4X,'UNITS')/)
      IF (ISKIP(16)-1) 130,170,260
  130 II=0
      DO 160 J=1,NJ
      IF (NCHAN(J,1).EQ.0) GO TO 160
      IF (MOD(II,50).NE.0) GO TO 140
      WRITE (6,110) TITL1,TITL
      WRITE (6,120) JSKIP
  140 II=II+1
      WRITE (6,150) J,(CON(J,I),I=1,8),OSAT(J),(CON(J,I),I=9,13)
  150 FORMAT (I6,F9.0,2F9.2,2E9.2,2F9.2,3F9.1,4F9.2)
  160 CONTINUE
      RETURN
```



```
C
C.... ALTERNATIVE PRINTOUT
  170 CONTINUE
      WRITE (6,110) TITL1,TITL
      DO 250 I=1,13
      IF (ISKIP(I).EQ.1) GO TO 250
      WRITE (6,180) (NAME(J,I),J=1,3),UNITS(I),JSKIP
  180 FORMAT (/,50X,3A4,', ',A8,' FOR DAY ',I3/)
      GO TO (190,210,210,230,230,210,210,210,210,210,210,210,210), I
  190 WRITE (6,200) (J,CON(J,I),J=1,NJ)
  200 FORMAT (10(I5,F8.0))
      GO TO 250
  210 WRITE (6,220) (J,CON(J,I),J=1,NJ)
  220 FORMAT (10(I5,F8.2))
      GO TO 250
  230 WRITE (6,240) (J,CON(J,I),J=1,NJ)
  240 FORMAT (10(I5,E8.2))
  250 CONTINUE
      RETURN
C
  260 CONTINUE
      IC=0
      DO 350 I=1,13
      IF (ISKIP(I).EQ.1) GO TO 350
      IC=IC+1
      IF (MOD(IC,2).EQ.1) WRITE (6,270)
  270 FORMAT (1H1)
      WRITE (6,280) (NAME(J,I),J=1,3),UNITS(I),JSKIP
  280 FORMAT (90X,3A4,', ',A8,' FOR DAY ',I3)
      GO TO (290,310,310,330,330,310,310,310,310,310,310,310,310), I
  290 WRITE (6,300) (J,CON(J,I),J=1,NJ)
  300 FORMAT (5(I7,F9.0))
      GO TO 350
  310 WRITE (6,320) (J,CON(J,I),J=1,NJ)
  320 FORMAT (5(I7,F9.3))
      GO TO 350
  330 WRITE (6,340) (J,CON(J,I),J=1,NJ)
  340 FORMAT (5(I7,E9.2))
  350 CONTINUE
      RETURN
  360 CONTINUE
C
C.... TIME HISTORY PLOTS
C
      DO 370 J=1,3
      DO 370 I=1,103
      X(I,J)=0.0
  370 Y(I,J)=0.0
      II=NPOINT/100+1
      MI=0
      DO 380 I=1,13
  380 HORIZ(I)=HORIZ1(I,1)
      DO 390 I=1,6
  390 TITLE(I)=TITLE1(I,1)
      DO 400 I=1,6
  400 VERT(I)=VERT1(I)
      DO 460 I=1,4
```

2-35/165

```
      IF (IPLOT(I).EQ.0) GO TO 460
      IP=IPLOT(I)
      TITLE(10)=NAME(1,IP)
      TITLE(11)=NAME(2,IP)
      TITLE(12)=NAME(3,IP)
      J=0
      DO 410 JJ=1,NPOINT,II
      J=J+1
      DO 410 K=1,3
      X(J,K)=DAY(JJ)
  410 CONTINUE
C
      NN=(NJP-1)/3+1
      LL=1
      DO 450 N=1,NN
      NT=NT+1
      L=LL+2
      IF (NJP.GT.L) L=NJP
      K=0
      DO 430 MM=LL,L
      K=K+1
      J=0
      DO 420 KK=1,NPOINT,II
      J=J+1
      Y(J,K)=CP(KK,MM,I)
  420 CONTINUE
      NPT(K)=J
  430 CONTINUE
C  SET NXPTS TO 0 SO X-AXIS INCREMENTS WILL BE PRINTED IN PPLOT
      NXPTS=0
      CALL CURVE (X,Y,NPT,K,NT)
      WRITE (6,440) (JPLOT(LI),LI=LL,L)
  440 FORMAT (1H0,30X,'NODE NUMBERS',I5,4H = 0,I5,4H = 1,I5,4H = 2)
      LL=L+1
  450 CONTINUE
  460 CONTINUE
      RETURN
C
C.... CONCENTRATION PROFILES
C
  470 CONTINUE
      NN=0
      DO 480 I=1,21
      DO 480 J=1,IPP
  480 X(I,J)=I
      DO 490 I=1,13
  490 HORIZ(I)=HORIZI(I,2)
      DO 500 I=1,9
  500 TITLE(I)=TITLEI(I,2)
      DO 510 I=1,6
  510 VERT(I)=VERTI(I)
      DO 590 II=1,4
      IF (NCONP(II).EQ.0) GO TO 590
      I=NCONP(II)
      TITLE(10)=NAME(1,I)
      TITLE(11)=NAME(2,I)
      TITLE(12)=NAME(3,I)
```

O U T P U T

```
      DO 580 I=1,NPP
      NN=NN+1
      DO 550 J=1,IPP
      NPT(J)=21
      IF (I.EQ.2) GO TO 530
      DO 520 K=1,21
  520 Y(K,J)=PROFA(K,J,II)
      GO TO 550
  530 DO 540 K=1,21
  540 Y(K,J)=PROFB(K,J,II)
  550 CONTINUE
C  SET NXPTS TO 21 SO PRINTING OF X-AXIS INCREMENTS IN PPLOT WILL BE SUP
      NXPTS=21
      CALL CURVE (X,Y,NPT,IPP,NN)
      WRITE (6,560) (NODEP(J,I),J=1,21)
  560 FORMAT (1I5,21I5,/,75X,'NODE')
      WRITE (6,570) (IPDAY(J),J=1,IPP)
  570 FORMAT (30X,'DAY OF THE YEAR',I5,4H = 0,I5,4H = 1,I5,4H = 2)
  580 CONTINUE
  590 CONTINUE
      RETURN
C
      END
```

```
      SUBROUTINE PINE(X1,Y1,X2,Y2,NSYM,NCT)
      COMMON/BIG/ SPACE(15249),A(51,101)
      DIMENSION SYM(3)
      DATA SYM/1H0,1H1,1H2/
      AXA=X1
      AXB=X2
      AYA=Y1
      AYB=Y2
      N=1
      IF(ABS(AXB-AXA).LT.ABS(AYB-AYA)) GO TO 290
C
C     SET PARAMETERS FOR X DIRECTION
C
      IF(AXB.GT.AXA) GO TO 245
      AXA=X2
      AXB=X1
      AYA=Y2
      AYB=Y1
  245 CONTINUE
      IXA=AXA+.5
      IXB=AXB+.5
      IYA=AYA+.5
      IYB=AYB+.5
  250 CONTINUE
      IF(IXA.LT.0.OR.IXA.GT.100) GO TO 260
      IF(IYA.LT.0.OR.IYA.GT.50) GO TO 260
      A(51-IYA,IXA+1)=SYM(NSYM)
  260 CONTINUE
      IXA=IXA+1
      YA=(N*(AYB-AYA))/(AXB-AXA)
      IYA=AYA+YA+0.5
      N=N+1
      IF(IXA.LE.IXB) GO TO 250
      GO TO 400
C
C     SET PARAMETERS FOR Y DIRECTION
C
  290 CONTINUE
      IF(AYB.GT.AYA)   GO TO 295
      AYB=Y1
      AYA=Y2
      AXB=X1
      AXA=X2
  295 CONTINUE
      IXA=AXA+.5
      IXB=AXB+.5
      IYA=AYA+.5
      IYB=AYB+.5
  300 CONTINUE
      IF(IXA.LT.0.OR.IXA.GT.100) GO TO 310
      IF(IYA.LT.0.OR.IYA.GT.50) GO TO 310
      A(51-IYA,IXA+1)=SYM(NSYM)
  310 CONTINUE
      IYA=IYA+1
      XA=(N*(AXB-AXA))/(AYB-AYA)
      IXA=AXA+XA+0.5
      N=N+1
```



```
      IF(IYA-IYB) 300,320,400
  320 IXA = IXB
      GO TO 300
  400 RETURN
      END
```

2-35-167

```
      SUBROUTINE PPLOT(IX,IY,K,NCT)
      DIMENSION SYM(9)
      COMMON/BIG/ SPACE(15249),A(51,101)
      COMMON/XAXE/NXPTS
      COMMON/LAB/XLAB(11),YLAB(6),TITLE(12),HORIZ(13),VERT(6),IUNITO
      DATA SYM/7*1H ,1HI,1H-/
C
      IF(K.EQ.100) GO TO 230
      IUNITO=6
      I=0
      IF (NCT .EQ. -1) GO TO 700
      WRITE(IUNITO,103) (TITLE(IN),IN=1,6),(TITLE(IN),IN=10,12),NCT
700   CONTINUE
C  THE FOLLOWING SECTION (THROUGH CARD 225) PRINTS ALL BUT THE X AXIS AND LABELS
      DO 225 II=1,6
      I=I+1
      WRITE (IUNITO,101) YLAB(II),(A(I,J),J=1,101)
      IF(II.EQ.6) GO TO 226
      DO 224 JJ=1,9
      I=I+1
      IF(I.NE.20) GO TO 221
      WRITE(IUNITO,106) VERT(5),VERT(6),(A(I,J),J=1,101)
      GO TO 224
  221 IF(I.NE.24) GO TO 222
C  PRINT Y-AXIS UNITS
      WRITE(IUNITO,106) VERT(1),VERT(2),(A(I,J),J=1,101)
      GO TO 224
  222 IF(I.NE.26) GO TO 223
      WRITE(IUNITO,106) VERT(3),VERT(4),(A(I,J),J=1,101)
      GO TO 224
  223 WRITE(IUNITO,100) (A(I,J),J=1,101)
  224 CONTINUE
  225 CONTINUE
C
  226 CONTINUE
C  NXPTS IS A FLAG FOR CONCENTRATION PROFILE PLOTS, SET TO 21 IN OUTPUT
C  IF NXPTS IS 21, DO NOT PRINT X-AXIS INCREMENTS OR UNITS
      IF(NXPTS.EQ.21) GO TO 229
C  PRINT THE X-AXIS UNITS FOR TIME HISTORY PLOTS
      WRITE(IUNITO,102) XLAB
      WRITE (IUNITO,105) HORIZ
  100 FORMAT(18X,101A1)
  101 FORMAT(1PE17.2,1X,101A1)
  102 FORMAT(F20.1,10F10.1)
103   FORMAT(1H1,42X,9A4,'PLOT NO.',I3,/)
  105 FORMAT(40X,13A4)
  106 FORMAT(7X,2A4,3X,101A1)
229   CONTINUE
      RETURN
C  THIS SECTION PREPARES PLOT OUTLINE
  230 DO 250 I=1,50
      DO 240 J=1,101
  240 A(I,J)=SYM(7)
      A(I,1)=SYM(8)
  250 CONTINUE
      DO 260 J=1,101
  260 A(51,J)=SYM(9)
      DO 270  I=1,101,10
  270 A(51,I)=SYM(8)
      DO 290 I=11,41,10
      A(I,1)=SYM(9)
  290 CONTINUE
      RETURN
      END
```

PPLOT

2-35-168

S C A L E

```
      SUBROUTINE SCALE (ARRAY,AXLEN,NPTS,INC)
      COMMON/XAXE/NXPTS
      DIMENSION ARRAY(4),INT(5)
      DATA INT /2,4,5,8,10/
      INCT=IABS(INC)
C
C                                         SCAN FOR MAX AND MIN
C
      AMAX=ARRAY(1)
      AMIN=ARRAY(1)
      DO 250 N=1,NPTS,INCT
      IF(AMAX.LT.ARRAY(N)) AMAX=ARRAY(N)
      IF(AMIN.GT.ARRAY(N)) AMIN=ARRAY(N)
  250 CONTINUE
      IF( AMAX - AMIN ) 275,255,275
C
C                                         RESET MAX AND MIN FOR ZERO RANGE
C
  255 IF( AMIN ) 265, 400, 260
  260 AMIN = 0.0
      AMAX = 2.0 * AMAX
      GO TO 275
  265 AMAX = 0.0
      AMIN = 2.0 * AMIN
  275 CONTINUE
C
C                                         COMPUTE UNITS/INCH
C
      RATE=(AMAX-AMIN)/AXLEN
C
C                                                  SCALE INTERVAL TO
C                                                  LESS THAN 10
      A=ALOG10(RATE)
      N=A
      IF(A.LT.0) N=A-0.9999
      RATE=RATE/(10.**N)
      L=RATE+1.00
C
C                                         FIND NEXT HIGHER INTERVAL
C
  280 DO 300 I=1,5
      IF(L-INT(I)) 320,320,300
  300 CONTINUE
C
C                                         L IS NEXT HIGHER INTERVAL
C                                         RANGE IS SCALED BACK TO FULL SET
C
  320 L=INT(I)
      RANGE=FLOAT(L)*10.**N
      IF(INC.LT.0) GO TO 350
C
C                                         SET UP POSITIVE STEPS
C
      K=AMIN/RANGE
      IF(AMIN.LT.0.) K=K-1
C
C                                         CHECK FOR MAX VALUE IN RANGE
```

S C A L E

```
C
      IF(AMAX.GT.(K+AXLEN)*RANGE) GO TO 330
      I=NPTS*INCT+1
      ARRAY(I)=K*RANGE
      I=I+INCT
      ARRAY(I)=RANGE
      RETURN
C
C                                         IF OUTSIDE RANGE RESET L AND N
C
  330 L=L+1
      IF(L.LT.11) GO TO 280
      L=2
      N=N+1
  340 GO TO 280
C
C                                         SET UP NEGATIVE STEPS
C
  350 K=AMAX/RANGE
      IF(AMAX.GT.0.) K=K+1
      IF (AMIN.LT.(K+AXLEN)*RANGE) GO TO 330
      I=INCT*NPTS+1
      ARRAY(I)=K*RANGE
      I=I+INCT
      ARRAY(I)=-RANGE
      RETURN
  400 WRITE(6,100)
  100 FORMAT( // 10X, 'RANGE AND SCALE ARE ZERO ON PLOT ATTEMPT'  )
      RETURN
      END
```

```
      SUBROUTINE SETUP
      COMMON/QUAL/ ISPACE(600),QIN(200),FILL(7700)
      COMMON/MISC/NJ,NC,NP,NDYN,NBND,MLIM,DELT,IPAGE,NHYD,IDAY,IDELT
     ..      NJP,IEE,KPLOT,ISKIP(16),ALL(20),IDYN(52),TITLE(20),TITL(20)
     ..      NOPERH(52),IPCYC,LDAY,NCYCH,INQUAL
      COMMON/BIG/ NCHAN(200,8),NJUNC(300,2),JUN(200),XLEN(300)
     ..      ALPH(200),ALPH1(200),AA(200),BB(200),BETA(200)
     ..      ASAVE(200,21),A(200,21),ALPHA(200,21),AC(300),AS(200)
     ..      DIF(300),Q(300),VS(300) ,QOU(200),ZZ(300)   ,VOL(200),Z(300)
     ..      CC1(300),CC4(300),DEP(200),HAVE(300),RS(300),VABS(300)
C
C.... INITIALIZE COEFFICIENT MATRIX TO ZERO
      M=NBND+1
      DO 160 J=1,NP
      DO 160 K=1,MLIM
  160 ASAVE(J,K)=0.0
C
      DO 1000 J=1,NP
      JJ=JUN(J)
      IF(NDYN.EQ.1) GO TO 188
      ALPH(J)=0.5
C
C.... COMPENSATE FOR HIGH TRIBUTARY INFLOWS
      TA=VOL(JJ)/DELT-QIN(JJ)
      IF(TA.LT.0.0) ALPH(J)=VOL(JJ)/(2.0*DELT*QIN(JJ))
      ALPH1(J)=1.0-ALPH(J)
  188 CONTINUE
      ASAVE(J,M)=QOU(JJ)
C
C.... ADD ADVECTION AND DIFFUSION TO COEFFICIENT MATRIX
      DO 250 K=1,8
      NDIR=0
      N=NCHAN(JJ,K)
      IF(N.EQ.0) GO TO 250
      IF(J.EQ.NJUNC(N,1)) GO TO 200
      JOPP=NJUNC(N,1)
      IF (Q(N).LE.0.0) NDIR=1
      GO TO 220
  200 CONTINUE
      JOPP=NJUNC(N,2)
      IF (Q(N).GT.0.0) NDIR=1
  220 CONTINUE
      JDIF=J-JOPP
      MM=M-JDIF
      IF(NDIR.EQ.1) GO TO 230
      ASAVE(J,M)=ASAVE(J,M)+DIF(N)
      ASAVE(J,MM)=ASAVE(J,MM)-ABS(Q(N))-DIF(N)
      GO TO 250
  230 ASAVE(J,M)=ASAVE(J,M)+ABS(Q(N))+DIF(N)
      ASAVE(J,MM)=ASAVE(J,MM)-DIF(N)
  250 CONTINUE
C
C.... ADD VOLUME EFFECTS AND APPLY ALPH AND ALPH1 FACTORS FOR DYNAMIC
      IF(NDYN.EQ.1) GO TO 1000
      DO 260 I=1,MLIM
      A(J,I)=-ASAVE(J,I)*ALPH(J)
  260 ASAVE(J,I)=ASAVE(J,I)*ALPH1(J)
```



```
      A(J,M)=A(J,M)+VOL(JJ)/DELT
      ASAVE(J,M)=ASAVE(J,M)+VOL(JJ)/DELT
 1000 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SOLVIT(CON)
      COMMON/MISC/NJ,NC,NEQ,NDYN,NBND,MLIM,DELT,IPAGE,NHYD,IDAY,IDELT
     ..       NJP,ILE,KPLOT,ISKIP(16),ALL(20),IDYN(52),TITLE(20),TITL(20)
     ..       NOPERH(52),IPCYC,LDAY,NCYCH,INDUAL
      COMMON/BIG/ NCHAN(200,6),NJUNC(300,2),JUN(200),XLEN(300)
     ..       ALPH(200),ALPH1(200),AA(200),BB(200),BETA(200)
     ..       ASAVE(200,21),A(200,21),ALPHA(200,21),AC(300),AS(200)
     ..       DIF(300),Q(300),VS(300) ,QOU(200),ZZ(300)  ,VOL(200),Z(300)
     ..       CC1(300),CC4(300),DEP(200),RAVE(300),RS(300),VABS(300)
      DIMENSION CON(1)
C
C**** FORWARD ELIMINATION
      JMIN = NBND + 1
      JMAX = JMIN + NBND
      NEQ=NEQ-1
      DO 280 I=1,NEQ
C
C**   NORMALIZE COEFFICIENTS
      TA=ALPHA(I,JMIN)
      DO 200 J=JMIN,JMAX
      ALPHA(I,J)=ALPHA(I,J)/TA
  200 CONTINUE
      BETA(I)=BETA(I)/TA
C
C**   SET-UP ROWS FOR ELIMINATION
      KMIN = I + 1
      KMAX = I + NBND
      IF (KMAX.GT.NEQ) KMAX=NEQ
      JK=NBND+1
      DO 260 K=KMIN,KMAX
      JK=JK-1
      IF(ALPHA(K,JK)) 210,260,210
  210 CONTINUE
C
C**   ELIMINATE VARIABLE I FROM EQUATION K
      J=NBND+1
      JJMIN=JK+1
      JJMAX = JK + NBND
      DO 240 JJ=JJMIN,JJMAX
      J=J+1
      ALPHA(K,JJ)=ALPHA(K,JJ)-ALPHA(I,J)*ALPHA(K,JK)
  240 CONTINUE
      BETA(K)=BETA(K)-BETA(I)*ALPHA(K,JK)
  260 CONTINUE
  280 CONTINUE
C
C**** BACK SUBSTITUTION
      NN=0
      BETA(NEQ)=BETA(NEQ)/ALPHA(NEQ,JMIN)
      DO 480 II=2,NEQ
      I= NEQ + 1 - II
      NN=NN+1
      IF(NN.GT.NBND) NN=NBND
      K=I
      J=NBND+1
      DO 460 JJ=1,NN
      J=J+1
```

SOLVIT

```
      K=K+1
      BETA(I)=BETA(I)-ALPHA(I,J)*BETA(K)
  460 CONTINUE
  480 CONTINUE
C
C.... ASSIGN CONCENTRATIONS BY EXTERNAL NODE NUMBERS
      DO 510 J=1,NEQ
      JJ=JUN(J)
      CON(JJ)=BETA(J)
  510 CONTINUE
      RETURN
      END
```

2. Water Use and Quality

Comment 36 (p. E-2-112, para. 2)

Estimate the probability and magnitude of supersaturated water passing through Watana and Devil Canyon reservoirs. Include specific estimates for water entering Watana reservoir, the likelihood of supersaturated conditions persisting through the reservoirs to the intake structures, any differences between saturation values of water entering outlet facilities and the turbine intakes, potential for air entrainment at both outlet facilities and the turbine intakes, and a description of the processes affecting supersaturation at the turbine outlet facilities.

Response

At present, no information is available on the level of gas saturation levels in waters entering the upstream end of the proposed Watana Reservoir. Therefore, no definitive statement about the probability and magnitude of such an occurrence can be made. It is assumed, however, that no supersaturation problem will exist in Watana Reservoir because of 1) the low potential for any sources of saturation above the proposed Watana Reservoir due to the low gradient of the river and lack of major turbulent areas, 2) the long residence time of water passing through the reservoir, 3) wind- induced mixing, and; 4) contributions of additional water from tributaries.

Intake facilities at both dams will be designed to prevent entrainment of air because such entrainment can lower the efficiency of the turbine and cause structural problems. The outlet facilities will have a subsurface discharge that will not entrain air and therefore will not increase saturation.

Cone valves will be provided in both dams to pass any discharges up to the 1 in 50 year flood. These structures are specifically designed to prevent supersaturation. Any discharges above the 1 in 50 flood will be passed over the spillway at each dam. These spillways will be designed to avoid or minimize any supersaturation problems. The final design of the spillways will follow the testing of a physical model before final design of the project is completed.

Water leaving Devil Canyon could be supersaturated even if no supersaturation were added by either dam. This is because supersaturation naturally occurs due to turbulent mixing at the rapids in Devil Canyon below the Devil Canyon damsite. This naturally occurring supersaturation would be generally lessened under the operation of either dam. The reason for this is that, under natural conditions, there is a positive correlation between increases in flows and increases in supersaturation values (see attached Figure 4I-3-45 from ADF&G 1983). This is probably related to the increase in turbulence and entrainment of air associated with increased flows. Under operation, the incidence of these higher flows will be diminished as would the corresponding supersaturation levels.

References

Alaska Dept. of Fish and Game. 1983. Susitna hydro aquatic studies phase II basic data report. Vol. 4. Aquatic Habitat and instream flow studies, 1982.

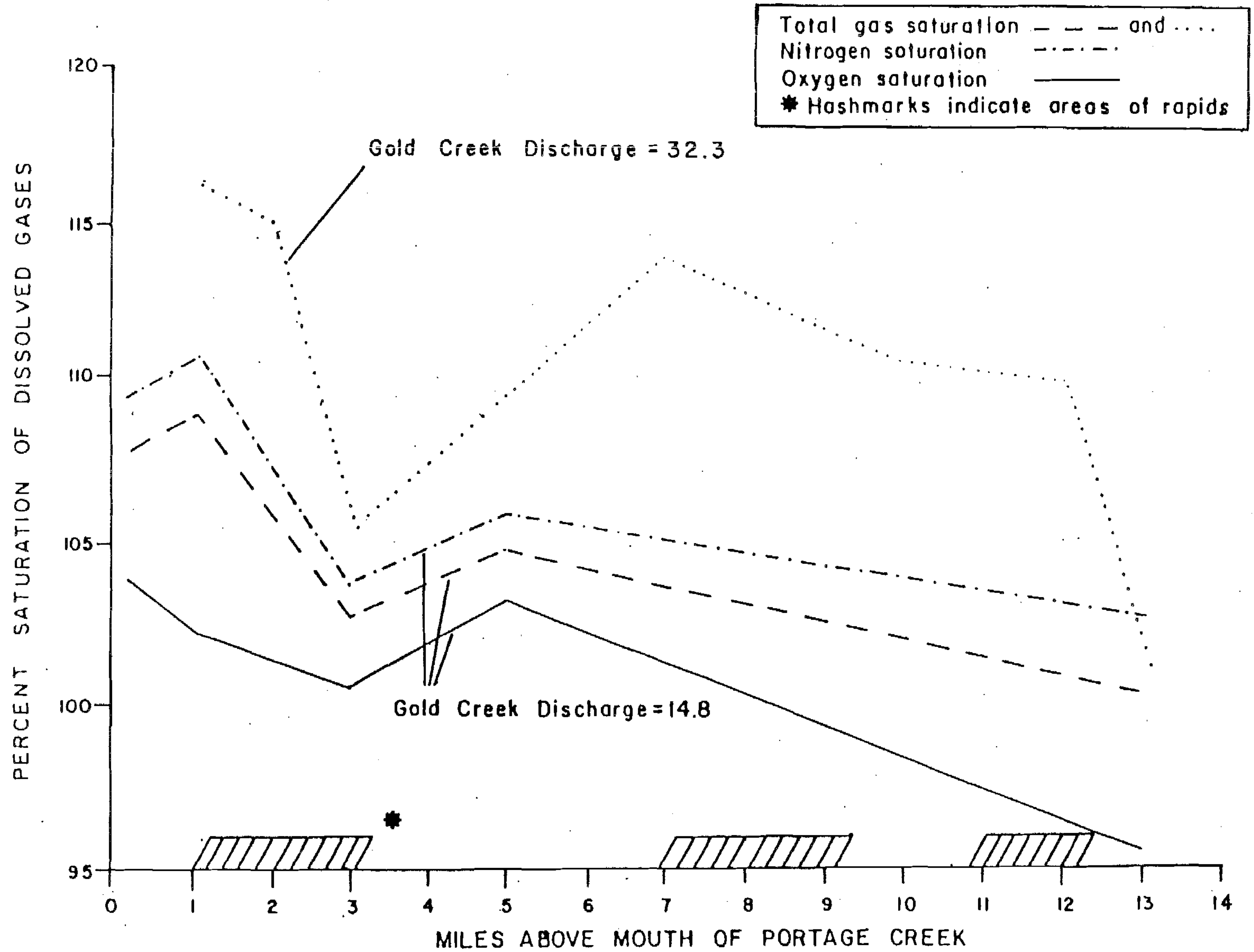


Figure 4I-3-45. Concentration of dissolved gases in the Devil Canyon rapids complex.

153

2-36-3

2. Water Use and Quality

Comment 38 (p. E-2-117, para. 2)

Describe the uncertainties associated with data collected during this period.

Response

Differences in the measured and simulated temperatures in the Eklutna Lake study (Acres American 1983, R&M 1982) may have resulted from uncertainties associated with the data collection and lake temperature measurements. Breakdowns of the instruments at the Eklutna Lake station resulted in data gaps in July and August. The missing data which occurred in periods of July 5-14, 16-21, 24-31, and August 1-11, 13-27, 1982, had to be estimated from the nearby stations (Figure 1) located at Palmer (Matanuska Valley Agricultural Experiment Station), Anchorage International Airport, and Chugach State Park Eagle River Visitor Center (Paradise Haven Lodge). Estimation of these missing data are the major sources of the data uncertainties.

The uncertainties associated with the estimation of the missing data are described below:

1. Air Temperature:

   The missing air temperatures at the Eklutna Lake station were estimated from the nearby stations, Chugach State Park Eagle River Visitor Center (11.4 miles southwest of lake, 630 ft. above mean sea level) and Eklutna River Hydro Power Station (10.8 miles north-norhtwest of lake, 38 ft. above mean sea level).

2. Wind Speed and Direction:

The missing wind speed and direction at Eklutna Lake were estimated from the station at Palmer.

3. Vapor Pressure:

The vapor pressures were converted from the relative humidity data. This was done by utilizing an empirical function of temperature to compute saturation vapor pressure at the average daily air temperature, which in turn was multiplied by average daily relative humidity. The missing relative humidity data for the periods were estimated from wind direction at the Eklutna Lake station.

4. Solar Radiation:

The missing data at the Eklutna Lake station for these periods were estimated from the Palmer and the Anchorage stations.

5. Cloud Cover and Long-Wave Radiation:

Due to various problems with power and connections to the instruments at the Eklutna Lake station, the cloud cover data obtained from the Anchorage station were used to estimate the long wave radiations.

6. Precipitation:

During the aforementioned periods, the precipitation at the Eklutna Lake station were estimated from the Chugach State Park Eagle River Visitor Center Station. From October through December the rain gauge experienced icing problems, therefore, the data from the Eagle River Visitor Center station were used.

7. Measured Temperature Profiles:

Error in measuring temperature profiles could occur from instrument's calibration being disturbed during relocation or operator error in reading the analog readout or instability in the temperature digital readout. In some cases during active convection, the instability in temperature would occur longer duration.

References

Acres American Incorporated, "Susitna Hydroelectric Project, Feasibility Study - Supplement, Chapter 8: Reservoir and River Temperature Studies," prepared for Alaska Power Authority, 1983.

R&M Consultants Incorporated, "Susitna Hydroelectric Project, Glacial Lake Studies," prepared for Acres and Alaska Power Authority, 1982.

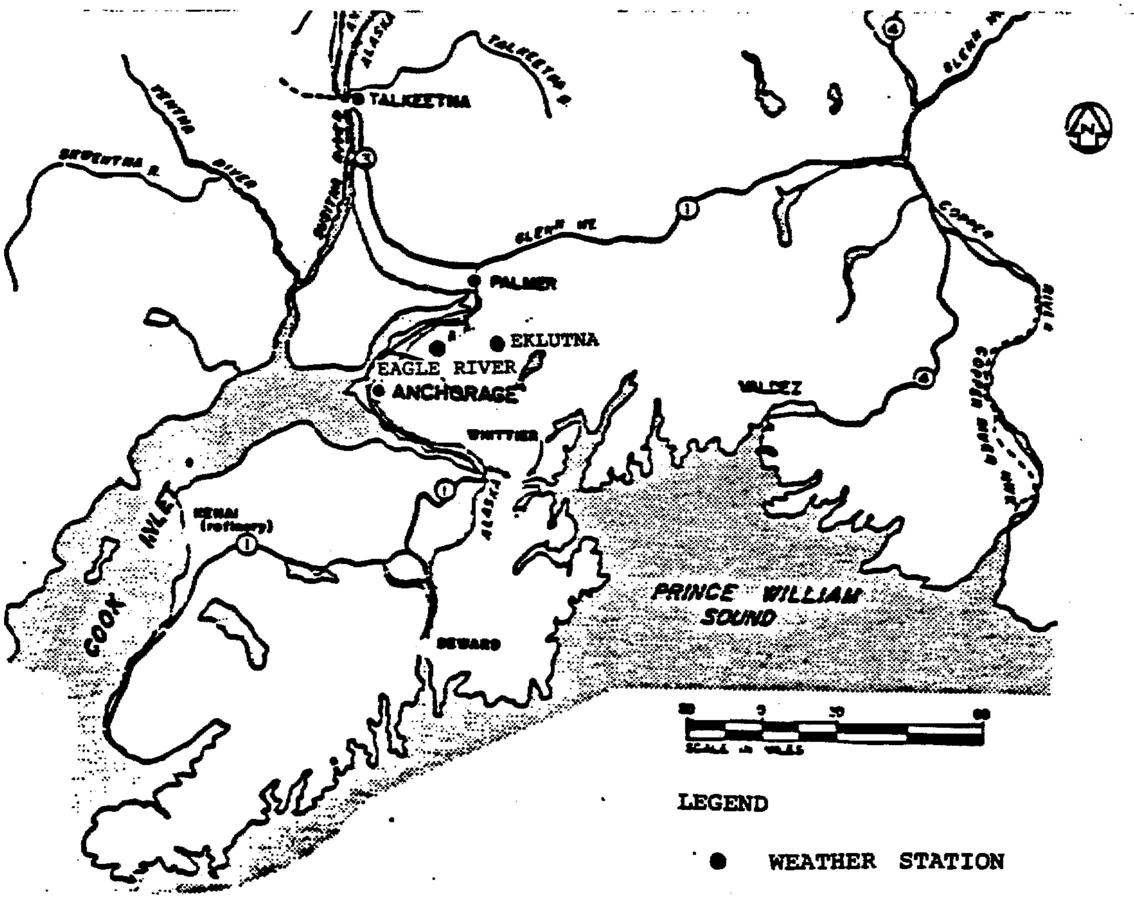


Figure 1 Approximate Location of Weather Station

2. Water Use and Quality

Comment 45 (p. E-2-133, para. 3)

Provide data for each fraction of nitrogen and phosphorus used in the calculation of the N:P ratio in Susitna River water.

Response

The mass ratio for N:P of 28:1 listed in the FERC License Application on page E-2-133 was derived from data on concentrations of inorganic nitrogen fractions and inorganic soluble ortho-phosphorus found June 1980 and 1981 in Susitna River water samples (see attached excerpts from R & M 1981 Water Quality Report, Tables 3.1 and 4.1).

SUSITNA HYDROELECTRIC PROJECT

WATER QUALITY
ANNUAL REPORT
1981

DECEMBER 1981

PREPARED BY:
R&M
R&M CONSULTANTS, INC.

PREPARED FOR:
ACRES

ALASKA POWER AUTHORITY

TABLE 3.1

R&M CONSULTANTS, INC.

1980 WATER QUALITY DATA - SUSITNA RIVER

AT VEE CANYON

NOTE: Dash indicates data not available.

	Date Sampled				
	6/19/80	8/8/80	9/5/80	9/17/80	10/17/80
Field Parameters (1)					
Dissolved Oxygen	12.4	----	----	9.7	13.8
Percent Saturation	98	----	----	84	104
pH, pH Units	7.8	7.9	7.8	7.6	7.6
Conductivity, umhos/cm @ 25°C	----	144	171	124	142
Temperature, °C	5.7	9.3	5.3	5.9	-0.1
Free Carbon Dioxide (2)	2.0	1.7	3.6	4.5	5.5
Alkalinity, as $CaCO_3$	47	54	81	63	88
Settleable Solids, ml/l	0.1	<0.1	<0.1	<0.1	≪0.1
Discharge c.f.s.	24,800	17,300	5,040	14,200	<5,000
Laboratory Parameters (1)(3)					
Ammonia Nitrogen	0.26	----	0.10	<0.05	0.26
Organic Nitrogen	<0.1	----	0.22	0.62	0.28
Kjeldahl Nitrogen	0.26	----	0.32	0.62	0.54
Nitrate Nitrogen	0.19	0.15	0.15	0.09	<0.10
Nitrite Nitrogen	<0.01	----	<0.01	<0.01	<0.01
Total Nitrogen	0.45	----	0.47	0.71	0.54
Ortho-Phosphate	<0.01	0.03	0.05	<0.05	<0.01
Total Phosphorus	0.05	0.03	0.09	0.10	<0.01
Alkalinity, as $CaCO_3$	----	----	----	----	66
Chemical Oxygen Demand	28	13	----	----	6

TABLE 3.1 - CONTINUED

	Date Sampled				
	6/19/80	8/8/80	9/5/80	9/17/80	10/17/80
Laboratory Parameters (1)(3) (continued)					
Chloride	3	9	11	8	18
Conductivity, umhos/cm @ 25°C	150	----	----	----	190
True Color, Color Units	----	40	10	45	10
Hardness, as $CaCO_3$ (4)	51	76	69	55	90
Sulfate	4	9	9	7	13
Total Dissolved Solids	70	90	114	38	115
Total Suspended Solids	242	310	25	132	8.3
Turbidity, NTU	94	97	10	33	1.8
Uranium	----	<0.05	----	----	----
Radioactivity, Gross Alpha, pCi/l	----	11.6±0.6	----	----	----
Total Organic Carbon	----	----	----	----	----
Total Inorganic Carbon	----	----	----	----	21
Organic Chemicals					
Endrin	----	<0.0001	----	----	----
Lindane	----	<0.001	----	----	----
Methoxychlor	----	<0.05	----	----	----
Toxaphene	----	<0.001	----	----	----
2, 4-D	----	<0.05	----	----	----
2, 4, 5-TP Silvex	----	<0.005	----	----	----
ICAP Scan					
Ag, Silver	<0.05	<0.05	<0.05	<0.05	<0.05
Al, Aluminum	1.6	<0.1	0.28	2.2	0.18
As, Arsenic	<0.05	<0.1	<0.1	<0.1	<0.1
Au, Gold	<0.05	<0.05	<0.05	<0.05	<0.05
B, Boron	<0.05	<0.05	<0.05	<0.05	<0.05

2-45-4

TABLE 3.1 - CONTINUED

	Date Sampled				
	6/19/80	8/8/80	9/5/80	9/17/80	10/17/80
Laboratory Parameters (1)(3) (continued)					
Ba, Barium	<0.1	0.11	<0.05	0.07	<0.05
Bi, Bismuth	<0.05	<0.05	<0.05	<0.05	<0.05
Ca, Calcium	13	16	22	18	28
Cd, Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01
Co, Cobalt	<0.05	<0.05	<0.05	<0.05	<0.05
Cr, Chromium	<0.05	<0.05	<0.05	<0.05	<0.05
Cu, Copper	<0.05	<0.05	<0.05	<0.05	<0.05
Fe, Iron	2.1	4.0	0.46	2.7	0.37
Hg, Mercury	<0.05	<0.1	<0.1	<0.1	<0.1
K, Potassium	<1.0	2.3	2.1	5.0	<1.0
Mg, Magnesium	1.4	3.4	3.1	1.2	4.5
Mn, Manganese	<0.05	0.10	<0.05	0.07	<0.05
Mo, Molybdenum	<0.05	<0.05	<0.05	<0.05	<0.05
Na, Sodium	2.6	2.4	5.1	3.5	7.2
Ni, Nickel	<0.05	<0.05	<0.05	<0.05	<0.05
Pb, Lead	<0.05	<0.05	<0.05	<0.05	<0.05
Pt, Platinum	<0.05	<0.05	<0.05	<0.05	<0.05
Sb, Antimony	<0.1	<0.1	<0.05	<0.1	<0.1
Se, Selenium	<0.05	<0.1	<0.1	<0.1	<0.1
Si, Silicon	4.8	5.3	3.6	6.9	4.1
Sn, Tin	<0.1	<0.1	<0.1	<0.1	<0.1
Sr, Strontium	0.05	0.06	0.07	0.07	0.10
Ti, Titanium	0.13	0.24	<0.05	0.17	<0.05

2-45-5

TABLE 3.1 - CONTINUED

	Date Sampled				
	6/19/80	8/8/80	9/5/80	9/17/80	10/17/80
Laboratory Parameters (1)(3) (continued)					
W, Tungsten	<1.0	<1.0	<1.0	----	<1.0
V, Vanadium	<0.05	<0.05	<0.05	<0.05	<0.05
Zn, Zinc	<0.05	<0.05	<0.05	<0.05	<0.05
Zr, Zirconium	<0.05	<0.05	<0.05	<0.05	<0.05

---

(1) Table values are mg/l unless noted otherwise.

(2) All values for free CO_2 determined from nomograph on p. 297 of Standard Method, 14th edition.

(3) Samples for all parameters except chemical oxygen demand, dissolved and suspended solids, and turbidity were filtered.

(4) Hardness calculated by R&M personnel.

2-45-6

TABLE 4.1

R&M CONSULTANTS, INC.

1981 WATER QUALITY DATA - SUSITNA RIVER

AT VEE CANYON

NOTE: Dash indicates data not available

	Date			
	1/13/81	5/20/81	6/18/81	6/30/81
Field Parameters (1)				
Dissolved Oxygen	10.7	10.4	----	11.6
Percent Saturation	84	83	----	99
pH, pH Units	7.2	6.6	7.8	7.7
Conductivity, umhos/cm @ 25°C	242	100	120	124
Temperature, °C	0.1	6.5	11.9	7.9
Free Carbon Dioxide (2)	20.0	----	3.2	2.2
Alkalinity, as $CaCO_3$	99	----	79	41
Settleable Solids, ml/l	$\ll$0.1	$\ll$0.1	$\ll$0.1	<0.1
Discharge c.f.s.	1,800	9,810	11,600	13,700
Laboratory Parameters (1)(3)				
Ammonia Nitrogen	<0.05	0.13	0.12	<0.05
Organic Nitrogen	0.85	0.34	0.63	0.39
Kjeldahl Nitrogen	0.85	0.47	0.75	0.39
Nitrate Nitrogen	<0.1	<0.1	<0.10	<0.10
Nitrite Nitrogen	<0.01	<0.01	<0.01	<0.01
Total Nitrogen	0.85	0.47	0.75	0.39
Ortho-Phosphate	<0.01	<0.01	<0.01	0.49
Total Phosphorus	0.07	<0.05	<0.05	0.49
Alkalinity, as $CaCO_3$	----	----	----	----
Chemical Oxygen Demand	12	8	8	16

TABLE 4.1 - CONTINUED

	Date			
	1/13/81	5/20/81	6/18/81	6/30/81
Laboratory Parameters (1)(3) (Cont'd)				
Chloride	18	4.5	5.0	5.0
Conductivity, umhos/cm @ 25°C	----	----	----	----
True Color, Color Units	10	15	5	20
Hardness, as $CaCO_3$ (4)	121	40	49	59
Sulfate	16	4	8	7
Total Dissolved Solids	149	100	170	91
Total Suspended Solids	0.6	93	340	130
Turbidity, NTU	0.35	25	66	29
Uranium	<0.05	----	----	----
Radioactivity, Gross Alpha, pCi/l	10.3±0.6	----	----	----
Total Organic Carbon	23	40	11	23
Total Inorganic Carbon	106	46	46	59
Organic Chemicals				
Endrin	<0.0002	----	----	<0.0002
Lindane	<0.004	----	----	<0.004
Methoxychlor	<0.1	----	----	<0.1
Toxaphene	<0.005	----	----	<0.005
2, 4-D	<0.1	----	----	<0.1
2, 4, 5-TP Silvex	<0.01	----	----	<0.01
ICAP Scan				
Ag, Silver	<0.05	<0.05	<0.05	<0.05
Al, Aluminum	<0.05	<0.05	<0.05	<0.05
As, Arsenic	<0.10	<0.10	<0.10	<0.10
Au, Gold	<0.05	<0.05	<0.05	<0.05
B, Boron	<0.05	<0.05	<0.05	<0.05

TABLE 4.1 - CONTINUED

	Date			
	1/13/81	5/20/81	6/18/81	6/30/81
Laboratory Parameters (1)(3) (Cont'd)				
Ba, Barium	<0.05	<0.05	0.07	0.11
Bi, Bismuth	<0.05	<0.05	<0.05	0.19
Ca, Calcium	36	13	16	19
Cd, Cadmium	<0.01	<0.01	<0.01	<0.01
Co, Cobalt	<0.05	<0.05	<0.05	<0.05
Cr, Chromium	<0.05	<0.05	<0.05	<0.05
Cu, Copper	<0.05	<0.05	<0.05	<0.05
Fe, Iron	<0.05	0.08	0.05	0.07
Hg, Mercury	<0.10	<0.10	<0.10	<0.10
K, Potassium	2	1.6	2.0	2.1
Mg, Magnesium	7.6	1.7	2.0	2.8
Mn, Manganese	<0.05	<0.05	<0.05	<0.05
Mo, Molybdenum	<0.05	<0.05	<0.05	<0.05
Na, Sodium	6.6	2.0	3.3	4.6
Ni, Nickel	<0.05	<0.05	<0.05	<0.05
Pb, Lead	<0.05	<0.05	<0.05	<0.05
Pt, Platinum	<0.05	<0.05	<0.05	<0.05
Sb, Antimony	<0.10	<0.10	<0.10	<0.10
Se, Selenium	<0.10	<0.10	<0.10	<0.10
Si, Silicon	5.0	1.7	2.0	2.6
Sn, Tin	<0.10	<0.10	<0.10	<0.10
Sr, Strontium	0.13	<0.05	0.06	0.07
Ti, Titanium	<0.05	<0.05	<0.05	<0.05

TABLE 4.1 - CONTINUED

	Date			
	1/13/81	5/20/81	6/18/81	6/30/81
Laboratory Parameters (1)(3) (Cont'd)				
W, Tungsten	0.4	<1.0	<1.0	<1.0
V, Vanadium	<0.05	<0.05	<0.05	<0.05
Zn, Zinc	<0.05	<0.05	0.07	<0.05
Zr, Zirconium	<0.05	<0.05	<0.05	<0.05

---

(1) Table values are mg/l unless noted otherwise.

(2) All values for free CO_2 determined from nomograph on p. 297 of Standard Method, 14th edition.

(3) Samples for all parameters except chemical oxygen demand, dissolved and suspended solids, and turbidity were filtered.

(4) Hardness calculated by R&M personnel.

2. Water Use and Quality

Comment 46 (p. E-2-136, para. 4)

Provide data on water quality, including nutrients, dissolved oxygen, and trace metal concentrations in Alaskan reservoirs of similar depths and in similar climatological regimes during and after filling.

Response

To our knowledge there are no Alaskan reservoirs of similar depths and similar climatological regimes from which to derive the data requested.

2. Water Use and Quality

Comment 47 (p. E-2-165, para. 4)

Provide a list of differences and similarities among Lake Eklutna, Watana, and Devil Canyon, including physiographic characteristics (e.g., depth, area, aspect, shoreline development) known to affect responses of reservoirs to meteorological changes and thermal characteristics.

Response

Table 1 provides a list of differences and similarities among Lake Eklutna, Watana, and Devil Canyon. Watana will have a much larger drainage area and a substantially greater inflow than Eklutna. However, the most notable difference between Lake Eklutna and Watana will be the size difference. Watana will be longer, deeper, wider, and have a much greater surface area and storage capacity. The shoreline length and shoreline development will also be greater. Maximum drawdown at Watana will be two times the drawdown at Eklutna. The length to width ratio at Watana will be approximately four times that at Eklutna. Eklutna is approximately 5 miles from the glacier, whereas Watana reservoir will be approximately 85 miles from its glacial source. This has a significant impact on the inflow water temperature during summer.

The similarities between the two reservoirs are also noteworthy. The percent of the drainage areas covered by glaciers are 5.9 and 5.2 percent for Watana and Eklutna respectively. Both reservoirs are glacially fed and have high a sediment input. Suspended sediment size distributions for both reservoirs indicate that a large fraction of the inflowing suspended sediment is finer than 2 microns. The ratios of live storage to total storage and the mean residence times will also be similar.

A comparison of Eklutna and Devil Canyon reservoir yields similar findings. Devil Canyon will be four times longer. It will also be much deeper and have more than twice the surface area and storage capacity. Discharge and distance downstream from the glaciers are greater significantly for Devil Canyon. Mean residence time for Devil Canyon will be much less than for Eklutna.

The percent of the drainage basins occupied by glaciers is virtually the same for both Eklutna and Devil Canyon. Although sediment input will be reduced because of the presence of Watana reservoir, Devil Canyon is expected to be turbid because of the fine suspended sediment particles passing through Watana. Maximum drawdown at both Eklutna and Devil Canyon will be similar.

TABLE 1

COMPARISON OF BASIN CHARACTERISTICS

BASIN CHARACTERISTICS	EKLUTNA	WATANA	DEVIL CANYON
Drainage Area (mi^2)	119	5,180	5,810
Glacier Areas (mi^2)	6.2	290	290
% of Drainage Area	5.2	5.9	5.0
Glacially Fed	Yes	Yes	Yes
Annual Inflow (ac. ft.)	234,300	5,750,000	6,610,000
RESERVOIR/LAKE CHARACTERISTICS			
Length (miles)	7	46.3	28.4
Maximum Depth (feet)	200	735	565
Mean Depth (feet)	121	250	140
Maximum Breadth (miles)	1.0	5	1.5
Mean Breadth (miles)	0.76	1.28	0.4
Surface Area (acres)	3,420	37,800	7,800
Capacity, Total (ac. ft.)	414,000	9,470,000	1,090,000
Live	213,271	3,920,000	351,000
Shoreline Length (miles)	16	183	76
Shoreline Development	1.95	6.7	6.1
Normal Maximum Elevation of Water Surface (feet)	868	2,185	1,455
Maximum Drawdown (feet)	60	120	50
Live Storage/Total Storage	0.52	0.41	0.32
Total Storage/Surface Area (feet)	121	250	140
Length/Average Depth	305	978	1,071
Drawdown/Average Depth	0.50	0.48	0.36
Length/Average Width	9.2	36	71
Mean Water Residence Time (days)	646	603	60
Water Quality	Turbid	Turbid	Turbid

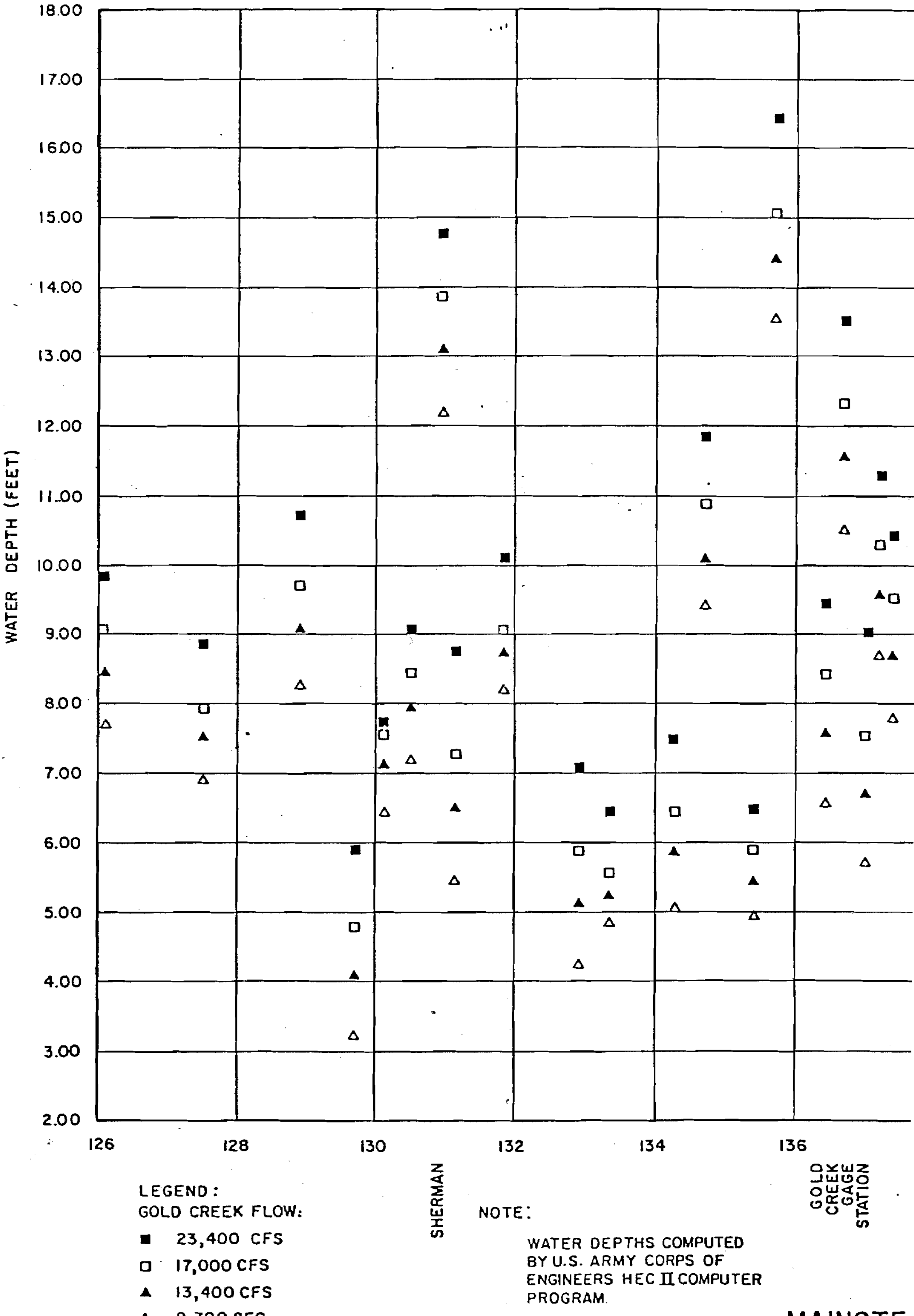
2. Water Use and Quality

Comment 49 (Fig. E.2.63 and E.2.64)

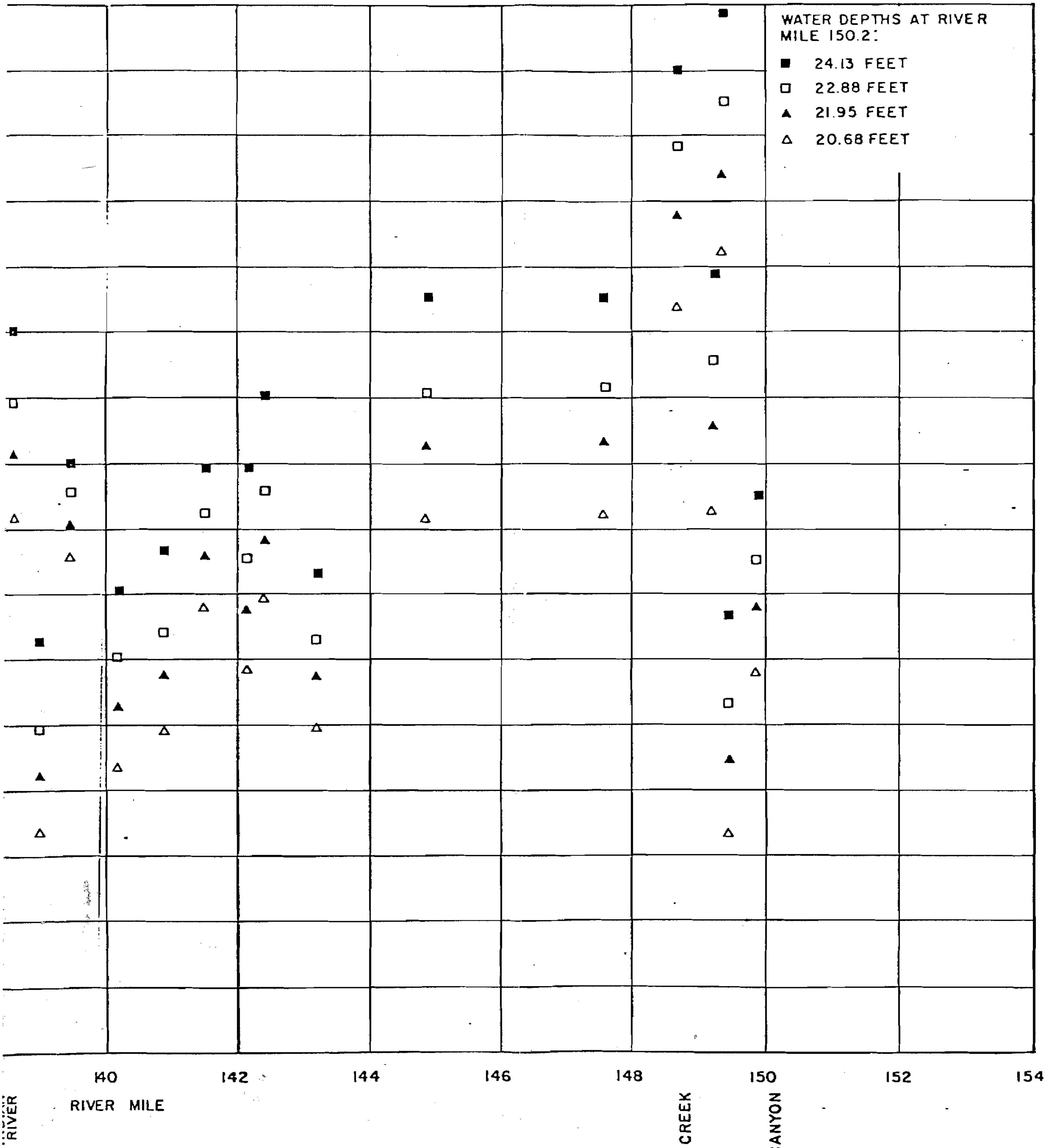
Provide clarification of the term "water depth" used in these figures (i.e., maximum depth, mean depth, or hydraulic radius).

Response

The term "water depth" used in these figures (attached in pp. 2-49-2 to 2-49-3) refers to maximum water depth in the cross-sections. That is, the distance from the water surface to the thalweg.



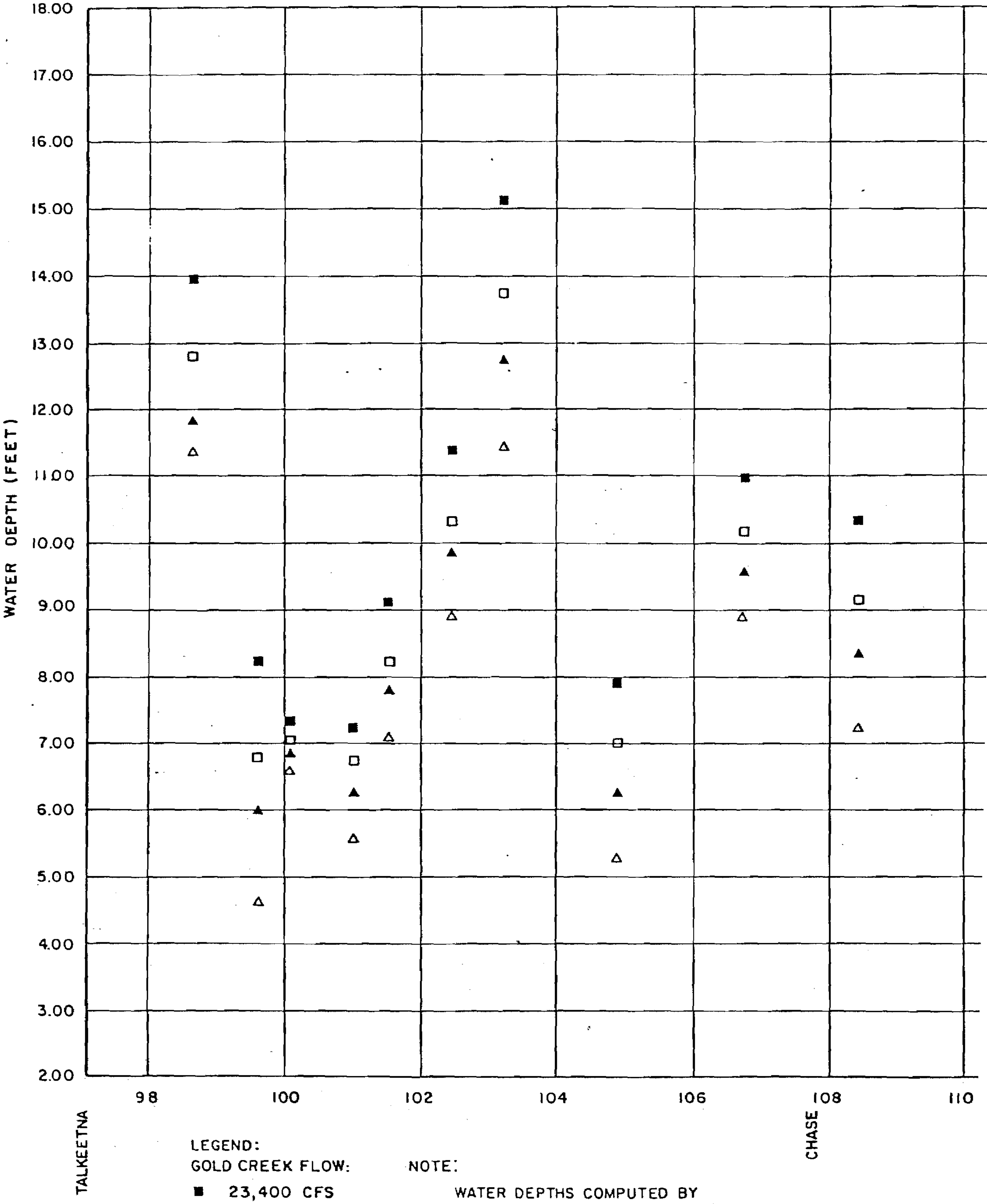
MAINSTE
DEVIL C.



WATER DEPTHS
YON TO RM 126

2-49-2

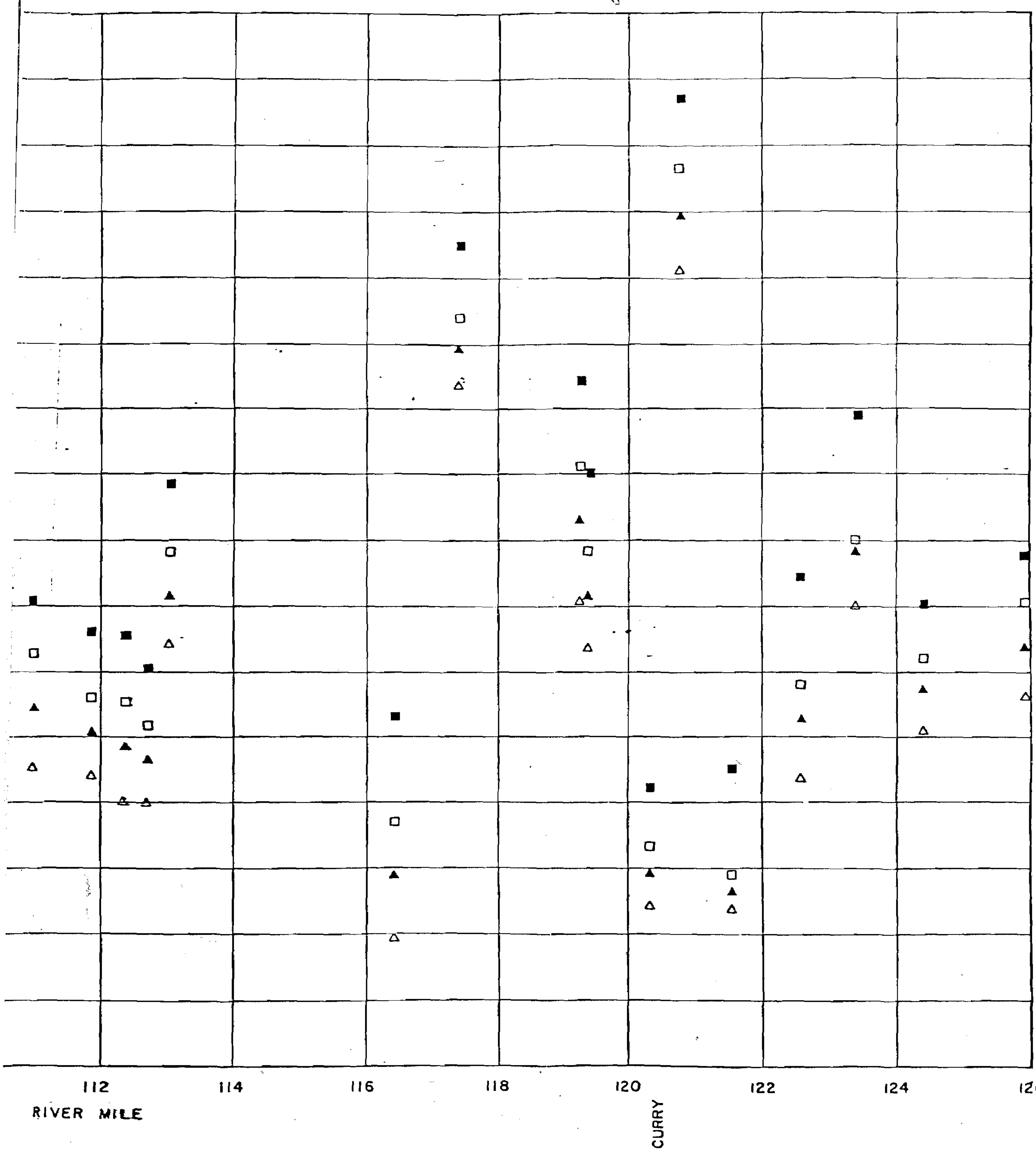
FIGURE E.2.6



LEGEND:
GOLD CREEK FLOW:
■ 23,400 CFS
□ 17,000 CFS
▲ 13,400 CFS
△ 9,700 CFS

NOTE:
WATER DEPTHS COMPUTED BY U. S. ARMY CORPS OF ENGINEERS HEC-II COMPUTER PROGRAM.

MAINSTEM
RM 126 T



WATER DEPTHS
TALKEETNA

2. Water Use and Quality

Comment 50 (Figure E.2.65)

Provide a description of the modeling procedures used to generate the water surface elevations in this figure. Provide the appropriate reference to Trihey's work (Trihey 1982 is ambiguous) and other ADF&G or R&M reports containing data used in this analysis.

Response

As stated in the response to Comment 4, (Exhibit E, Chapter 2) the water surface elevations (shown as solid lines in Figure E.2.65 p. 2-50-3) for mainstem flows of 12,500 cfs and 22,500 cfs are based on water surface measurements taken on August 2, 1982 and August 24, 1982. The water surface elevations at ADF&G gages #129.2 WIA and WIB (station -4 + 50) for the intermediate mainstem flows of 16,000 cfs and 10,000 cfs (shown as dashed lines in Figure E.2.65) were obtained from the water surface elevation - mainstem discharge relationship shown on Figure E.2.66 in the Exhibit, which was based on observed data. The water surface elevation was assumed to be the same at ADF&G gage #129.2 WI as it was at the upstream riffle, since pools existed at flows of 12,500 and 22,500 cfs. Also, since Slough 9 is not overtopped at mainstem discharges up to 18,000 cfs, outflow from the slough is quite small and it has no appreciable effect on the water surface profile downstream of the riffle at passage reach B. Slough flow was set at 3 cfs to represent a plausible worst case entrance condition during the inmigration period for spawning chum salmon. The depth of flow through the riffle at passage reach B for a flow of 3 cfs was estimated from water depths recorded by ADF&G while surveying the bed profile of Slough 9 on August 24, 1982. Slough flow was measured as 3.4 cfs on August 25, 1982.

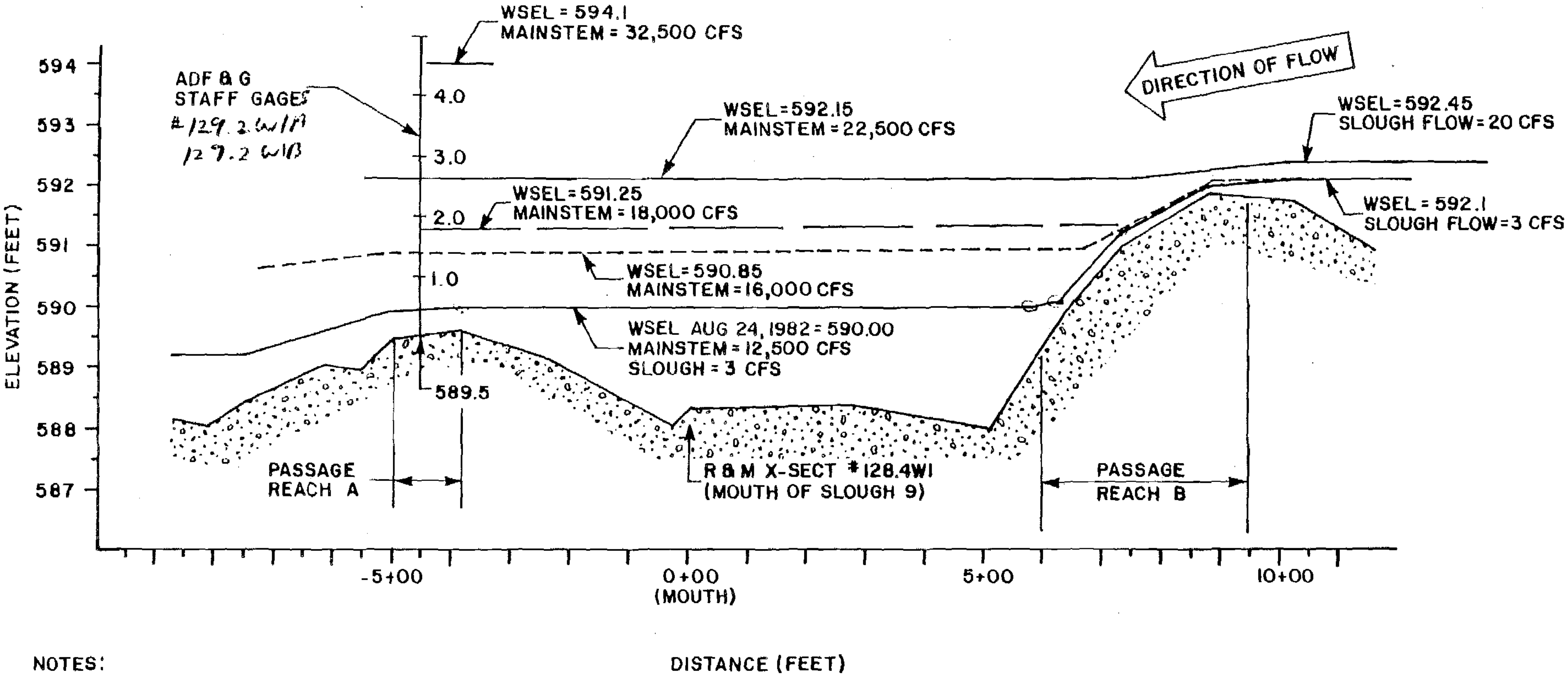
The reference to Trihey's work is given below:

Trihey, E. Woody. 1982. Preliminary Assessment of Access by Spawning Salmon to Side Slough Habitat Above Talkeetna. Prepared for Acres American Inc. Buffalo, New York. 26 pp.

Additional information is contained in the following references:

Alaska Department of Fish and Game (ADF&G), 1983. Susitna Hydro-Aquatic Studies Phase II Basic Data Report Volume 4. Aquatic Habitat and Instream Flow Studies, 1982.

R&M Consultants Inc. 1982. Susitna Hydroelectric Project 1982 Hydrographic Surveys Report, Prepared for Acres American Inc.



NOTES:

1. MOUTH OF SLOUGH AT STATION 0+00.
2. SELECT MAINSTEM DISCHARGES MEASURED AT GOLD CREEK.

2-50-3

BACKWATER PROFILES AT THE MOUTH OF SLOUGH 9

FIGURE E.2.65

2. Water Use and Quality

Comment 51 (Table E.2.2, Table E.2.4)

Provide tables of monthly average flow data at Gold Creek, Chulitna River, Talkeetna River, and Susitna Station for water years 1950 through 1981. Provide corresponding monthly average temperature data at these four stations for every month during water years 1950 through 1981 for which this is possible.

Response

Tables 1 through 4 of this response provide monthly average flow data at Gold Creek, Chulitna River, Talkeetna River, and Susitna Station for water years 1950 through 1981. The flow data is supplemented with filled in data obtained from a correlation analysis where flow records do not exist. The periods of estimated or filled-in data are noted in each table.

Available monthly average temperature data for water years 1950 through 1981 are presented in Tables 5 and 6 for Gold Creek and Susitna Station, respectively. For the Chulitna River, there are no continuous records from which monthly average temperature can be computed. For the Talkeetna River, the only monthly average temperature data available is for water year 1954 and is as follows: May 7.2°C, June 11.1°C, July 11.7°C, August 10.6°C, and September 7.2°C.

TABLE 1

GOLD CREEK MONTHLY FLOW (CFS)

USGS GAGE 15292000

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	6335.	2583.	1439.	1027.	788.	726.	870.	11510.	19600.	22600.	19880.	8301.
1951	3848.	1300.	1100.	960.	820.	740.	1617.	14090.	20790.	22570.	19670.	21240.
1952	5571.	2744.	1900.	1600.	1000.	880.	920.	5419.	32370.	26390.	20920.	14480.
1953	8202.	3497.	1700.	1100.	820.	820.	1615.	19270.	27320.	20200.	20610.	15270.
1954	5604.	2100.	1500.	1300.	1000.	780.	1235.	17280.	25250.	20360.	26100.	12920.
1955	5370.	2760.	2045.	1794.	1400.	1100.	1200.	9319.	29860.	27560.	25750.	14290.
1956	4951.	1900.	1300.	980.	970.	940.	950.	17660.	33340.	31090.	24530.	18330.
1957	5806.	3050.	2142.	1700.	1500.	1200.	1200.	13750.	30160.	23310.	20540.	19800.
1958	8212.	3954.	3264.	1965.	1307.	1148.	1533.	12900.	25700.	22880.	22540.	7550.
1959	4811.	2150.	1513.	1448.	1307.	980.	1250.	15990.	23320.	25000.	31180.	16920.
1960	6558.	2850.	2200.	1845.	1452.	1197.	1300.	15780.	15530.	22980.	23590.	20510.
1961	7794.	3000.	2694.	2452.	1754.	1810.	2650.	17360.	29450.	24570.	22100.	13370.
1962	5916.	2700.	2100.	1900.	1500.	1400.	1700.	12590.	43270.	25850.	23550.	15890.
1963	6723.	2800.	2000.	1600.	1500.	1000.	830.	19030.	26000.	34400.	23670.	12320.
1964	6449.	2250.	1494.	1048.	966.	713.	745.	4307.	50580.	22950.	16440.	9571.
1965	6291.	2799.	1211.	960.	860.	900.	1360.	12990.	25720.	27840.	21120.	19350.
1966	7205.	2098.	1631.	1400.	1300.	1300.	1775.	9645.	32950.	19860.	21830.	11750.
1967	4163.	1600.	1500.	1500.	1400.	1200.	1167.	15480.	29510.	26800.	32620.	16870.
1968	4900.	2353.	2055.	1981.	1900.	1900.	1910.	16180.	31550.	26420.	17170.	8816.
1969	~~[illegible]~~ 3822	~~[illegible]~~ 7630	~~[illegible]~~ 832	~~[illegible]~~ 724	~~[illegible]~~ 723	~~[illegible]~~ 816	~~[illegible]~~ 1510	~~[illegible]~~ 11045	~~[illegible]~~ 15503	~~[illegible]~~ 16103	~~[illegible]~~ 8819	~~[illegible]~~ 5053
1970	3124.	1215.	866.	824.	768.	776.	1080.	11380.	18630.	22660.	19980.	9121.
1971	5288.	3407.	2290.	1442.	1036.	950.	1082.	3745.	32930.	23950.	31910.	14440.
1972	5847.	3093.	2510.	2239.	2028.	1823.	1710.	21890.	34430.	22770.	19290.	12400.
1973	4826.	2253.	1465.	1200.	1200.	1000.	1027.	8235.	27800.	18250.	20290.	9074.
1974	3733.	1523.	1034.	874.	777.	724.	992.	16180.	17870.	18800.	16220.	12250.
1975	3739.	1700.	1603.	1516.	1471.	1400.	1593.	15350.	32310.	27720.	18090.	16310.
1976	7739.	1993.	1081.	974.	950.	900.	1373.	12620.	24380.	18940.	19800.	6881.
1977	3874.	2650.	2403.	1829.	1618.	1500.	1680.	12680.	37970.	22870.	19240.	12640.
1978	7571.	3525.	2589.	2029.	1668.	1605.	1702.	11950.	19050.	21020.	16390.	8607.
1979	4907.	2535.	1681.	1397.	1286.	1200.	1450.	13870.	24690.	28880.	20460.	10770.
1980	7311.	4192.	2416.	1748.	1466.	1400.	1670.	12060.	29080.	32660.	20960.	13280.
1981[1]	7725.	~~3986.~~ 3569	~~1773.~~ 1915	~~1454.~~ 2013	~~1236.~~ 1975	~~1114.~~ 1585	~~1368.~~ 2040	~~13317.~~ 16550	~~18143.~~ 19300	~~32000.~~ 33490	~~30530.~~ 37870	~~13171.~~ 13790

1/ USGS HAS REVISED THE GOLD CREEK DISCHARGES FOR WATER YEAR 1981

2-51-2

TABLE 2

CHULITNA RIVER MONTHLY FLOW (CFS)[1]

USGS GAGE 15292400

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	9314.	3271.	2143.	1588.	1172.	1030.	1143.	19880.	27252.	33669.	25265.	6424.
1951	3268.	1236.	891.	980.	912.	845.	1282.	6101.	19760.	24161.	20961.	14193.
1952	6526.	2407.	1771.	1385.	1166.	1075.	1409.	11664.	28489.	26547.	19653.	11001.
1953	6142.	2047.	1496.	1597.	1141.	956.	1267.	9575.	19571.	22840.	17478.	10757.
1954	4381.	1680.	1287.	1221.	1043.	834.	1054.	16618.	22528.	25827.	27064.	11888.
1955	4668.	2304.	1437.	1148.	894.	861.	1047.	7928.	26568.	34256.	31861.	12604.
1956	6087.	2005.	1476.	1323.	1296.	1104.	1030.	20025.	33241.	31196.	23329.	23260.
1957	6516.	3014.	1741.	1673.	1298.	1238.	1306.	8447.	24914.	28656.	26519.	14011.
1958	5718.	2752.	1419.	1306.	1044.	948.	1220.	10460.	23170.	25010.	20760.	8000.
1959	4197.	1883.	1262.	1097.	1049.	738.	890.	7413.	23660.	25650.	22100.	9957.
1960	4723.	2283.	1700.	1448.	1103.	933.	1000.	13890.	17390.	23650.	19320.	12420.
1961	5135.	1950.	1745.	1452.	1100.	1079.	1600.	10100.	20490.	27420.	24580.	16030.
1962	5777.	2400.	1500.	1300.	1000.	930.	1170.	7743.	20620.	27220.	21980.	13470.
1963	3506.	1500.	1552.	1600.	1300.	846.	700.	11060.	17750.	28950.	18390.	11330.
1964	8062.	2300.	1000.	1007.	820.	770.	1133.	2355.	40330.	24430.	20250.	9235.
1965	5642.	2900.	2100.	1600.	1400.	1300.	1400.	7452.	20070.	23230.	22550.	22260.
1966	6071.	1620.	1350.	1200.	1100.	1100.	1300.	3971.	21740.	23750.	27720.	12200.
1967	4682.	1680.	1500.	1458.	1257.	1045.	972.	12400.	25520.	35570.	33670.	12510.
1968	3483.	1660.	1397.	1235.	1200.	1148.	1347.	10940.	29000.	30140.	20710.	7375.
1969	2898.	1480.	1139.	974.	900.	824.	1333.	6001.	18560.	20820.	11300.	6704.
1970	4578.	1887.	1316.	1200.	1154.	1100.	1437.	9643.	19670.	26100.	24660.	11330.
1971	3826.	2210.	1403.	1113.	950.	934.	982.	4468.	22180.	27280.	23810.	11080.
1972	5439.	2157.	1432.	1174.	1041.	939.	873.	9765.	17900.	25770.	20970.	12120.
1973	6461.	2176.	1508.	1160.	1031.	889.	1106.	4896.	20005.	22761.	18676.	7112.
1974	4475.	1891.	1397.	1335.	955.	904.	1218.	15330.	20941.	26819.	24749.	12527.
1975	4841.	1783.	1371.	1287.	1056.	1061.	1345.	6928.	25244.	33977.	22307.	12170.
1976	5525.	1525.	1091.	1120.	1077.	873.	1168.	10430.	22642.	25395.	24271.	10336.
1977	6201.	2537.	2091.	1498.	987.	962.	1441.	8160.	33629.	25801.	20186.	12388.
1978	5429.	2113.	1641.	1458.	1123.	981.	1052.	4702.	15587.	24633.	15323.	10351.
1979	4900.	2184.	1651.	1406.	1117.	936.	1276.	11396.	19616.	27740.	22897.	11231.
1980	6420	3180	1740	1520	1371	1304	1767	9142	22490	34450	20780	6240
1981	5711	3213	2016	1623	1414	1171	1440	9972	22420	29860	33170	11960

(1) Discharge data for Water years 1950 through 1957 ~~and~~ for October, November, December and January of water year 1958, ~~and~~ for water years 1973 through 1979 ~~and for October through April of water~~ ~~were~~ estimated from correlation analysis. Discharge data for October through April of water year 1980 estimated from Gold Creek and Talkeetna discharge records and the long term average ratio of Gold Creek and Talkeetna discharges to the Susitna River discharge.

TABLE 3

TALKEETNA RIVER MONTHLY FLOW (CFS)[1]

USGS GAGE 15292700

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	3096	1577	1026	616	468	397	384	4319	8918	11735	10605	5216
1951	2319	770	515	536	403	379	607	3156	7543	10123	9355	8460
1952	2388	1090	780	583	467	413	489	2638	11369	9476	8770	7048
1953	3188	1556	931	635	470	453	653	4946	9868	9499	8029	5616
1954	2024	1134	693	649	472	386	429	3569	9556	10045	18033	6925
1955	2426	926	632	594	522	444	450	2530	10207	12349	14206	6302
1956	2291	1033	789	630	628	502	497	6415	14812	11729	12932	8179
1957	3017	1786	1034	707	606	502	524	4355	12779	10848	11373	9327
1958	3662	1689	1019	822	609	515	705	4463	16030	13654	12100	4514
1959	2424	821	615	579	527	436	567	4171	7490	10509	13065	7053
1960	2948	933	803	623	479	412	496	3826	5318	9181	12319	7648
1961	3264	1485	1239	1001	806	621	742	4107	15161	12516	14030	7879
1962	3095	1556	1034	815	736	569	648	3260	16992	9665	9270	5663
1963	3576	1378	1107	777	700	537	456	4328	9949	13023	10087	3778
1964	2040	916	693	529	440	384	371	1694	17080	9820	8396	3815
1965	3115	1568	1100	720	620	540	580	3474	11090	12180	11150	10610
1966	4438	1460	876	711	526	395	422	2410	12970	10100	10730	5370
1967	2308	897	750	637	546	471	427	4112	9286	12600	14160	6971
1968	2029	1253	987	851	777	743	983	8840	14100	11230	7546	4120
1969	1637	827	556	459	401	380	519	3869	5207	7080	3787	2070
1970	1450	765	587	504	458	440	545	3950	7979	10320	8752	5993
1971	2817	1647	1103	679	459	402	503	2145	19040	11760	16770	5990
1972	2632	1310	845	727	628	481	519	3516	12700	12030	9576	8709
1973	3630	1373	889	748	654	574	577	3860	12210	7676	9927	3861
1974	1807	960	745	645	559	482	535	5678	8030	7755	7704	4763
1975	1967	1002	774	694	586	508	522	4084	13180	12070	8487	7960
1976	2884	773	558	524	480	470	613	3439	10580	9026	8088	3205
1977	1857	1105	1069	700	549	506	548	4244	18280	9344	8005	5826
1978	3268	1121	860	746	576	485	534	2950	7429	10790	7001	3567
1979	1660	1138	932	762	652	577	710	7790	12010	14440	8274	4039
1980	3379	1718	868	808	741	700	1038	4823	11380	13900	7224	5402
1981	2600	1144	717	652	535	545	671	4527	6589	15410	14680	4384

(1) Discharge data for water years 1950 to 1964 estimated from correlation analysis. Continuous streamflow records are available from June 1964.

TABLE( ) (1)

SUSITNA STATION MONTHLY FLOW (CFS)

USGS GAGE 15294350

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1950	26869.	11367.	6197.	6072.	5256.	5377.	5657.	66294.	101616.	124890.	106432.	39331.
1951	18026.	6933.	5981.	7074.	7295.	6382.	7354.	59273.	82255.	123164.	100947.	73471.
1952	31053.	16364.	6989.	8274.	7036.	5853.	5985.	45294.	132547.	137322.	116186.	82076.
1953	44952.	16289.	9746.	8069.	6775.	6350.	7993.	88840.	130561.	125949.	97610.	44168.
1954	20169.	11829.	5272.	7202.	4993.	4980.	6306.	58516.	108881.	116732.	128587.	66275.
1955	23896.	9168.	6183.	7255.	5845.	5316.	6412.	58164.	169045.	148877.	120120.	53504.
1956	19923.	10522.	7295.	6179.	6831.	6324.	7182.	82486.	161346.	168815.	131620.	104218.
1957	41822.	21548.	14146.	10600.	8356.	7353.	7705.	63204.	176219.	140318.	124813.	87825.
1958	52636.	19887.	10635.	7553.	6387.	6679.	8099.	70321.	112897.	122280.	99609.	53053.
1959	30543.	9528.	4763.	7795.	6564.	5666.	6468.	56601.	110602.	146217.	138334.	67904.
1960	25754.	10165.	7005.	6716.	6310.	5651.	5830.	50062.	84134.	129403.	113972.	81565.
1961	33782.	12914.	13768.	12669.	10034.	9193.	9803.	85457.	151715.	138969.	116697.	62504.
1962	29029.	13043.	8977.	9050.	6183.	5951.	6635.	54554.	163049.	143441.	121221.	74806.
1963	27716.	10755.	8865.	8671.	7854.	6058.	5565.	53903.	85648.	146420.	106707.	70782.
1964	37846.	11702.	5626.	6351.	5762.	4910.	5531.	35536.	153126.	124806.	92280.	46110.
1965	28747.	10458.	6127.	6952.	6196.	6170.	7120.	49485.	110075.	138407.	111846.	89944.
1966	36553.	12313.	9159.	8031.	7489.	7091.	8048.	52311.	125183.	117607.	118729.	63887.
1967	26396.	12963.	8322.	8029.	7726.	6683.	7281.	58107.	134801.	136306.	137318.	89527.
1968	37725.	15873.	15081.	11604.	11532.	8772.	8763.	94143.	137867.	130514.	86875.	42385.
1969	~~[illegible]~~ 15540	~~[illegible]~~ 6606	~~[illegible]~~ 4279	~~[illegible]~~ 5022	~~[illegible]~~ 5137	~~[illegible]~~ 5172	~~[illegible]~~ 6452	~~[illegible]~~ 44467	~~[illegible]~~ 85126	~~[illegible]~~ 162121	~~[illegible]~~ 62358	~~[illegible]~~ 34065
1970	22683.	6799.	5016.	6074.	5581.	5732.	5769.	53036.	94612.	132985.	117728.	80585.
1971	32817.	16607.	8633.	6509.	6254.	5883.	5788.	29809.	122258.	139183.	133310.	69021.
1972	32763.	14922.	8791.	9380.	8458.	6646.	6895.	74062.	176024.	142787.	107597.	60220.
1973	26782.	14853.	8147.	7609.	7477.	6313.	7688.	64534.	122797.	123362.	107261.	45227.
1974	20976.	10113.	6081.	7402.	6747.	6294.	6963.	61458.	67838.	102184.	80252.	56124.
1975	19520.	10400.	9419.	8597.	7804.	7048.	6867.	47540.	128800.	135700.	91360.	77740.
1976	31550.	9933.	6000.	6529.	5614.	5368.	7253.	70460.	107000.	115200.	99650.	48910.
1977	30140.	18270.	13100.	10100.	8911.	6774.	6233.	56180.	165900.	143900.	125500.	83810.
1978	38230.	12630.	7529.	6974.	6771.	6590.	7033.	48670.	90930.	117600.	102100.	55500.
1979	36810.	15000.	9306.	8823.	7946.	7032.	8683.	81260.	119900.	142500.	128200.	74340.
1980	58640.	31590.	14690.	10120.	9017.	8906.	12030.	66580.	142900.	181400.	126400.	~~[illegible]~~ 77377
1981	34970.	16200.	8516.	7774.	7589.	6177.	10350.	83580.	108700.	152800.	159600.	67170.

(1) Discharge data for water years 1950 to 1974 estimated from correlation analysis. Continuous streamflow records are available from October 1974.

(2) ~~[illegible]~~ 1983 Revision by USGS

2-51-5

TABLE 5

GOLD CREEK MONTHLY AVERAGE WATER TEMPERATURES[1] (°C)

FOR WATER YEARS FOR WHICH DATA IS AVAILABLE

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1974											9.5[2]	8[2]
1975	3.8[2]											6.5[2]
1976								2.5[3]	6.5	10.5[4]	11.0[5]	9.7[6]
1977								5.3[7]	5.7	8.8[8]		
1978									9.5[9]	10.9[10]	11.5[11]	8.2[12]
1979	1.9[13]	0.2	0.2					6.5[14]	7.9	11.6[15]	10.1	7.2
1980	2.9	1.5						5.1[16]	6.0	9.3	7.6	4.8
1981												

(2) MEAN OF MONTHLY MAXIMUM AND MINIMUM

(1) GOLD CREEK DATA MAY BE INFLUENCED BY INFLOW FROM GOLD CREEK.

(3) MAY 11-31 (4) JUL 1-5, 7-17, 22-24 (5) Aug 5, 8-9, 19 (6) Sep 4-12 (7) May 29-31

(8) Jul 1-8 (9) JUN 15-30 (10) JUL 1-9 (11) Aug 14-31 (12) Sep 1-24 (13) Dec 1-15 (14) May 22-31 (15) Jul 1-9 (16) May 14-[illegible]

NOTE: NO DATA AVAILABLE FOR WATER YEARS 1950-1973

TABLE 6

SUSITNA STATION 2 MONTHLY AVERAGE WATER TEMPERATURES (°C)
FOR WATER YEARS FOR WHICH DATA ARE AVAILABLE

NOTE No data available for WY 1950-1973

WATER YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1974												
1975									10.3 (1)	10.8 (1)	11 (1)	7.8 (1)
1976	2.3	0.5	0				0.5 (2)	2.9	11.4	12.1	10.0	7.2
1977	9.8 (3)							6.8 (4)	10.5	12.5	11.5	7.5
1978								7.5 (5)	11.0	12.0	12.0	9.0 (6)
1979								9.5 (7)	10.5	12.5	11.5	8.0
1980	3.7 (8)	0.4 (9)						7.4 (10)	10.0	11.5	10.5	7.0
1981	2.6 (11)											

(1) Values are mean of monthly maximum and (2) Apr 12-30 (3) Oct 1-6
(4) May 20-31 (5) May 1-2, 16, 24-31 (6) Sep 1-25 (7) May 15-31 (8) Oct 1-23, 31
(9) Nov 1-2, 9-24 (10) May 19-31 (11) Oct 1-23