FRASER RIVER WATER QUALITY AT THE PATTULLO BRIDGE

E. M. LAWSON
G. B. MITCHELL
D. G. WALTON
LOWER MAINLAND REGION
WASTE MANAGEMENT
MINISTRY OF ENVIRONMENT
PROVINCE OF BRITISH COLUMBIA

DECEMBER 1983

SUMMARY

Waste Management decisions affecting the Fraser River have been hampered by an insufficient data base. To rectify this deficiency water quality was monitored from September 1981 through November 1982, at surface and mid-depth for three cross-river sampling locations near the Pattullo Bridge in New Westminster. Metal, nutrient, bacteriological, and physical parameters were measured and the results correlated with seasonal changes in climate and Fraser River discharge volume. Large stormwater outflows from rivers near the sampling site from December through April during the Fraser River's flow period account for major concentration variations of some parameters at this time. As these rivers enter from the north close to the sampling location it is likely that mixing with the Fraser is still occurring as a sidedness is apparent in the data with data extremes noted from the northerly sampling location. For most parameters the dominating influence on observed concentration variations is the spring freshet. Periods of heavy rainfall in various areas of the drainage basin account for other observed parameter variations. Per day loadings calculated monthly for some parameters further emphasizes the predominance of freshet with minor affects from fall rains. In general the Pattullo Bridge sampling location has major drawbacks and consideration for future programs should be given to a sampling location near Mission where a flow gauge is located, there are fewer local natural or industrial/municipal discharges, and there is no tidal influence to complicate the data analysis.

TABLE OF CONTENTS

List of Tables

1. INTRODUCTION

The Fraser River drains much of British Columbia's lower mainland and interior to just beyond Prince George. The River's drainage basin area above the Port Mann Bridge is approximately 232,000 km^2. In recent years the increasing population density and use of the waterway especially along its lower reaches is suspected of impairing its water quality.

In a series of reports published in the late 1970's and early 1980's the Federal-Provincial Fraser River Estuary Study Group evaluated the present status of the lower Fraser River and made recommendations concerning its future management. They often noted an insufficient data base on which to base decisions.

Of particular interest here is the Water Quality Report (Drinnan and Clark, 1980). The authors found that historically agencies had, for different study areas, analyzed different parameters using different sampling procedures and schedules and different formats for the storage and reporting of results. The additional possibility of inter-laboratory procedures not being comparable made it extremely difficult to compare all of the water quality data for the lower Fraser River except in a general way. In their recommendations they suggested a twelve month baseline study be undertaken for routine surveillance of selected parameters at one location, near the Pattullo Bridge in New Westminster, with the aims of examining seasonal variation and vertical and horizontal stratification of parameters within the water column.

Following review of the Estuary Study's reports and recommendations, the Pollution Control Board recognized the need to alleviate the gaps in the information on which Waste Management decisions must be based and urged the Government of British Columbia to undertake a background water quality study of the Fraser River, as it enters the metropolitan Vancouver area. Such a project was initiated in the fall of 1981 by Waste Management, Region 2 (Ministry of Environment). This report discusses the results of the study.

2. METHODS

2.1 Sampling Location and Frequency

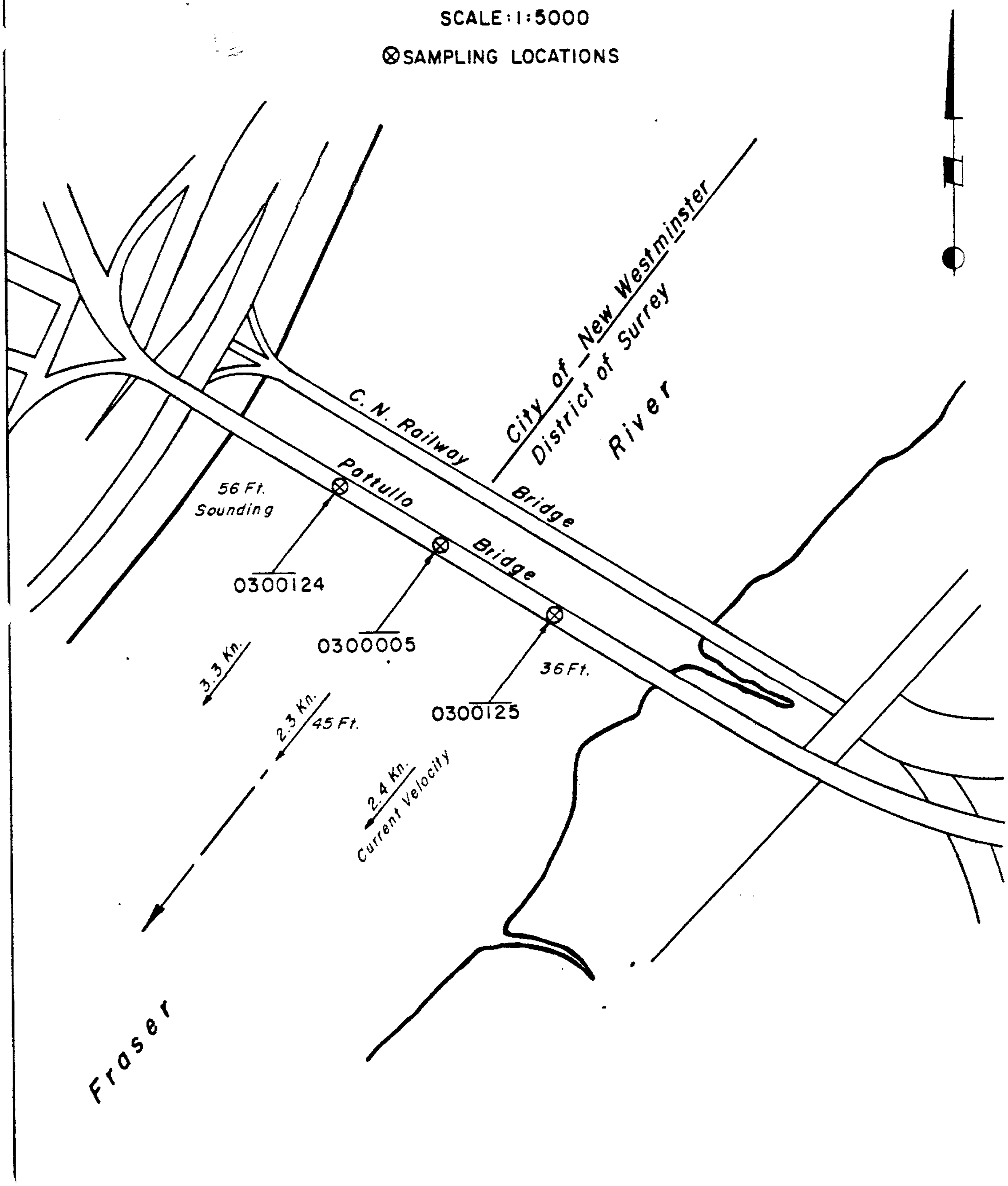
Sites sampled were established by our office in 1975. These sites, approximately 25 km from the ocean at the Pattullo Bridge in New Westminster, have EQUIS computer identification numbers 0300005, 0300124, and 0300125 which correspond to locations in mid-river, halfway to the north bank, and halfway to the south bank respectively (Figure 1).

From September 1981 through November 1982, samples were collected at approximately biweekly intervals from surface and mid-depth (7.0 m for 0300005 and 0300125, 9.0 m for 0300124) whenever possible on an ebb tide approaching low slack water.

2.2 Sampling Procedure

Water samples were obtained using a Van Dorn water sampler lowered from a drifting boat. A composite sample was aliquoted into sample bottles and preserved where required as soon as practical thereafter. A portion of this sample was also used for field tests. Temperature, dissolved oxygen, and conductivity were measured using a thermometer, Yellow Springs Instrument Co. -Model 54 dissolved oxygen meter, and Yellow Springs Instrument Co. -Model 33 conductivity meter respectively. Following collection, the fecal coliform samples were

FIGURE 1 **SAMPLING LOCATIONS AT PATTULLO BRIDGE**



2.2 Sampling Procedure (Continued)

delivered the same day to the bacteriology laboratory while the remaining water samples were sent to the analytical laboratory by courier.

2.3 Parameter Analysis

A number of physical, chemical, and bacteriological parameters were examined (Table 1). Fecal coliform analyses were performed by the water bacteriology laboratory of the Ministry of Health in Vancouver. All other parameters were measured by the Ministry of Environment laboratory in Vancouver following analytical procedures outlined in "A Laboratory Manual for the Chemical Analysis of Water, Wastewaters, Sediments, and Biological Materials." (Department of Environment, 1976).

2.4 Data Analysis

Data was entered into the EQUIS computer and computer plots of these results obtained.

Hydrological flow data for the Fraser River gauge located at Mission (Station 08MH024) and the Coquitlam River gauge at Port Coquitlam (Station 08MH002) from the Water Resources Branch (Environment Canada), tidal information for New Westminster from the Institute of Ocean Sciences at Pat Bay (Department of Fisheries and Oceans), and meteorological data from the

TABLE 1

Fraser River Water Quality Parameters Monitored

September 1981 to November 1982

Parameter	*1. Recommended For Routine Monitoring	*1. Recommended For Special Studies Only	EQUIS Code Preparation Method
Field Tests:			
Temperature	yes		034
Dissolved Oxygen	yes		002
Specific Conductance	yes		013
Laboratory Tests:			
pH	yes		0040101
Nonfilterable Res.105°C	yes		0080103
Specific Conductance	yes		0110101
Alkalinity:Tot.	no	yes	1020101
Chloride: Diss.	no	no	1041702
Silica: reactive	yes		1201702
Ammonia	no	yes	1081704
Kjeldahl Nitrogen	yes		1130101
Nitrogen NO_2/NO_3	yes		1091703
Nitrogen Total	yes		1140001
Ortho-Phosphate	no	yes	1181703
Phosphate Tot.Diss.	yes		1191703
Phosphorus Tot.	yes		1190103
Copper Tot.	yes		2560210
Zinc Tot.	yes		2660210
Mercury Tot.	yes		2613503
Faecal Coliform[2.*]	-	-	
Residue Tot. 105°C	no	no	0050101

*1. Recommended by Drinnan and Clark (1980).
*2. Recommended by Churchland (1980).

2.4 Data Analysis (Continued)

Atmospheric Environment Services (Environment Canada) was obtained in order to examine these influences on the water chemistry data. The Mission flow data was also used with the water chemistry results to calculate the daily loading rates for each month.

3. RESULTS

3.1 River Discharge

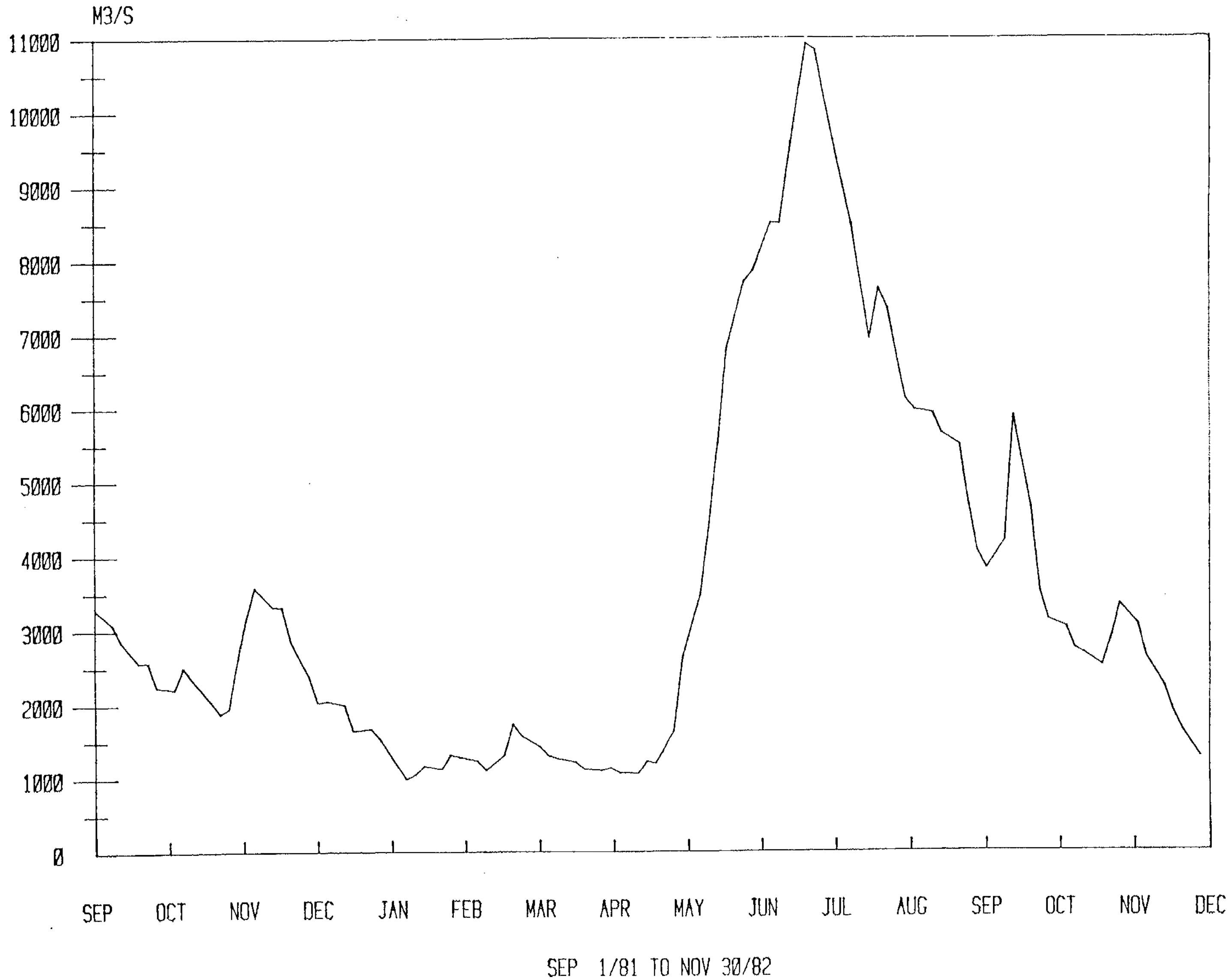
(a) Climate.

Through the period of study regional climatic factors affecting the Fraser River discharge rate were observed (Appendix 1). Rain in the Lower Mainland (Vancouver to Hope) was heavy from October (1981) to mid-December (1981), mid-January (1982) to the end of February (1982), and in late October (1982) through November (1982). The Lower Mainland's coolest temperatures were from late December (1981) through January (1982) and precipitation occurred as snow. In the Spences Bridge area the heaviest rainfall occurred in late November (1981), mid-July (1982), and late September (1982). Freezing temperatures prevailed here from December (1981) through February (1982) with almost all precipitation as snow. In the Williams Lake - Prince George area cold winter temperatures resulted in virtually all the precipitation occurring as snow. Heavy rainfall is recorded for the Williams Lake area in July (1982) and during September (1982) for the Prince George area.

(b) Fraser River Flow.

Discharge data for the Fraser River from the Mission flow gauge (Station #08MH024) reflects these meteorological events (Figure 2). The mid-October (1981) to

Figure 2 5-Day Average of Fraser River Discharge Rates (m^3/s) for September, 1981, through November, 1982 (Mission Gauge, Station 08MH024; Water Resources Branch data)



(b) Fraser River Flow (Continued)

December (1981) flow increase coincides with heavy rainfall in the Lower Mainland with lesser amounts falling throughout the northern drainage basin. Fraser River flow remains at a minimum (1000 - 1500 m^3/s) from January (1982) until mid-April (1982) as freezing temperatures blanket much of the drainage basin. In February the small flow increase results from considerable rain in the Lower Mainland with warmer temperatures likely melting the snow from low elevations. By mid-April warmer temperatures throughout the drainage basin and moderate spring rains combine to melt the high elevation snowpack and freshet results. The discharge volume peaked at approximately 11,000 m^3/s. A wet July (1982) with heavy rainfall from Hope to Williams Lake and a wet September (1982) with moderate rain in the Hope area and heavy rain in the Prince George area significantly increased Fraser River flows. Lastly, the November (1982) increase in discharge results from rain only in the Lower Mainland.

In general the Fraser River discharge rate decreases through the fall and remains at low flow through much of the winter. With the onset of freshet in mid to late April flows increase dramatically as the snowpack melts. Following peak flows

(b) **Fraser River Flow** (Continued)
in mid-summer the discharge again decreases through the fall.

(c) Discharge from the Lower Mainland Fraser River Tributaries.

The Fraser River's snow melt/ freshet characteristic is also apparent in recorded flows for some Lower Mainland streams particularly the Harrison River and, to a lesser degree, the Pitt River (Water Resources Branch, 1981). Other tributaries such as the Brunette, Coquitlam, and Salmon Rivers do not exhibit this freshet characteristic. Flow increases in these rivers are largely governed by rainfall runoff. The topography of the north bank area immediately above the Pattullo sampling site indicates a considerably larger drainage area than the south bank hence more stormwater runoff will enter the Fraser on the north via the Brunette, Coquitlam, and Pitt Rivers. Peak flows from these rivers occur when the Fraser's flow is least during the fall and through the spring. The three rivers' combined discharge volume may amount to approximately 15-30% of the Fraser River's flow at this time. From where these three tributaries enter to the sampling site the Fraser River is not turbulent hence only nominal mixing may occur increasing the probability that channeling of their inflow may produce water chemistry horizontal stratification at the Pattullo sampling location.

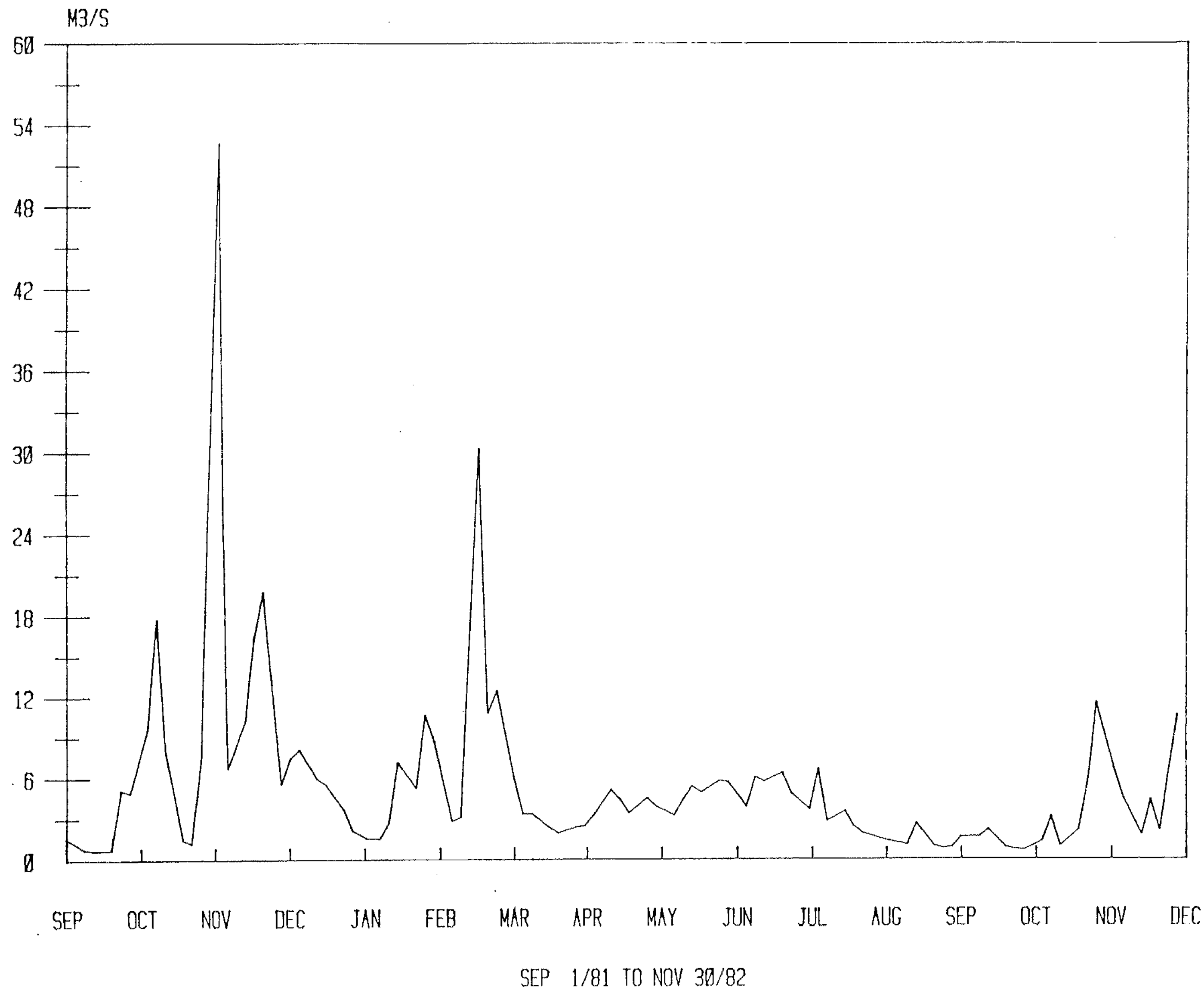
(c) Discharge from the Lower Mainland Fraser River Tributaries (Continued)

Discharge data from the Coquitlam River (flow gauge station #08MH002) indicates the periods of heavy runoff from the Lower Mainland (Figure 3).

(d) Tidal Influence.

Flow in the study area is also affected by tides. Although attempts were made to sample on an ebb tide approaching low slack water this was not always possible. It was observed while sampling during the non-freshet period that after low slack water and just prior to an ebb tide the current velocity was essentially nil. River height measured on the New Westminster tidal gauge for the sampling times varied from 1 cm to 227 cm (Appendix 2) being highest during freshet. The tidal effect on current diminished with flow hence the influence is least during freshet. Under low flow conditions tides affect the Fraser River upstream beyond the Port Mann bridge. Potentially the tide could cause effluent discharges to flow up the Fraser River and back up outflow from the Brunette, Coquitlam, and Pitt Rivers. On an ebbing tide a larger than expected slug discharge outflow may then be realized.

Figure 3 5-Day Average of Coquitlam River Discharge Rates (m^3/s) for September, 1981, through November, 1982 (Port Coquitlam Gauge, Station 08MH002; Water Resources Branch data)



(e) Flow at the Pattullo Sampling Site

Downstream from the Port Mann Bridge the Fraser River curves to the south and becomes constricted at the Pattullo Bridge. As noted by Tamburi and Hay (1978), and from nautical charts and field observations the north station (0300124) is the deepest and has the most current while the south station (0300125) is the most turbulent. Tamburi and Hay (1978) indicate that at this bend the river is undergoing a helical motion with upwelling occurring at the 0300125 site producing turbulence.

3.2 Physical Parameters (See Figures in Appendix 3 and data summary in Appendix 4)

(a) Temperature

Water temperature ranged 0-18°C and is seasonally dependent. When the water is cooling through the fall and early winter no difference in temperature was observed either among the sampling sites or between surface and depth samples from the same site. During the spring as the water warms the depth samples from all sites are marginally warmer. A cold water episode in late July - mid-August correlates with a period of rain possibly flushing out the Brunette, Coquitlam and Pitt Rivers. The helical movement of the water immediately above and at the sampling location accounts for the cold water being

(a) Temperature (Continued)
mainly apparent at depth on the north side (0300124) and at the surface on the south side (0300125).

(b) Dissolved Oxygen

As expected from gas solubility in water the dissolved oxygen concentration is negatively correlated with water temperature and is thereby seasonally dependent. The concentration of dissolved oxygen is highest in the winter peaking at 14-15 mg/L before gradually decreasing to levels of 4.5 - 9 mg/L in August (1982). Little difference in concentration was observed from surface and depth samples or between stations except for an episode of low dissolved oxygen during August (1982). The dissolved oxygen concentration trend is surprisingly positively correlated with the water temperature at this time suggesting an outflow of stagnant water from the local rivers after the rain storm. Again the observed variation may be due to a helical water movement as the lowest dissolved oxygen levels occur at depth at the north location (0300124) and on the surface at the south station (0300125). Some measurement variation may be due to instrument error.

(c) pH

Measurements of pH range from 7 to 8 and exhibit little consistent difference between stations or between surface and depth samples from the same station. Variation is

(c) pH (Continued)

fairly erratic with possible trends to lower pH reflecting the pH of water inflows from rainstorms and snowmelt - freshet.

(d) Specific Conductance (Field and Laboratory)

Field conductivity measurements varied from 30 to 115 umhos/cm while laboratory measurements vary from 40 to 130. The same general trends observed in field data are noted from the laboratory measurements except the data extremes are accentuated perhaps due to instrument variation. The general trend observed is increasing conductivity during the low flow winter and spring followed by a decline in conductivity with the onset of freshet.

The January to March (1982) data anomaly correlates with the local weather. The characteristically low winter and spring Fraser River flow is partially due to nominal runoff from the frozen drainage basin. From mid-January through February (1982) rainfall and temperature were unseasonably high in the Lower Mainland area. The heavy runoff from both rainfall and low level snowpack increased flows of local rivers and may have resulted in a considerable inflow of water of low conductivity. Further evidence for the conductivity dip being due to runoff inflows from local rivers is that conductivity

(d) Specific Conductance (Continued)
measurements of 20 - 50 are not uncommon for the Pitt River system at this time of the year, a coincident decline in silica concentrations which is also known to be in low concentrations in some Fraser River tributaries, and an observed sidedness in the conductivity data whereby the lowest conductivity is measured on the north side (0300124) of the river. A similar, though smaller, runoff affect on conductivity occurred during October - November (1982).

3.3 Chemical Parameters

(a) Phosphorus-Dissolved Ortho

Concentrations ranged from less than the detection limit to 0.014 mg/L and averaged 0.0046 mg/L. Significant concentrations were found mainly from late November (1981) until late April (1982), the period of low sunlight and Fraser River flow. The November to early December (1981) increase in orthophosphate concentration correlates with a flow increase in the Fraser River while the January to mid-February (1982) orthophosphate increase coincides with a discharge increase only from the local tributaries. A plateau in concentration is depleted following freshet when concentrations fall below the minimal detection limit. Little vertical stratification is evident but some sidedness is again observed especially in January-February (1982) when heavy

(a) Phosphorus-Dissolved Ortho (Continued)
runoff in local rivers has the greatest impact on the low Fraser River flows.

(b) Phosphorus - Total Dissolved

Although the concentrations (0.021 mg/L maximum, 0.004 mg/L minimum, 0.008 mg/L average) are higher than for orthophosphate the same general features noted for freshet also pertain to dissolved phosphorus. A seasonal trend to higher total dissolved phosphorus concentrations through the winter low flow period is highlighted by episodes of runoff with accompanying increases in total dissolved phosphorus in November-December (1981) and January-February (1982). A slight increase in total dissolved phosphorus concentration with the onset of freshet is rapidly diminished attaining nominal levels by mid-May (1982). No clear horizontal or vertical stratification is evident.

(c) Phosphorus - Total

Total phosphorus levels (0.33 mg/L maximum, 0.01 mg/L minimum, 0.065 mg/L average) are 5 - 10 times higher than for other forms of phosphorus examined consequently only comparatively gross concentration changes are observed in the curves. The main influence on total phosphorus concentration is the Fraser River's rate of discharge. Coinciding with the onset of freshet in mid-April is a

(c) Phosphorus - Total (Continued)

large increase in total phosphorus which peaks shortly thereafter falling to nominal levels by late May. Another large concentration increase occurs in September-October (1982) again correlated with a substantial increase in Fraser River flow. Both peaks in total phosphorus concentration occur when suspended solids are at a maximum suggesting that a large amount of phosphorus is bound to solids. Some vertical and horizontal stratification is evident which is directly related to the suspended solids.

(d) Nitrogen-Ammonia

A general trend toward higher concentrations of ammonia through the winter is observed. Ammonia concentrations varied from non-detectable to 0.08 mg/L with an average of 0.0175 mg/L. The November (1981) increase in Fraser River flow combined with the November-December (1981) increase in flow from the local tributaries, and the January-February (1982) flow increase of local tributaries both resulted in significant increases in ammonia levels. Concentrations which roughly plateau through February until mid-April fall off rapidly during freshet and remain at low levels for much of the summer. Little vertical stratification is observed but the data occasionally show a sidedness with higher concentrations again found at the north (0300124) sampling location.

(e) Nitrogen - Dissolved Nitrate + Nitrite

Though not as accentuated the same general trends observed for nitrogen-ammonia are noted here. NO_2/NO_3 concentrations are approximately three-fold higher (0.30 mg/L maximum, 0.04 mg/L minimum, 0.115 mg/L average) than ammonia. Increases in concentration accompany the November-December (1981) and January-February (1982) flow increases. A March through late April plateau in NO_2/NO_3 concentration gradually decreases as freshet progresses. A general increase in NO_2/NO_3 is noted through the winter while only nominal concentrations were measured through the summer. Little trend to vertical or horizontal stratification is seen.

(f) Nitrogen - Total Kjeldahl

Both the organic and ammonia forms of nitrogen are measured by total Kjeldahl nitrogen. Concentrations averaged 0.18 mg/L (0.58 mg/L maximum, 0.03 mg/L minimum) and peaked with freshet in early May. A very slight increase in concentration during November-December (1981) with larger increases in January-February (1982) and September-October (1982) are noted in association with increases in discharge rate. The January-February (1982) episode is due to runoff from the Lower Mainland while that in September-October appears due to runoff from Hope to Prince George. During the Fraser River's

(f) Nitrogen - Total Kjeldahl (Continued)

low flow period ammonia accounts for approximately 20 - 30% of the total Kjeldahl nitrogen. After mid-March and through until November (1982) this proportion falls to 1-5%. The corresponding May and September (1983) peaks in both suspended solids and Kjeldahl nitrogen suggests that a large amount of organic nitrogen may be bound to the solids. Unlike ammonia, Kjeldahl nitrogen does not exhibit a general increase over the winter and no consistent vertical or horizontal stratification trend is observed.

(g) Nitrogen - Total

Concentrations of total nitrogen (0.75 mg/L maximum, 0.14 mg/L minimum, 0.29 mg/L average) follow a trend similar to total Kjeldahl nitrogen but with greatly accentuated peaks. A slight winter-spring total nitrogen increase is diminished by late May after the start of freshet. The May and September (1982) peaks correspond to increases in suspended solids. The January-February (1982) and early April (1982) nitrogen increases correspond to periods of rainfall in the Lower Mainland area while the November-December (1981) increase is related to runoff throughout the drainage basin and the August-September (1982) increase is associated with rainfall runoff from Hope to Prince George. A tendency towards horizontal stratification (January 1982, March 1982) is evident when

(g) Nitrogen - Total (Continued)

inflows from the local Lower Mainland rivers significantly impact the Fraser River flow. Little vertical stratification is evident except possibly during peak flows at the north (0300124) site.

(h) Silica - Reactive

Concentrations of silica (7.0 mg/L maximum, 3.7 mg/L minimum, 5.29 mg/L average) exhibit a general increase through the low flow (winter-spring) period before declining in May shortly after the start of freshet. Some of the Fraser River's tributaries, such as the Pitt River, have comparatively low silica concentrations so that large inflows from them, especially when the Fraser River has low flow, may result in large coincident declines in silica concentration. Increases in flow generally act to decrease silica concentrations (e.g. September, 1982) but when combined with high flows on local rivers (February, 1982; October, 1982) lower concentrations are found on the north side of the river (0300124). No vertical stratification is evident.

(i) Residue - Non-filterable 105°

Concentrations ranged from a minimum of 5 mg/L, to a maximum of 426 mg/L, with an average of 63 mg/L. Two major increases in non-filterable residue occurred, one associated with the start of freshet and the second with the Fraser River's September flow increase from rain in the Hope to Prince George portion of the drainage basin. The minor peak in June corresponds to a similar freshet-associated pause then increase in Fraser River flow. Field observations noted the south (0300125) side of the river to be consistently more turbulent. Higher non-filterable residue results for the south side suggests the turbulence resuspends or prevents settling of materials. Little vertical stratification is observed.

(j) Residue - Total 105°

Total residue (540 mg/L maximum, 49 mg/L minimum, 131 mg/L average) remained at consistently low levels from September through until mid-April, when freshet started. By mid-May following a month of increased Fraser River flows the residue levels declined. As with non-filterable residue the June shoulder on the total residue curve corresponding to Fraser River flow, horizontal stratification observed with high solids levels on the south side of the river, and the major September (1982) residue concentration increases associated with Fraser River flow increases from rainfall runoff are observed

(j) Residue - Total 105° (Continued)

with the total residue measurements. During the low flow period (September, 1981 to mid-April, 1982) filterable residue accounts for more of total residue than non-filterable residue. Although both filterable and non-filterable residue increase with river flow, the magnitude of the non-filterable residue increase is much greater. Little vertical stratification is evident.

(k) Copper - Total

Copper concentrations ranged from less than detectable (0.001 mg/L) to 0.02 mg/L. Elevated levels were noted during periods of increased flow either from local tributaries (January - March, 1982) or freshet (mid-April-July, 1982). The September (1982) Fraser River flow increase also results in an increase in copper concentrations. Occasional, abnormally high copper concentrations (surface, 0300125 in mid-February, 1982; depth 0300005 in January, 1982; depth, 0300124 in mid-February to mid-March) remain anomalies. No consistent vertical or horizontal stratification is evident.

(l) Zinc - Total

Nominal zinc concentrations were found from mid-October (1981) to March (1982), the Fraser River low flow period. Significant concentrations are noted in association with freshet, Fraser River and local tributaries' flow increases in September to November (1981), August (1982), and October (1982). Although no vertical or horizontal stratification is noted some anomalous data points are apparent.

(m) Mercury - Total

Detectable (0.0002 mg/L maximum) mercury concentrations were found mainly during the December (1981) to mid-April (1982) Fraser River low flow period. In September (1981), April (1982), and August (1982) episodes of positive mercury analyses occur for several stations at both surface and depth which appear loosely related to periods of rainfall and flow increases. Little vertical or horizontal stratification is seen.

(n) Chloride - Dissolved

Concentrations ranged from a maximum of 7.6 mg/L, to a minimum of 0.7 mg/L, with an average of 1.87 mg/L. Elevated levels were generally recorded from December (1981) to mid-April (1982) when the Fraser River flow was minimal and usually under the conditions of low rainfall or just at the beginning of a period of rain. During freshet concentrations fell markedly and stayed low while the

(n) Chloride - Dissolved (Continued)

Fraser River discharge rate remained elevated. Only from December (1981) to late January (1982) was any horizontal stratification evident with higher concentrations on the south (0300125) side. No vertical stratification was found.

(o) Alkalinity - Total

Alkalinity ranges from a maximum of 53 mg/L, to a minimum of 16 mg/L, with an average of 42.2 mg/L. Local tributary flow increases from rainfall in October-November (1981), January-February (1982), and October-November (1982) impact markedly on the measured alkalinity. Increases in alkalinity towards the north (0300124) side of the Fraser River reflect the influence of the Brunette, Coquitlam and Pitt Rivers. A general increase in alkalinity occurring over the winter and spring is depleted following the onset of freshet in mid-April. Many of the trends noted in total alkalinity variation are also evident in the specific conductivity and silica data. No vertical stratification is noted for alkalinity.

3.4 Bacteriological

(a) Fecal Coliform

Coliform levels ranged from 20 - 16,000 MPN varying in relation to the volume of flow in the Fraser River and the River height (i.e. degree of tidal flushing) when the sample was taken. The majority of coliform levels in excess of 1,000 MPN occurred between mid-October to mid-April during the period of low Fraser River flow (Appendix 2, Figure 2). Higher levels of coliform are found toward the north (0300124) side of the Fraser River at both surface and depth. On sampling occasions when the river height was high hence the degree of tidal flushing at New Westminster is low the coliform level measured is higher than anticipated. Little vertical stratification was noted.

3.5 Parameter Loading Rates

Loading rates were calculated for several parameters (Appendix 5) as a false impression of total quantities may be given unless the volume discharge is also taken into account. Where fewer than six detectable amounts for a parameter were measured for a given month the loading rate for that month was not calculated. Comparatively little mercury loading and only a moderate zinc loading were noted. The seasonal trend for most parameters is a major increase with the May freshet. Loading decreases

3.5 Parameter Loading Rates (Continued)

through the summer and fall as the flow abates. Minor increases in loading occur in the early fall perhaps indicating a rain washout of material accumulated over the summer. Loadings generally are least during the January to April low flow period.

4. DISCUSSION

The aims of this project were to monitor the Fraser River for a 12 month period in order to establish baseline water chemistry data and examine vertical, horizontal, and annual variations. By sampling at one location, the Pattullo Bridge, an assessment can be made on the feasibility of sampling at one location for present baseline and any long term changes in quality of Fraser River water entering the Vancouver area.

The major influence on the Fraser's water chemistry is the discharge rate which reflects climatic cycles in the drainage basin. Fall rains result in transient flow increases but these inflows are greatly enriched washing away materials collected during the dry summer. By November falling temperatures result in precipitation in the more northerly portion of the drainage basin changing to snow. From December to mid-April with nominal runoff from much of the drainage basin increases in lower mainland river flow from rainfall and snow melt can account for a large proportion of the Fraser River flow and significantly impact the water chemistry.

Warmer temperatures and rain in the spring melts the snow pack and freshet results. By mid-summer the tenfold flow increases associated with freshet abate and periods of rainfall runoff again can significantly impact on the Fraser River flows.

During freshet tidal affects at New Westminster are overshadowed by the high flows. As the coliform

4. DISCUSSION (Continued)

data indicates, sampling on occasions when tidal flushing is nominal and the Fraser River discharge rate is low, the impact of stormwater outfalls and any other local discharges is enhanced and the water chemistry data can be greatly influenced.

Just as the river undergoes a helical turbulent flow in the vicinity of the Pattullo Bridge so such forces will act to promote mixing eliminating any vertical stratification. Such layering would likely originate from inputs close to the monitoring location such as the Brunette, Coquitlam, and Pitt Rivers and be associated with rain events therefore their occurrence would be transitory. Parameters such as temperature and total phosphorus exhibit vertical stratification but comparatively little is seen in the data.

Horizontal stratification would result from a channelling of inflow along the side of the Fraser River. As with vertical stratification, the same mixing forces will eliminate horizontal stratification so that only local inflows of some magnitude will influence the water chemistry. Inputs include stormwater runoff from industrial, commercial, and residential areas both entering the river directly or via the local streams and discharges under Waste Management Permit. Tidal influence may back up the runoff especially from the Pitt River so that a greater than expected outflow hence influence on water chemistry may be experienced. Parameters showing horizontal stratification include ammonia, silica, chloride,

4. DISCUSSION (Continued)

alkalinity and fecal coliforms.

Annual cycling of parameters was noted in association with several factors. The variation of some parameters is strongly related to others. Water temperature and dissolved oxygen are negatively correlated while the low pH of precipitation is reflected in the low pH of the river during rain events. Silica, alkalinity, and conductivity express very similar trends varying inversely with periods of large local runoff when the Fraser River flow is nominal. This may reflect a dilution of groundwater inflow characteristics by rainfall and snowmelt or more simply an inflow of this precipitation normally low in these characteristics. Some parameters such as ammonia, nitrate + nitrite - nigrogen, and orthophosphate represent a single as opposed to a multiplicity of chemical species as measured by nitrogen-total or phosphorus - total whose corresponding graphical scales may mask small variations. Dissolved forms such as orthophosphate and ammonia tend to be present in low concentrations which are quickly diluted with major increases in flow while the larger concentrations associated with "totals" (e.g. nitrogen or phosphorus) increase with these flows by either washing in directly or by being associated with suspended solids which peak with flow increases at freshet or with the first fall rains (e.g. September, 1982). Some measurement variation may be due to sampling technique or analytical error either in the laboratory or with the

4. DISCUSSION (Continued)

field equipment. Occasional erratic results may reflect sampling a "package" of water which has unusual characteristics and hasn't become integrated.

By accounting for the discharge volume a different perspective on the total quantity of a parameter being discharged is apparent. Although Fraser River discharge volumes from Mission are used in the calculations, thereby not taking into account flows from the local Pitt, Brunette, and Coquitlam Rivers, the large concentration variations for some parameters noted during spring storms do not have a major impact on the loading rates. For most parameters peak loading coincides with freshet. Minor loading increases appear associated with the first heavy fall rain runoff.

The suitability of the Pattullo site for further baseline monitoring of the Fraser River can be seriously questioned. Despite its easy access the influence of tide, local river inflows, hydrological characteristics, nearby stormwater discharges, and nearby municipal and industrial effluents associated with the site should be given consideration. As recently suggested by the Inter-governmental Aquatic Monitoring Committee, chaired by G. R. Gough (Waste Management, Region 2) long term monitoring of the Fraser River at a site near Mission where many of the mentioned problems can be avoided and a flow gauge is situated may be preferable.

REFERENCES

(1) Churchland, L.M. 1980. Microbial Water Quality, 1970-1977. Fraser River Estuary Study-Water Quality, 144 pp.

(2) Drinnan, R. W. and Clark, M. J. R. 1980. Water Chemistry, 1970-1978. Fraser River Estuary Study-Water Quality, 160 pp.

(3) Tamburi, A. and Hay, D. 1978. An Introduction to River Mechanics and the Lower Fraser River. Department of Public Works, Canada, 72 pp.

(4) Water Resources Services. 1976. A Laboratory Manual for the Chemical Analysis of Waters, Wastewaters, Sediments, and Biological Materials (2nd Edition). Department of Environment, 389 pp.

ACKNOWLEDGEMENTS

Thanks are due to the Ministry of Environment and the Ministry of Health Laboratories for their analytical skills, Mr. G. R. Gough for his review and comments on the work, and Mrs. F. Aiken for typing the report.

APPENDIX 1 - CLIMATE DATA

Table 2 Air Temperatures (^{o}C) for Selected Stations in the Fraser River Drainage Basin from September, 1981, through November, 1982 (Atmospheric Environment Services' data)

	Vancouver International Airport	Abbotsford Airport	Hope Airport	Spences Bridge	Williams Lake	Prince George
September mid 1981	15.3	16.9	17.9	19.3	13.6	13.1
September end 1981	13.5	13.2	13.3	14.2	10.0	10.0
October mid 1981	9.3	9.5	9.9	9.8	4.4	5.1
October end 1981	9.4	9.6	9.7	9.6	4.8	4.9
November mid 1981	8.9	9.5	8.2	7.6	4.2	3.4
November end 1981	6.3	6.2	5.1	2.0	-1.8	-1.5
December mid 1981	4.7	4.9	3.3	-1.0	-6.6	-6.4
December end 1981	3.0	2.1	0.8	-6.0	-10.1	-10.9
January mid 1982	-0.3	-1.9	-2.64	-8.7	-14.8	-17.1
January end 1982	4.0	3.0	1.3	-5.3	-13.2	-16.5
February mid 1982	2.6	2.3	0.7	-4.4	-10.6	-14.4
February end 1982	5.7	4.9	3.8	2.3	-3.4	-9.0
March mid 1982	7.9	5.9	5.9	3.5	-4.9	-5.8
March end 1982	5.6	6.0	6.4	5.9	-0.9	-1.8
April mid 1982	6.8	6.7	6.5	6.6	-0.5	-0.8
April end 1982	8.5	9.3	9.4	10.8	4.4	4.8
May mid 1982	10.8	10.4	10.6	12.3	6.7	7.6
May end 1982	13.4	12.9	14.0	15.3	9.9	10.0
June mid 1982	14.9	14.6	15.2	18.7	13.8	14.2
June end 1982	18.6	19.2	20.0	24.1	18.3	18.2
July mid 1982	16.4	15.8	15.6	18.3	13.7	15.9
July end 1982	17.5	17.4	17.0	22.5	16.3	16.8
August mid 1982	16.2	16.2	17.2	20.5	13.4	14.3
August end 1982	17.4	17.4	18.3	21.3	14.2	13.3
September mid 1982	15.6	16.2	16.3	18.6	12.0	11.6
September end 1982	13.7	14.0	15.5	16.2	11.2	11.3
October mid 1982	11.0	11.7	12.0	11.2	6.9	7.6
October end 1982	9.5	9.4	8.6	8.6	3.2	3.8
November mid 1982	4.8	4.4	3.7	1.1	-2.5	-1.5
November end 1982	3.6	3.1	0.6	-2.6	-7.7	-9.7

Table 3 Rainfall (mm) for Selected Stations in the Fraser River Drainage Basin from September, 1981, through November, 1982 (Atmospheric Environment Services' data)

	Vancouver Inter-National Airport	Abbotsford Airport	Hope Airport	Spences Bridge	Williams Lake	Prince George
September mid 1981	18	10.8	32.1	7.8	23.1	20.6
September end 1981	66.1	80.5	77.6	13.6	30.2	21.2
October mid 1981	94.2	152.3	124.4	11.6	8.0	25.1
October end 1981	106	117.2	105.9	1.0	8.5	17.5
November mid 1981	64.6	120.3	113.5	22.8	15.5	21.3
November end 1981	131.8	134.6	80.8	4.4	0	4.3
December mid 1981	104.3	116.5	176.2	10.4	0	2.6
December end 1981	69.1	72.1	27.6	8.4	0	0.4
January mid 1982	54.4	43.1	82.4	0	0	0
January end 1982	122.8	200.9	218.5	2.6	0	0
February mid 1982	113.2	174.4	125.8	2	0	0
February end 1982	105.3	145.8	139.9	4	0	2.2
March mid 1982	46.2	77	95.5	8.8	0	1.0
March end 1982	18.7	25.9	14.9	2.2	0	0
April mid 1982	75.3	63.2	80.2	2	0.2	0.6
April end 1982	14.0	17.2	48.9	0	2.4	12.8
May mid 1982	10.0	18.1	56.9	6.4	46.6	19.2
May end 1982	13.0	16.8	27.4	7.4	25.0	35.6
June mid 1982	4.6	14.0	9.3	9.7	8.9	3.4
June end 1982	24.6	29.1	18.0	11.6	13.2	11.6
July mid 1982	65.9	59.9	123.5	35.4	130.6	76.0
July end 1982	1.1	18.1	20.0	14.0	66.5	55.2
August mid 1982	23.8	37.2	45.1	14.0	66.1	53.1
August end 1982	13.4	7.4	20.7	1.2	5.8	35.8
September mid 1982	37.8	5.6	89.2	5.6	47.5	112.7
September end 1982	6.4	3.8	76.5	27.6	25.8	20.2
October mid 1982	35.4	31.4	92.8	0	14.6	18.6
October end 1982	82.6	94.0	148.9	18.2	3.4	20.5
November mid 1982	58.9	86.2	68.0	2.6	0	3.9
November end 1982	116.0	119.8	55.8	3.0	0	0

Table 4 Snowfall (cm) for Selected Stations in the Fraser River Drainage Basin from September, 1981, through November, 1982 (Atmospheric Environment Services' data)

	Vancouver Inter-National Airport	Abbotsford Airport	Hope Airport	Spences Bridge	Williams Lake	Prince George
September mid 1981						
September end 1981						
October mid 1981						0.2
October end 1981						1.6
November mid 1981					2.5	5.7
November end 1981					6.3	12.6
December mid 1981		1.4	5.1	24	20	28.4
December end 1981	14.8	26.4	21.1	6.8	16.3	13.4
January mid 1982	21.5	31.6	47.9	3.0	40.2	71.3
January end 1982	32.4	37.4	80.5	16.0	76.6	103.4
February mid 1982	5.3	11.9	11.9	3	3.2	40.8
February end 1982	3.6	29.8	25.4		14.3	28.8
March mid 1982			9.7		10.0	29.7
March end 1982		1.4	0.5		11.4	5.4
April mid 1982		0.8	0.2		18.8	1.0
April end 1982					3.2	3.0
May mid 1982					1.1	7.4
May end 1982						
June mid 1982						
June end 1982						
July mid 1982						
July end 1982						
August mid 1982						
August end 1982						
September mid 1982						
September end 1982						
October mid 1982						
October end 1982					3.4	3.8
November mid 1982			10.4		3.7	8.9
November end 1982			11.3		7.6	25.5

APPENDIX 2 - RIVER HEIGHT AND COLIFORM DATA

Table 5 Fraser River Height (cm) at New Westminster at the Sampling Times and the Corresponding Coliform Levels (MPN) Found for the Sampling Stations for September 8, 1981, through November, 1982 (Tidal Information from the Institute of Ocean Sciences, Pat Bay)

DATE - TIME (PST)				Height (cm)	0300124 0.m.	0300124 9.m.	0300005 0.m.	0300005 7.m.	0300125 0.m.	0300125 7.m.
September	8	1981	0930	31	130	80	80	80	50	20
September	10	1981	1030	11	80	110	110	170	130	140
September	23	1981	1000	1	20	330	130	40	50	20
October	15	1981	0900	168	16000	3500	1700	170	330	230
October	22	1981	0900	6	270	110	50	170	330	170
November	24	1981	1145	138	1100	1700	490	790	490	1100
November	30	1981	1445	153	1800	3500	490	1700	1300	2400
December	8	1981	1000	102	1700	1300	1300	330	490	490
December	15	1981	1445	191	2400	2400	1100	3500	3500	790
January	6	1982	1000	117	1300	490	460	790	330	790
January	21	1982	1015	165	16000	9200	3500	490	2400	1300
February	4	1982	1000	135	2400	3500	3500	2400	330	790
February	18	1982	1000	189	330	1300	220	490	330	790
February	24	1982	1330	97	490	1300	130	220	490	330
March	9	1982	1330	103	1700	140	40	130	330	230
March	23	1982	1230	81	1100	1300	230	330	130	230
April	7	1982	1200	44	3500	2400	490	790	1300	1300
April	21	1982	1145	24	170	790	230	130	460	80
May	5	1982	1130	65	170	170	330	220	110	490
May	19	1982	1030	150	110	170	170	80	110	330
June	1	1982	1115	180	170	330	330	330	270	170
June	17	1982	1045	211	210	230	220	130	260	330
June	29	1982	0845	227	490	170	330	330	330	790
July	14	1982	0900	169	170	330	170	490	230	130
July	29	1982	1000	122	80	110	20	110	110	230
August	12	1982	1100	163	170	460	270	330	700	220
August	26	1982	0730	69	220	80	310	170	140	220
August	31	1982	0815	54	170	110	170	330	790	170
September	14	1982	1045	84	490	330	490	790	490	790
September	29	1982	1030	21	490	330	460	700	1700	790
October	13	1982	1030	3	170	330	790	230	490	840
October	27	1982	0930	74	260	310	330	790	1300	1700
November	15	1982	1200	126	330	170	110	220	170	70

MAX 16 000
95 % 3500
90th % 1700
75 " 790
50 " 330

APPENDIX 3 - PARAMETER TRENDS

Figure 4 Comparison of Surface Fraser River Water Temperature, September 1981 to December 1982. (0300124 ——, 0300005 .——., 0300125 --———--)

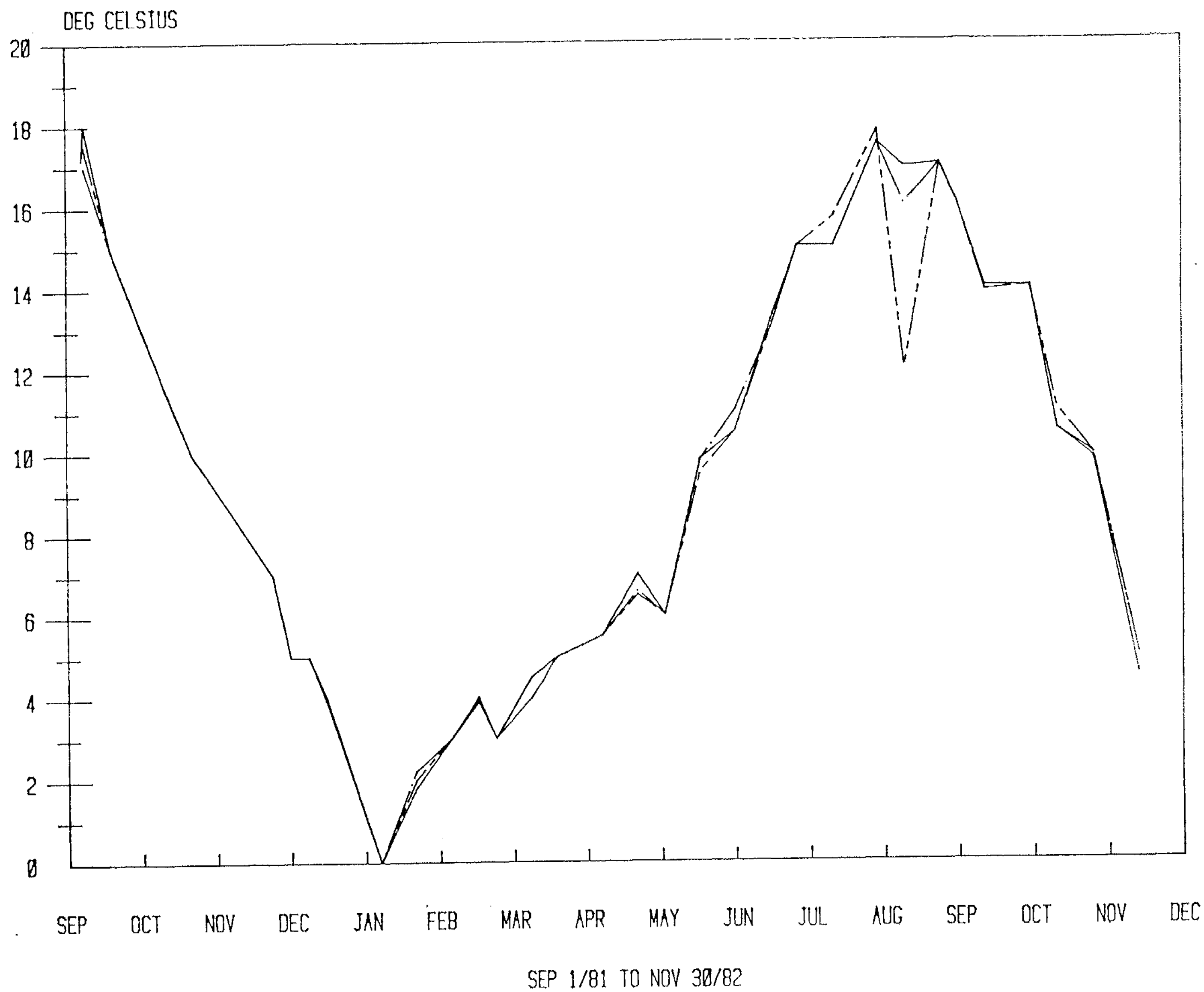


Figure 5 Comparison of Fraser River Water Temperatures at Depth, September 1981 to December 1982 (0300124 ——, 0300005 .——., 0300125 --——--)

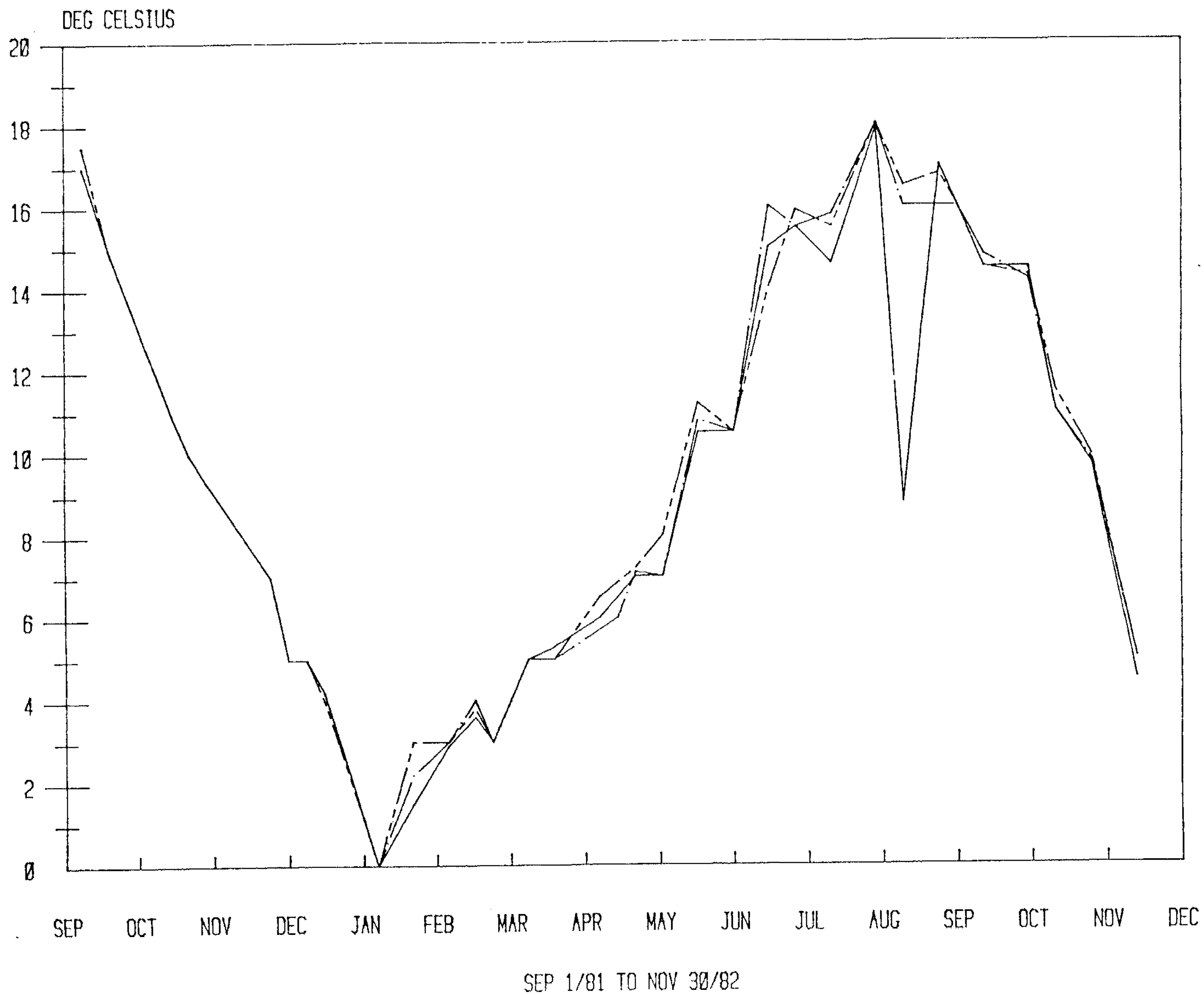


Figure 6 Surface and Depth Comparison of Fraser River Water Temperatures at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ——, 9.m – – – –)

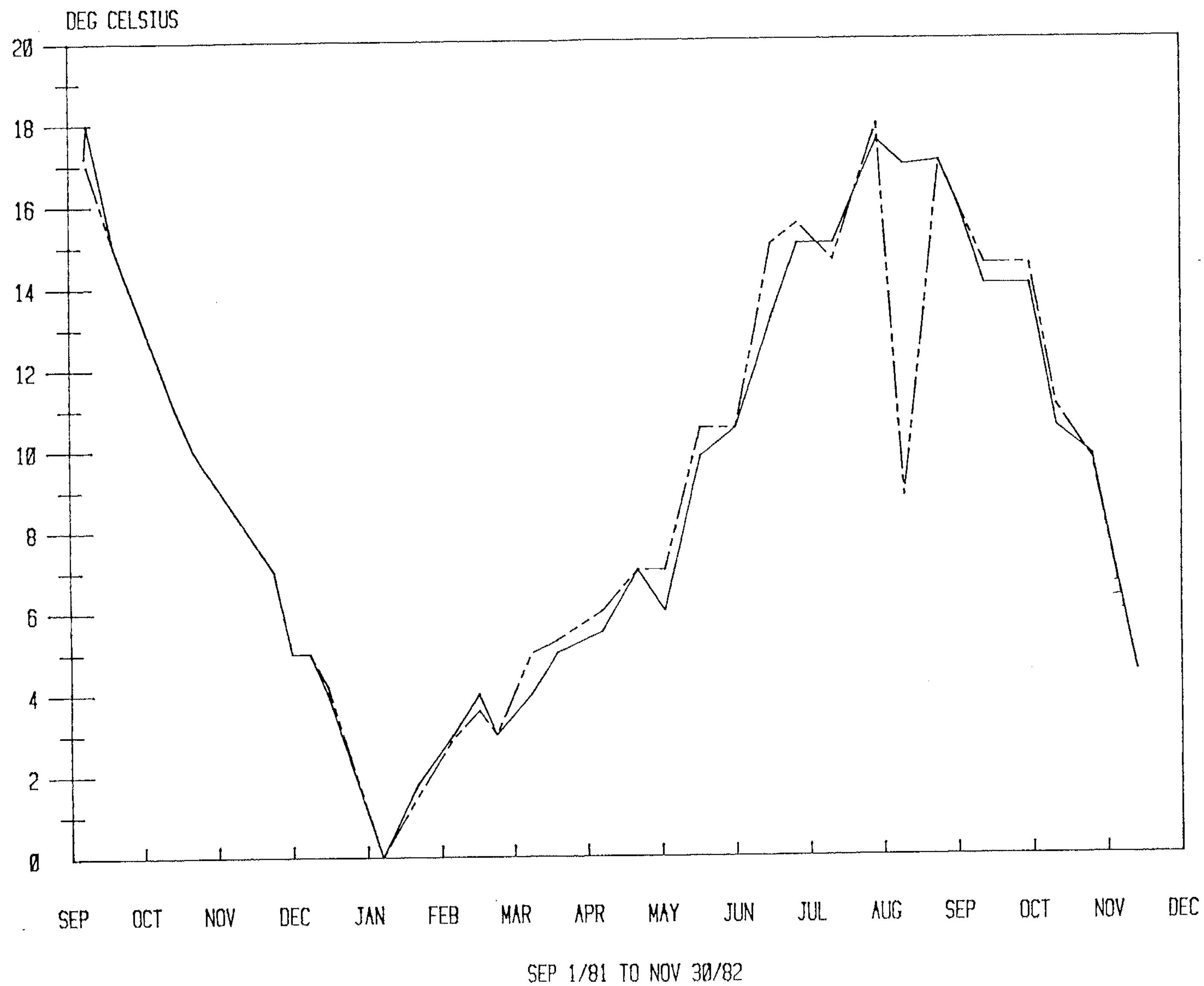


Figure 7 Surface and Depth Comparison of Fraser River Water Temperatures at the Mid-River Sampling Location September 1981 to December 1982 (0300005; 0.m ——, 7.m --------)

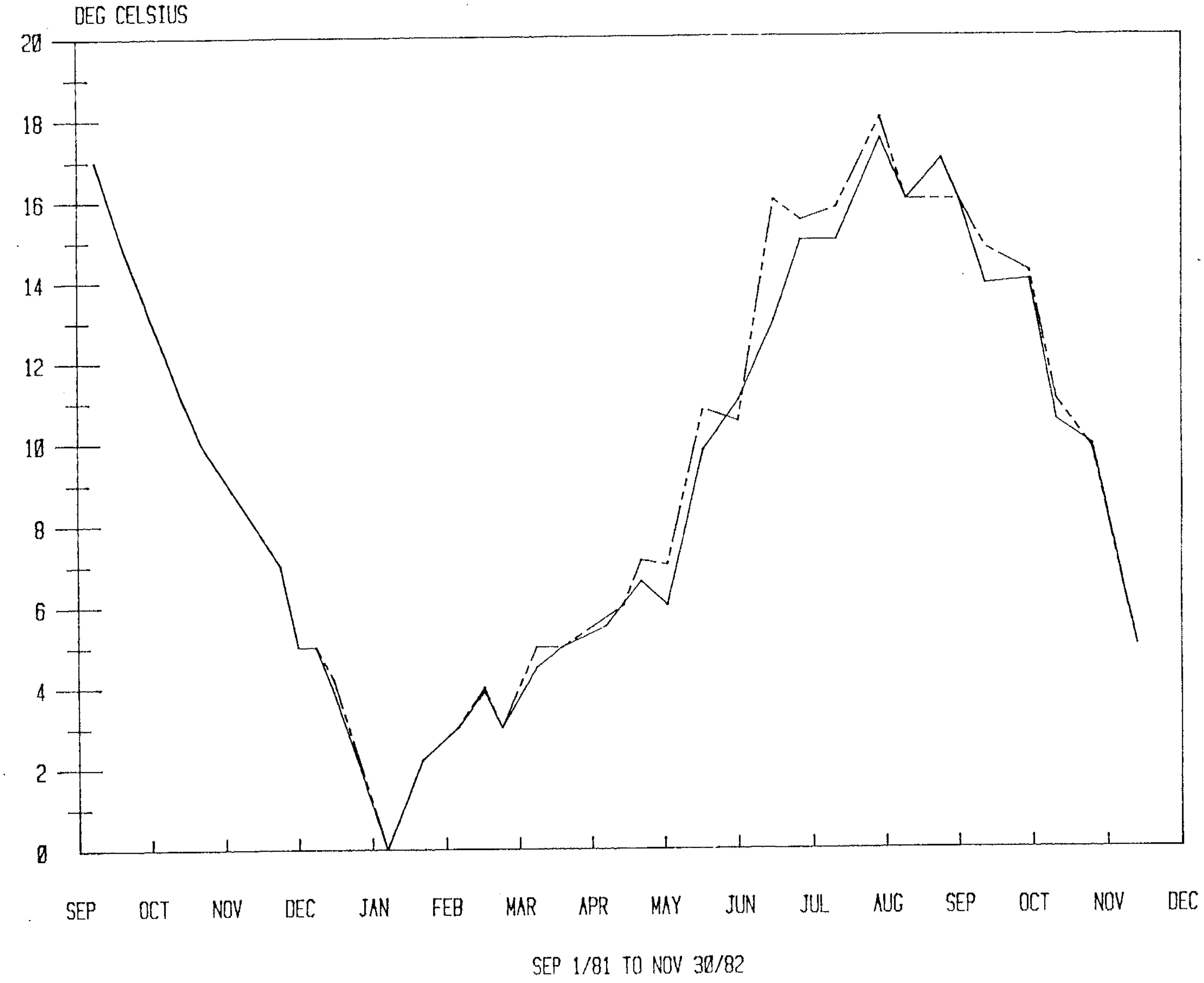


Figure 8 Surface and Depth Comparison of Fraser River Water Temperature at the South Sampling Location September 1981 to December 1982 (0300125; 0.m ———, 7.m -- -- -- --)

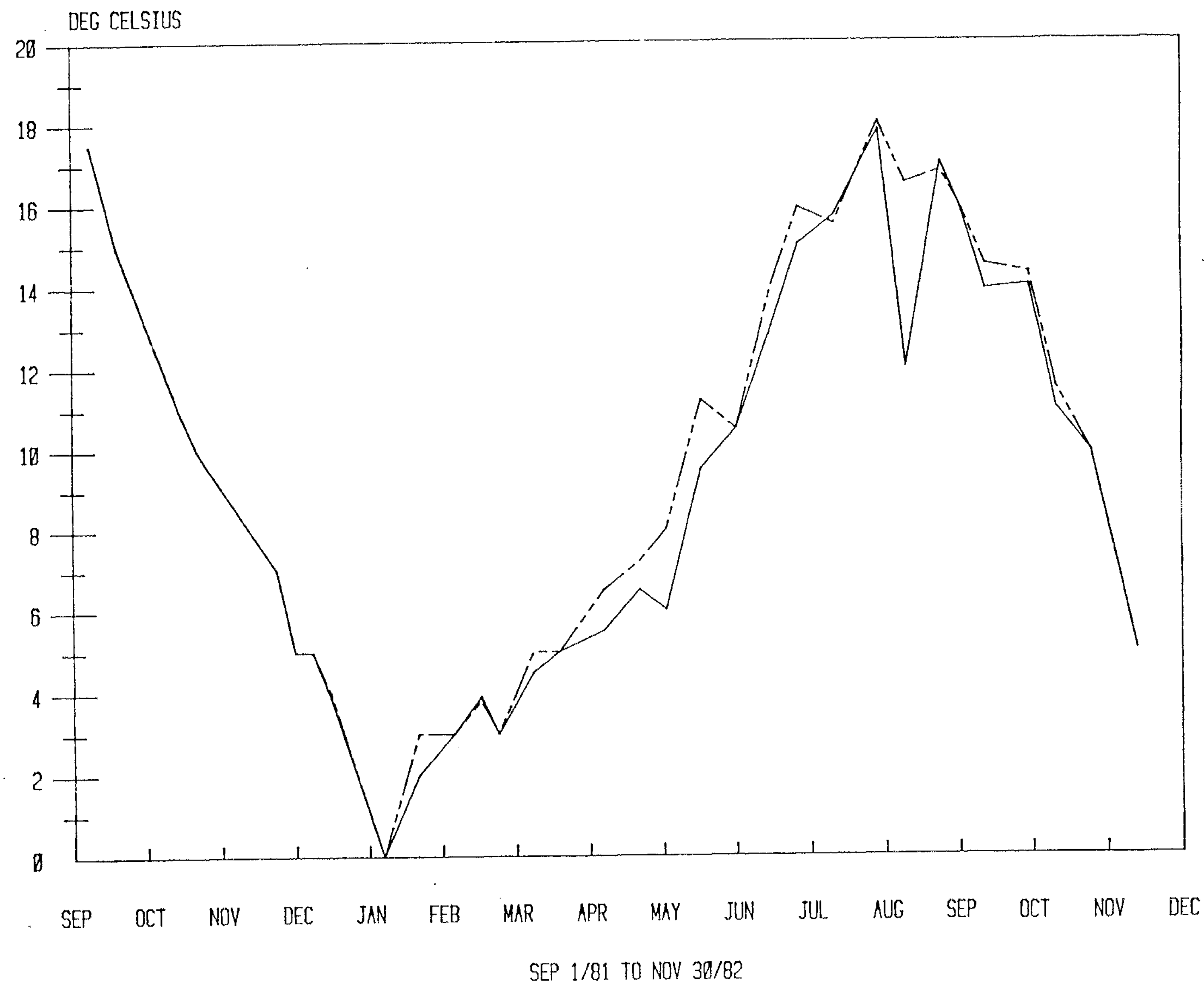


Figure 9 Comparison of Surface Fraser River Dissolved Oxygen Levels, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

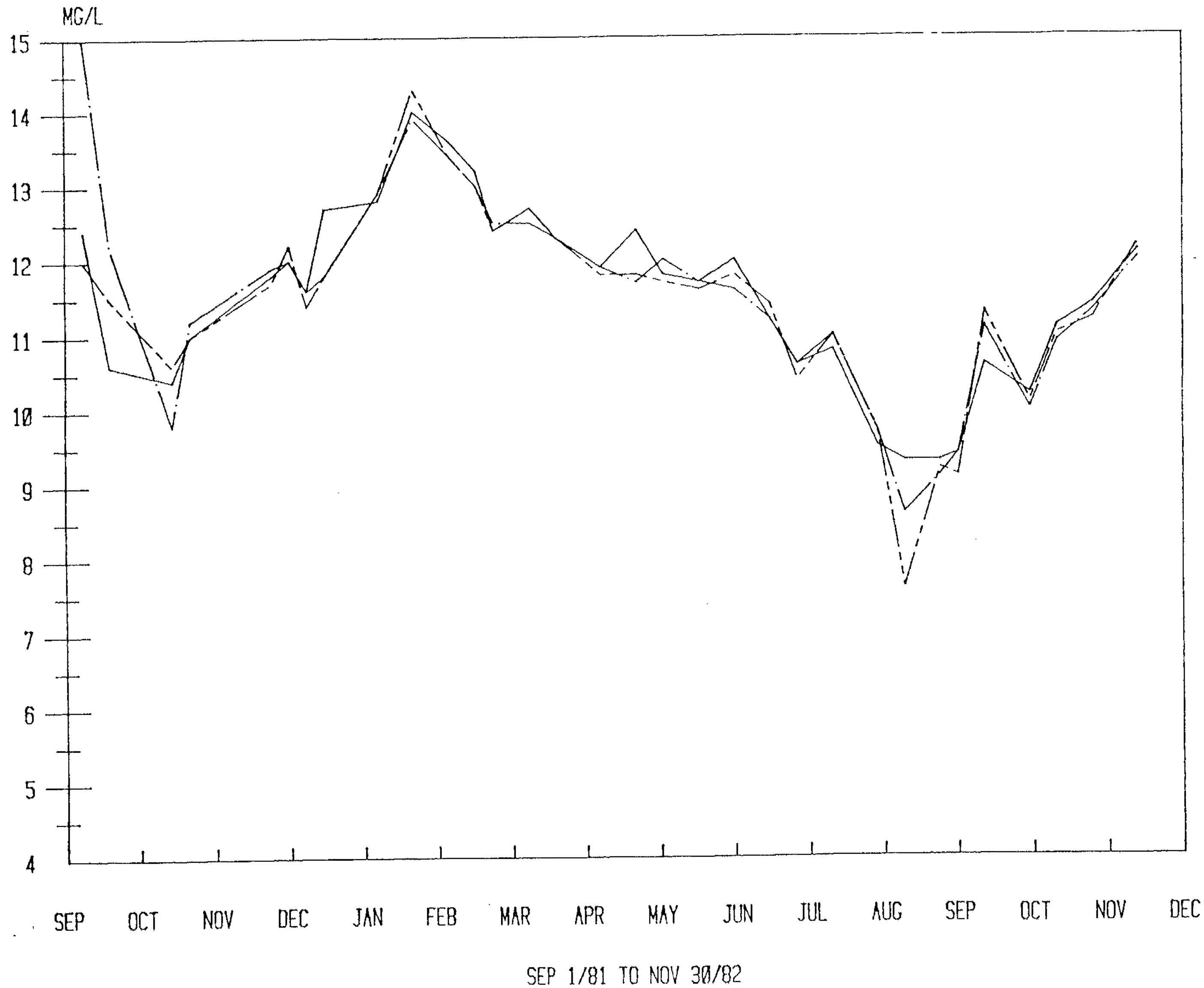


Figure 10 Comparison of Fraser River Dissolved Oxygen Levels at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300005 -- ——— --)

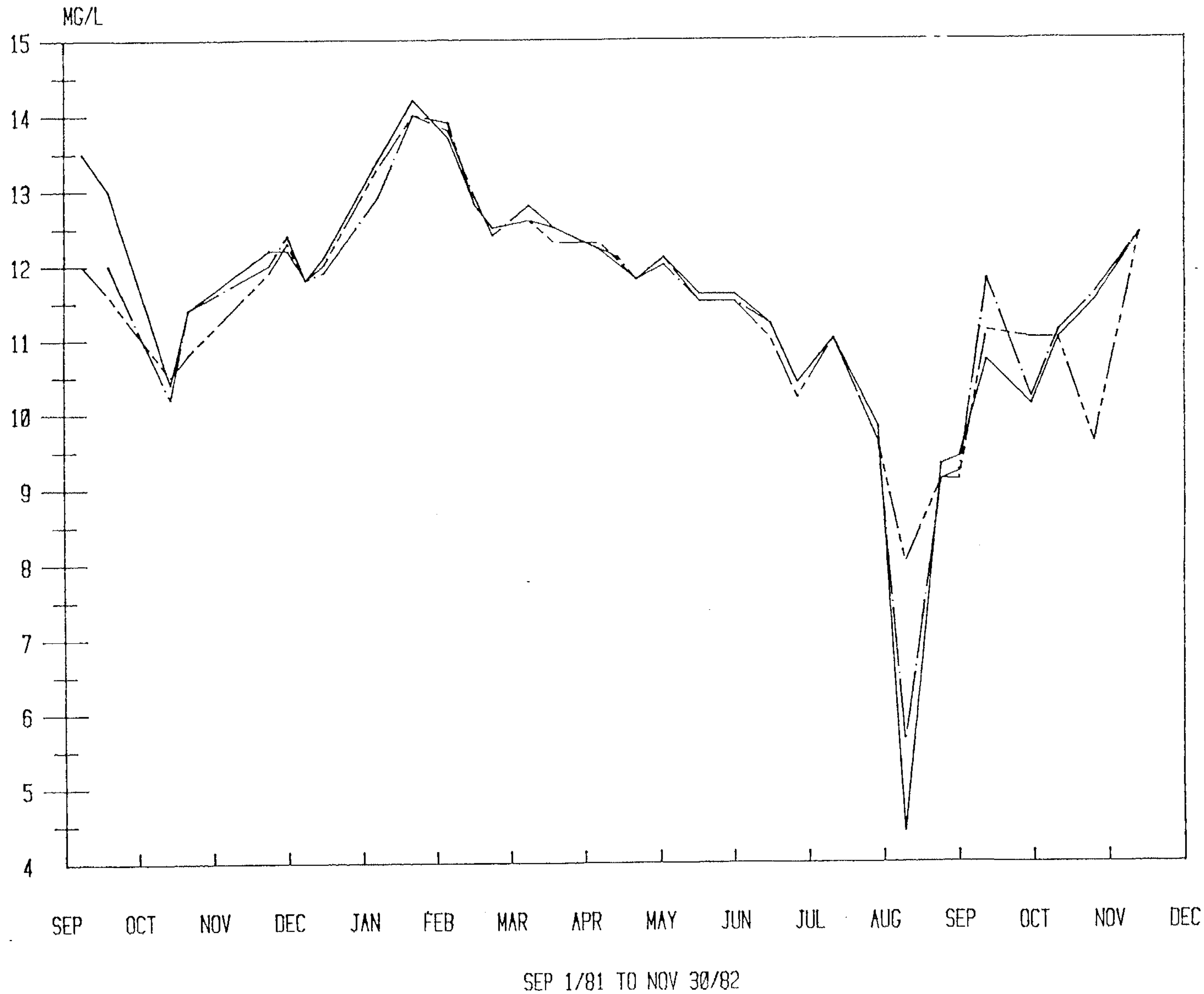


Figure 11 Surface and Depth Comparison of Fraser River Dissolved Oxygen Levels at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

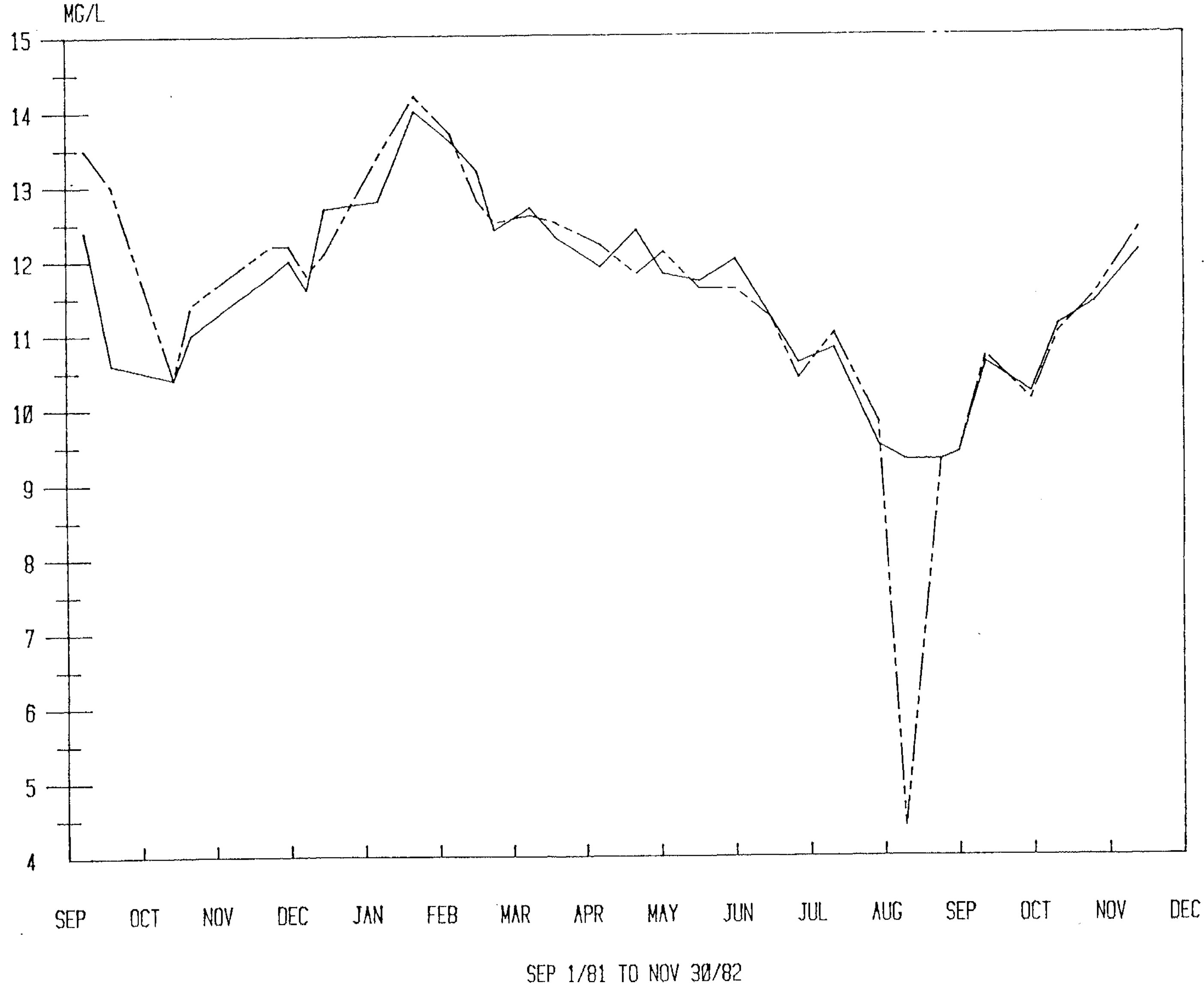


Figure 12 Surface and Depth Comparison of Fraser River Dissolved Oxygen Levels at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

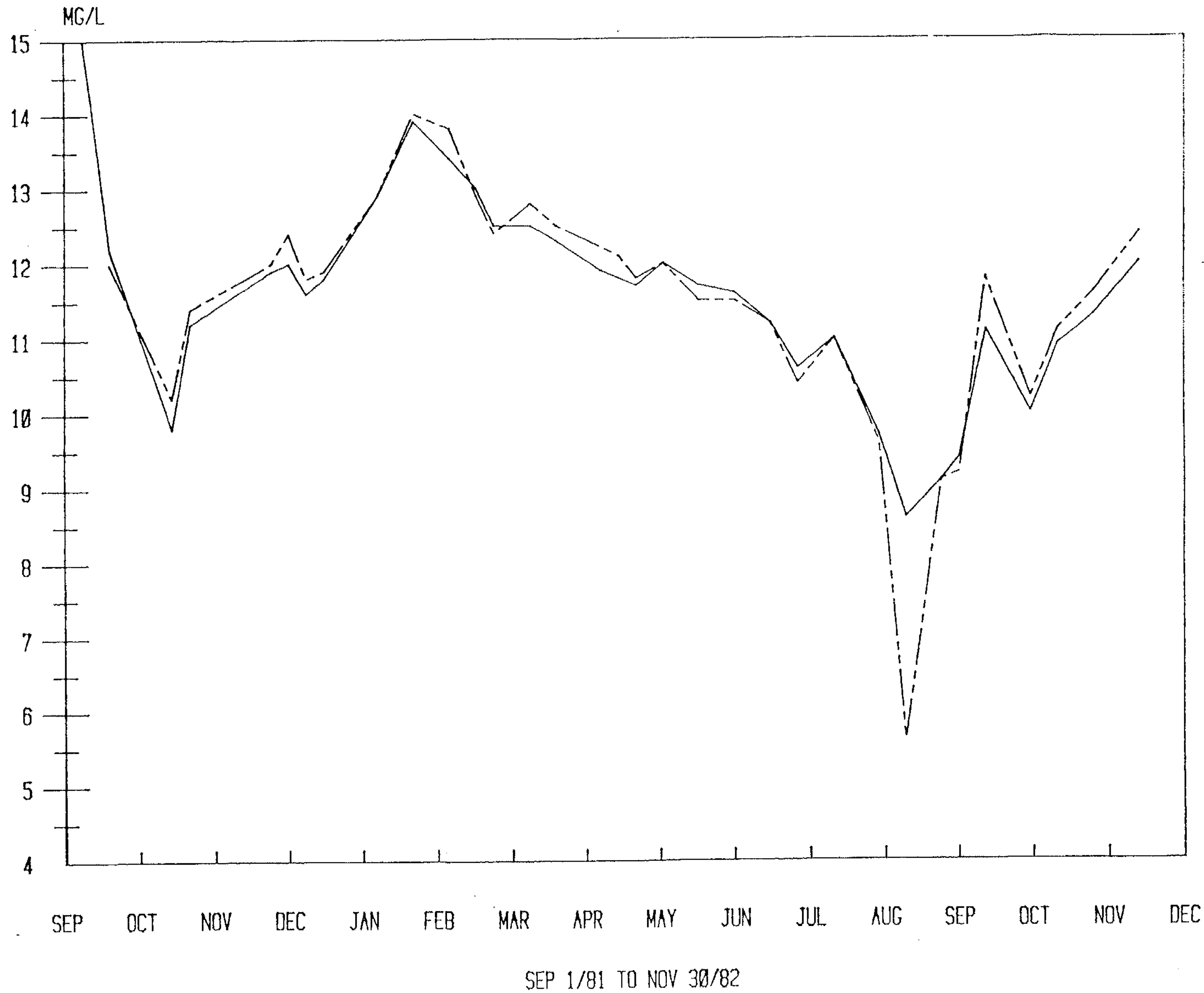


Figure 13 Surface and Depth Comparison of Fraser River Dissolved Oxygen Levels at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

Figure 14 Comparison of Surface Fraser River pH, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

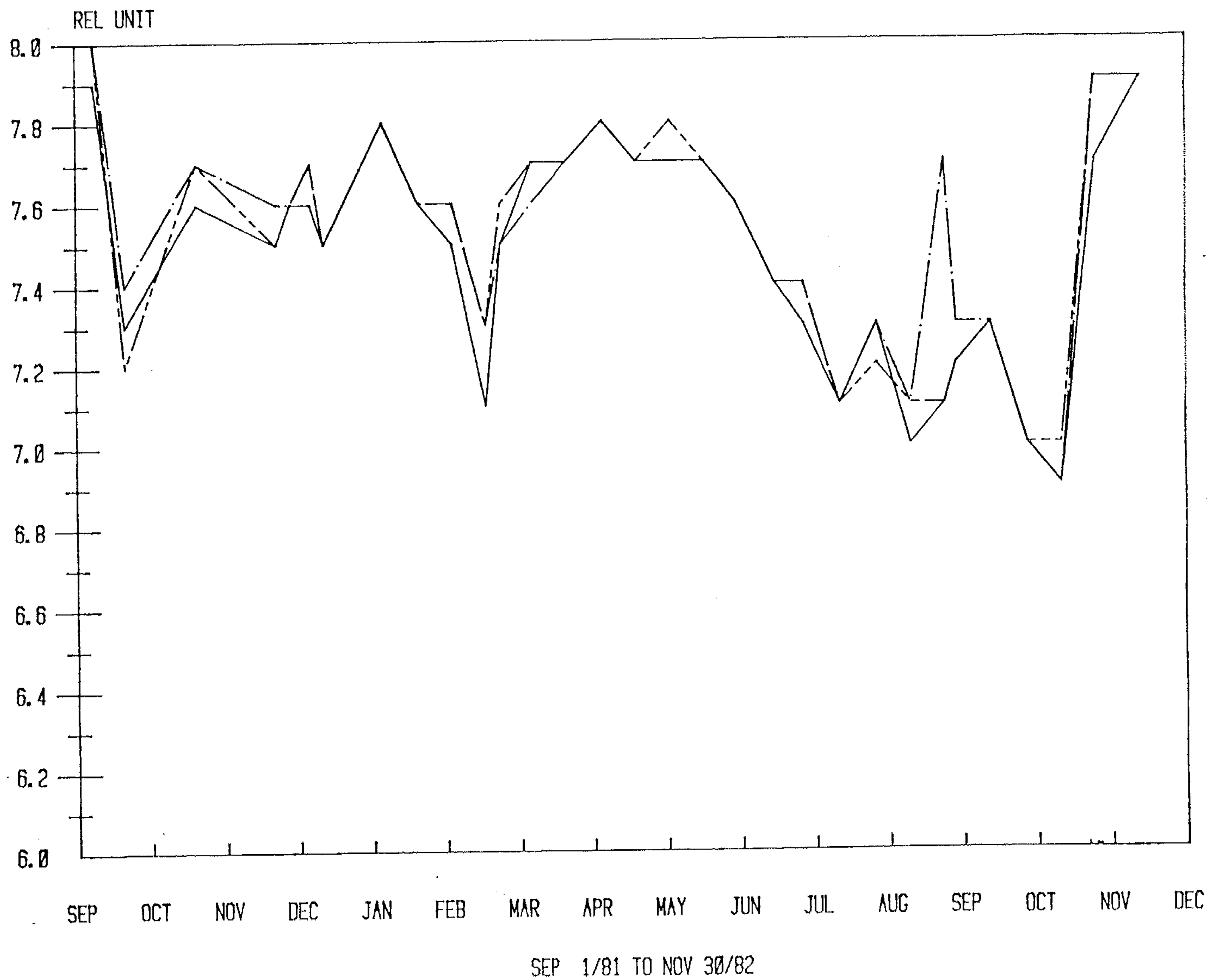


Figure 15 Comparison of Fraser River pH at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 --———--)

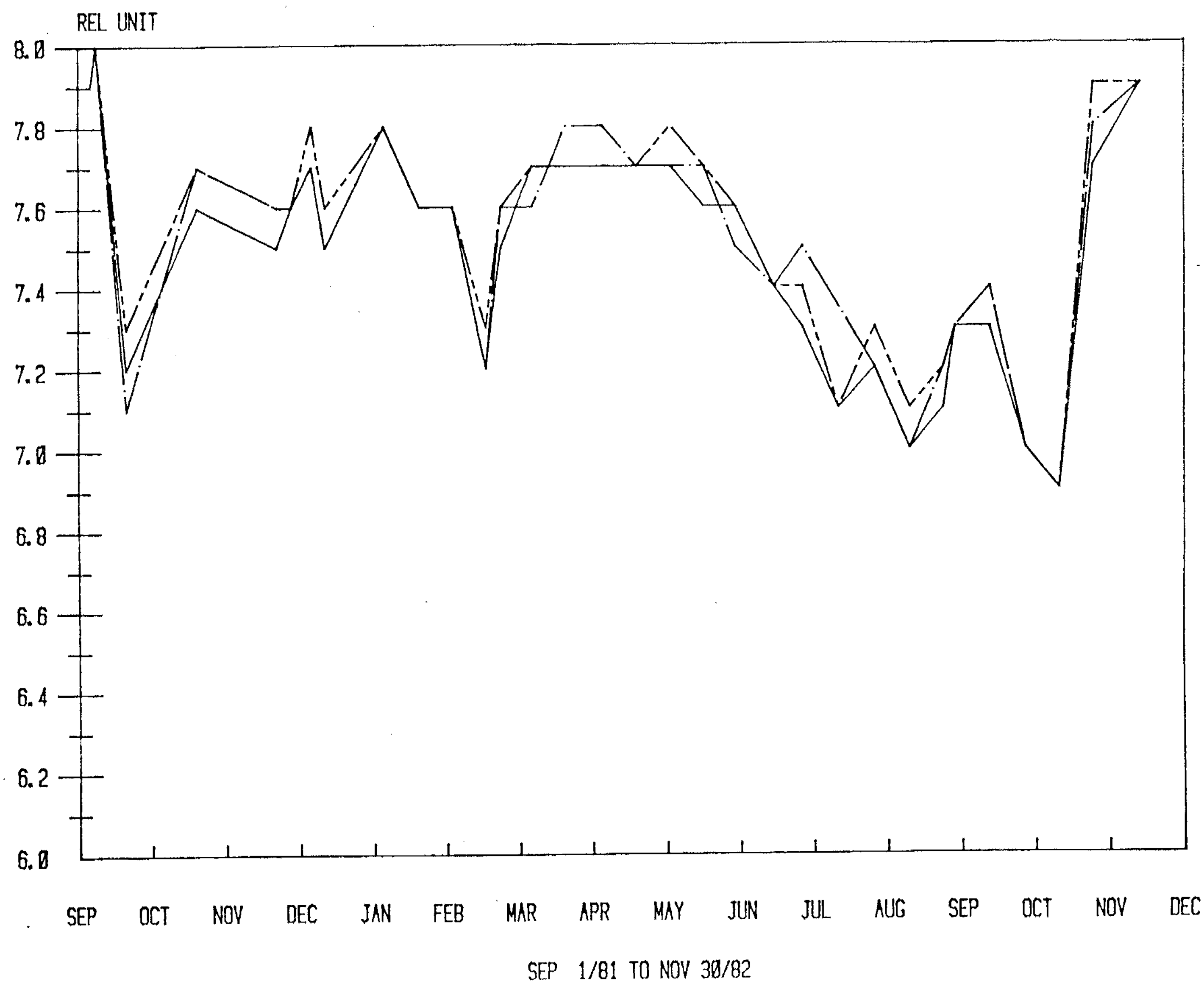


Figure 16 Surface and Depth Comparison of Fraser River pH at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

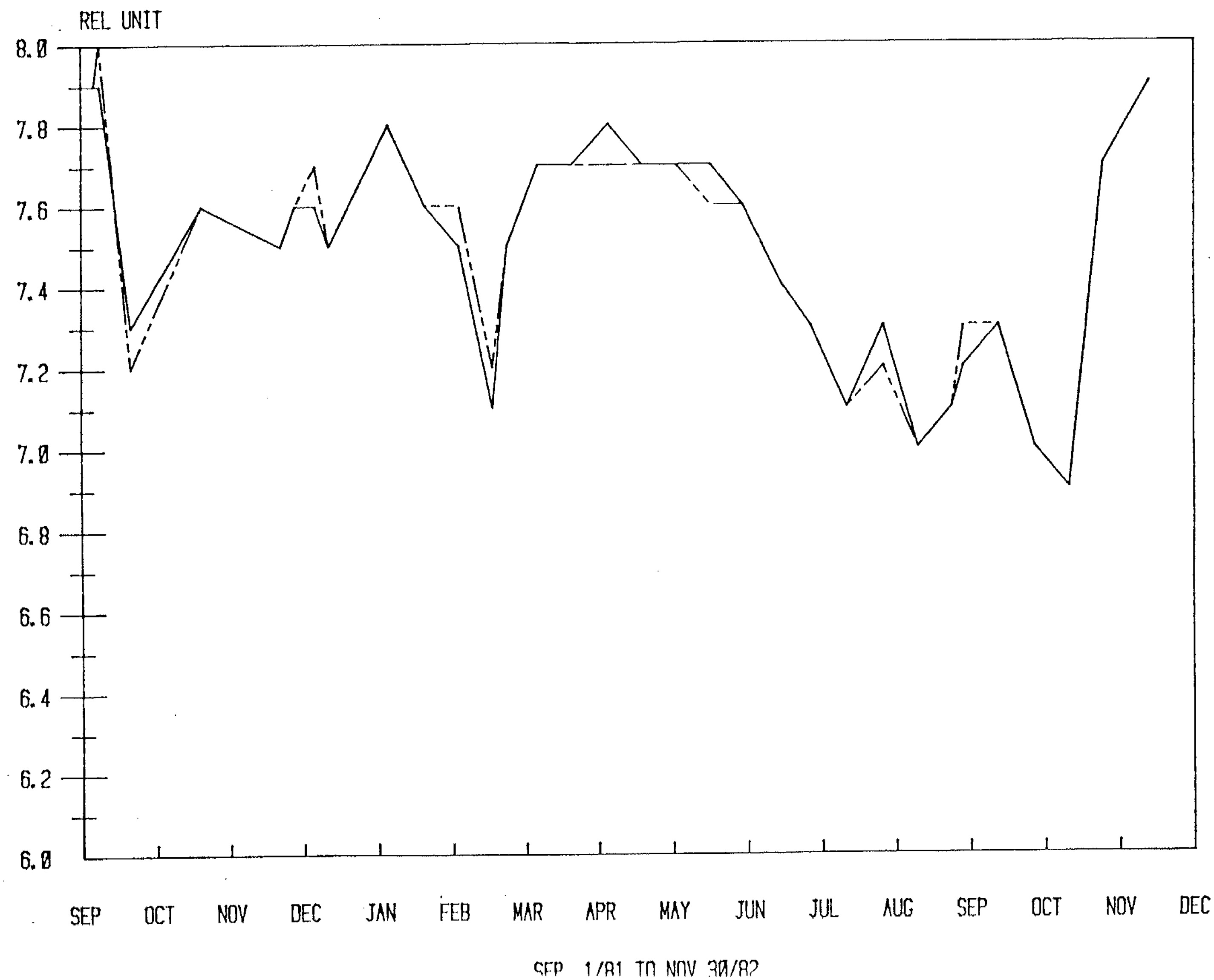


Figure 17 Surface and Depth Comparison of Fraser River pH at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

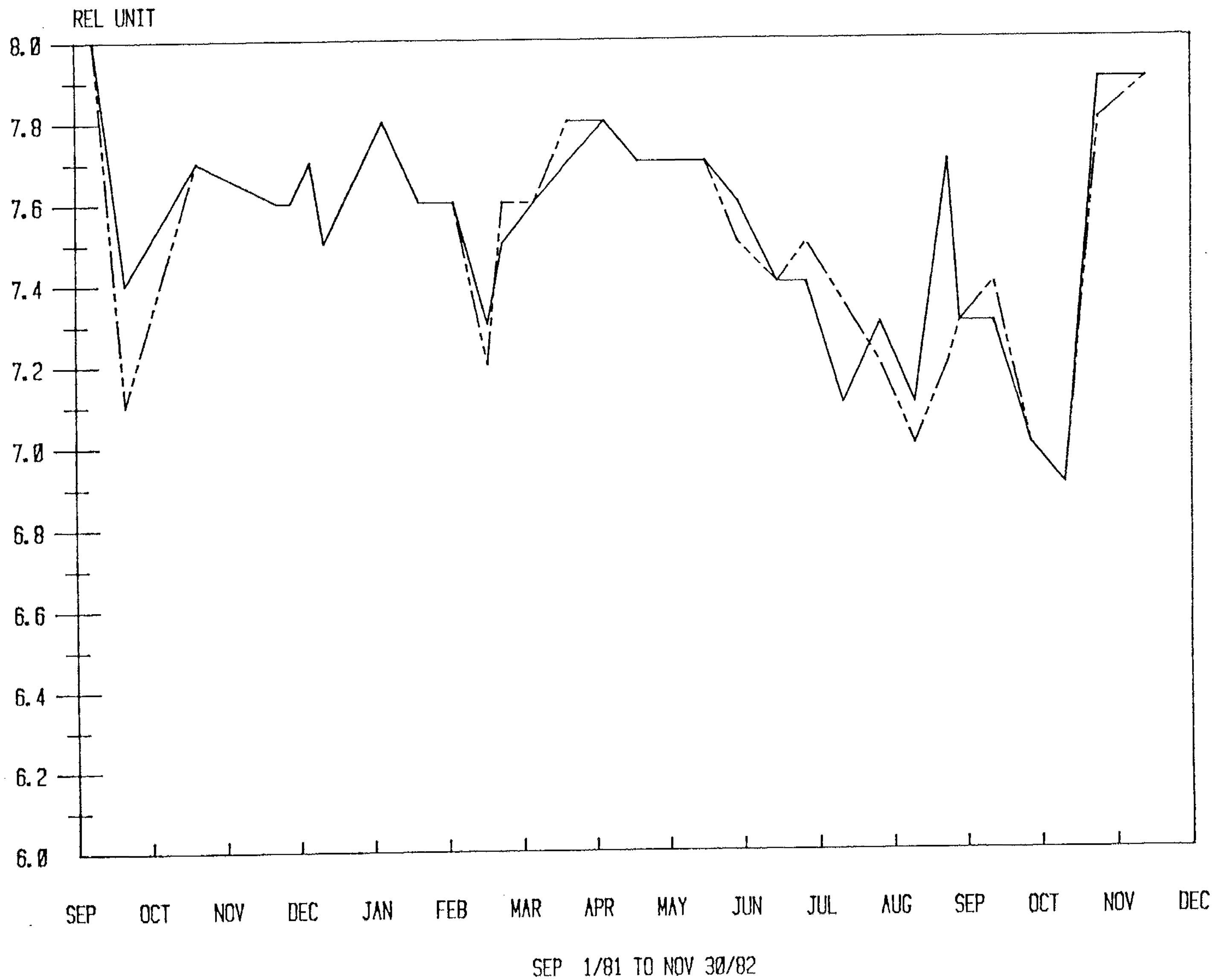


Figure 18 Surface and Depth Comparison of Fraser River pH at the South Sampling Location, September 1981 to December 1982 (0300125; 7.m -- ——— --)

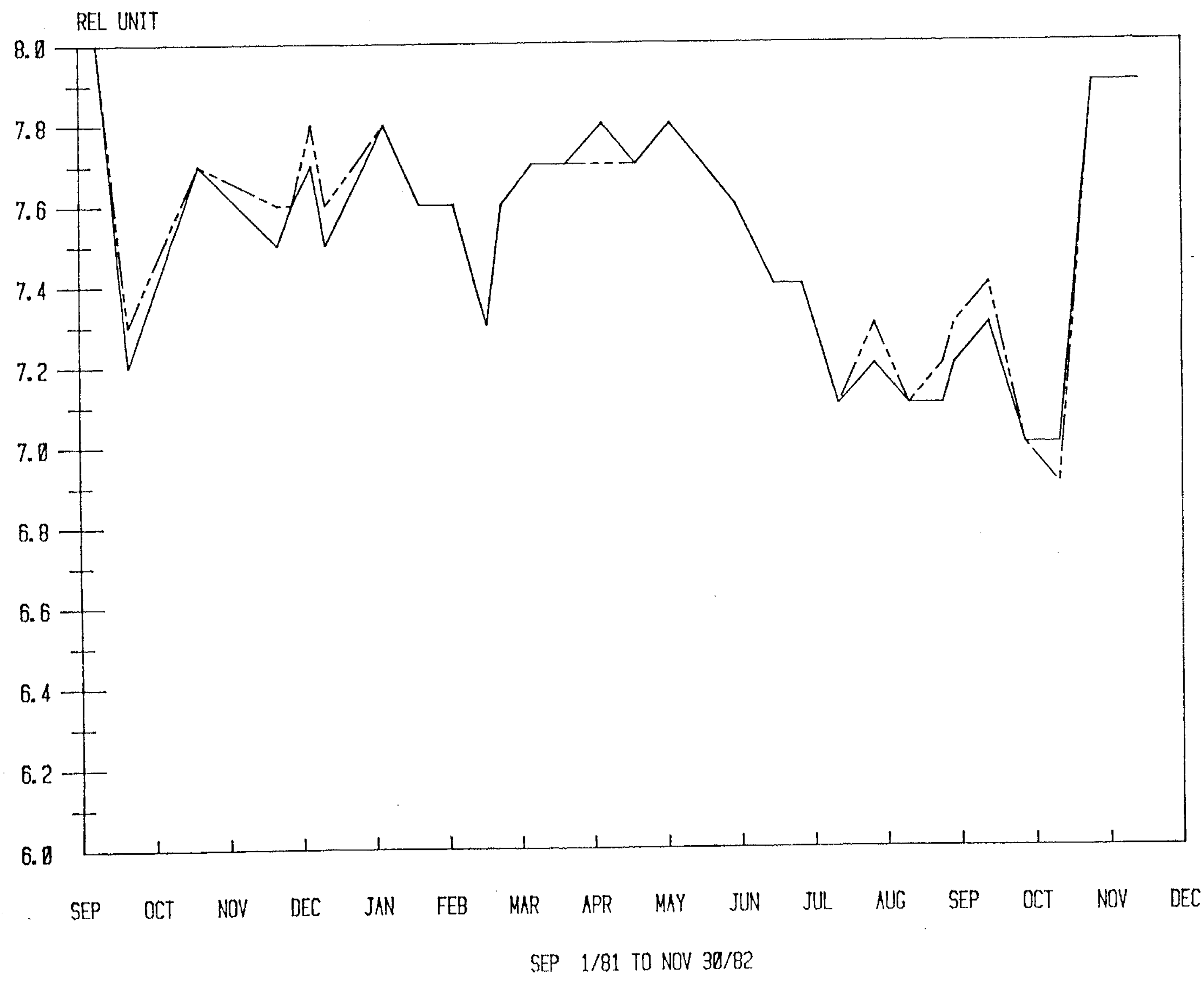


Figure 19 Comparison of Surface Fraser River Specific Conductance (field), September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

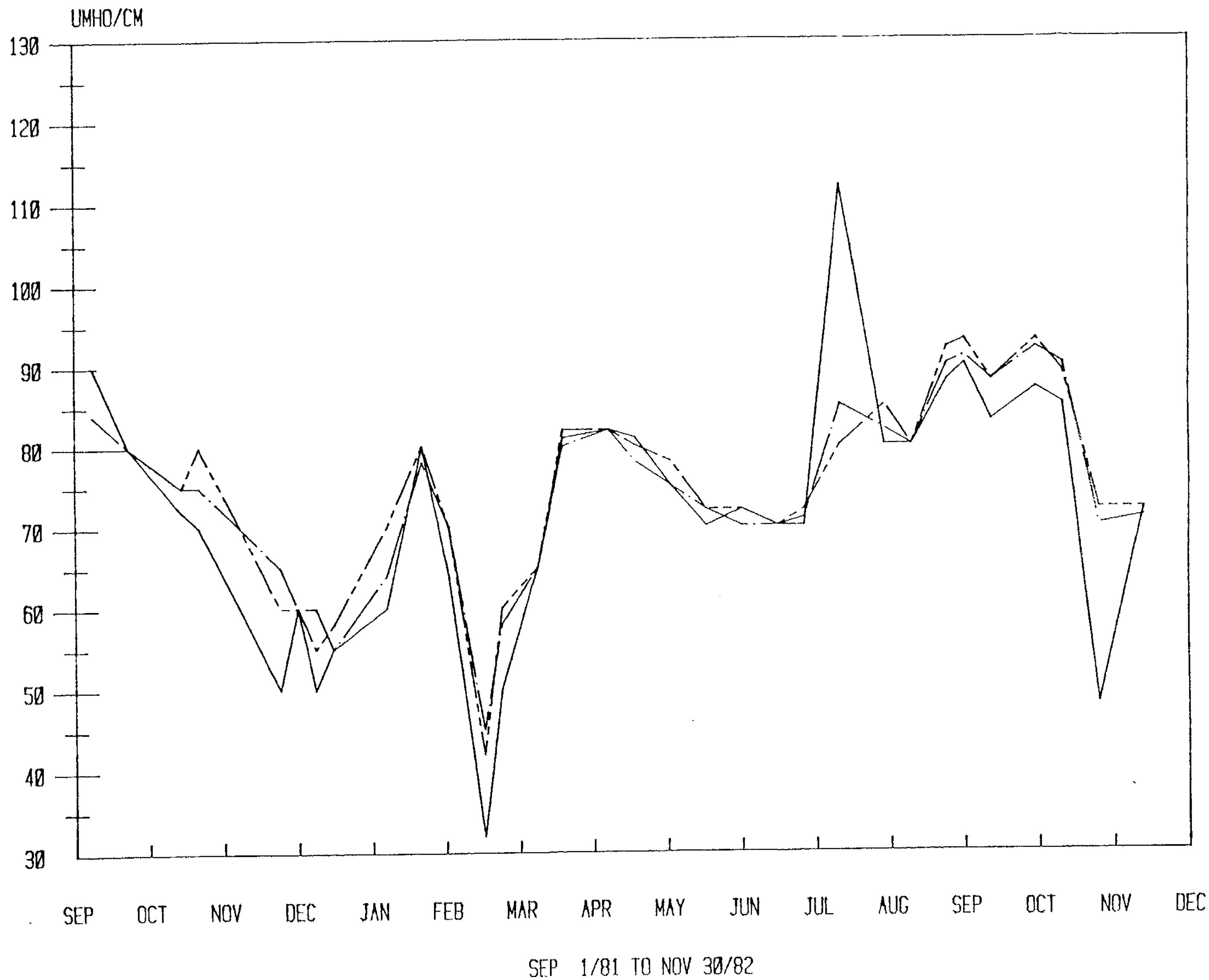


Figure 20 Comparison of Fraser River Specific Conductance (field) at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

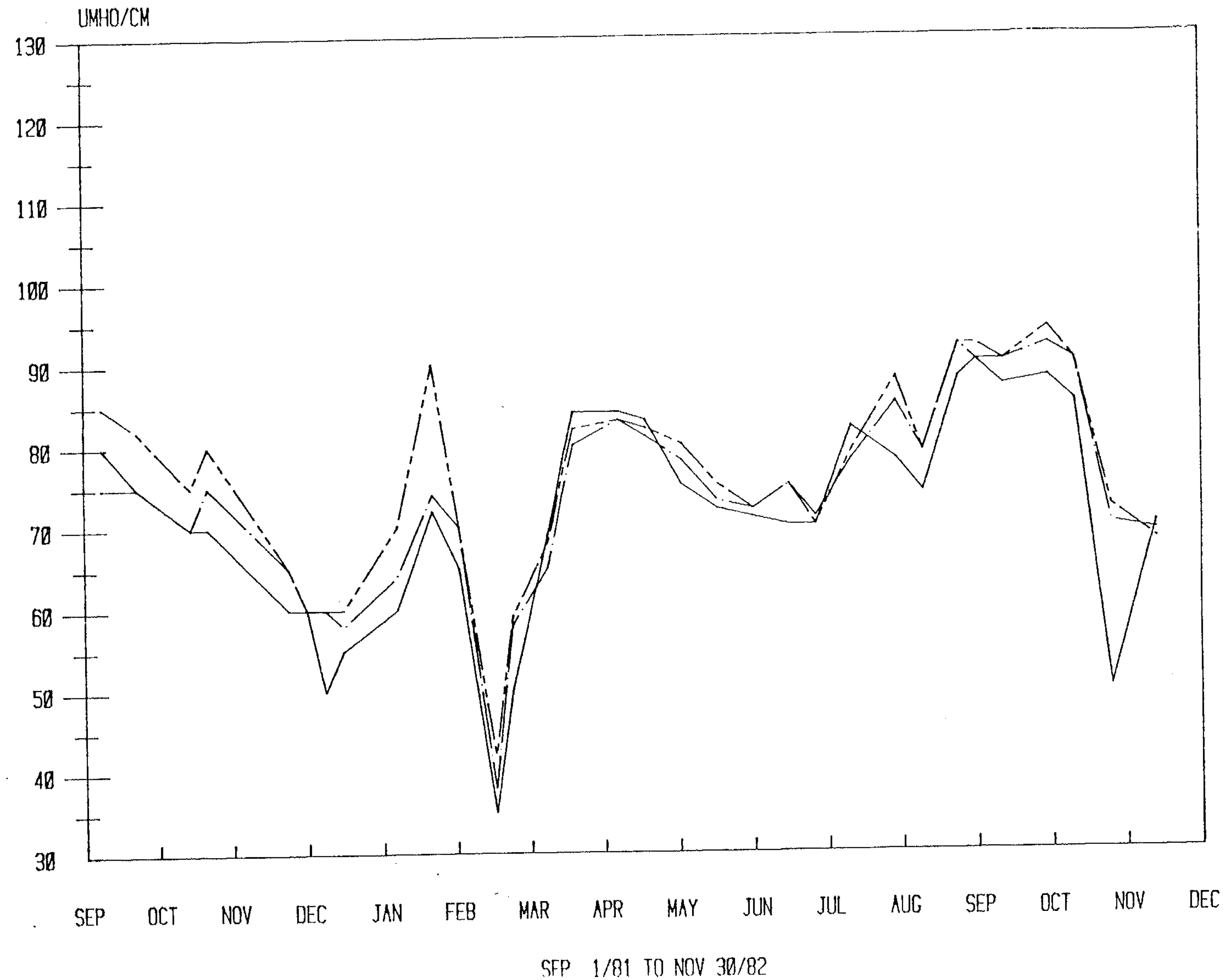


Figure 21 Surface and Depth Comparison of Fraser River Specific Conductance (field) at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

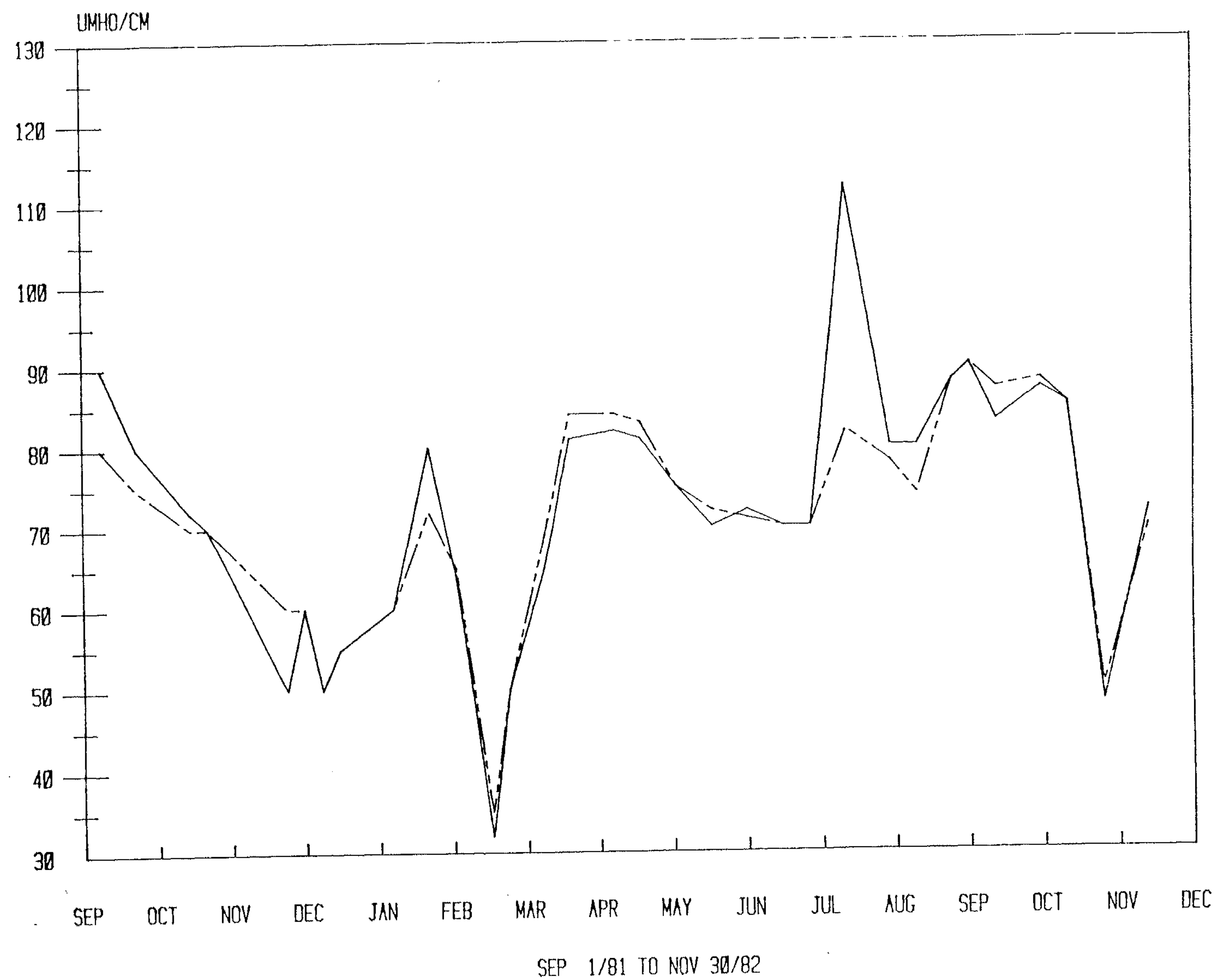


Figure 22 Surface and Depth Comparison of Fraser River Specific Conductance (field) at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ——, 7.m -- —— --)

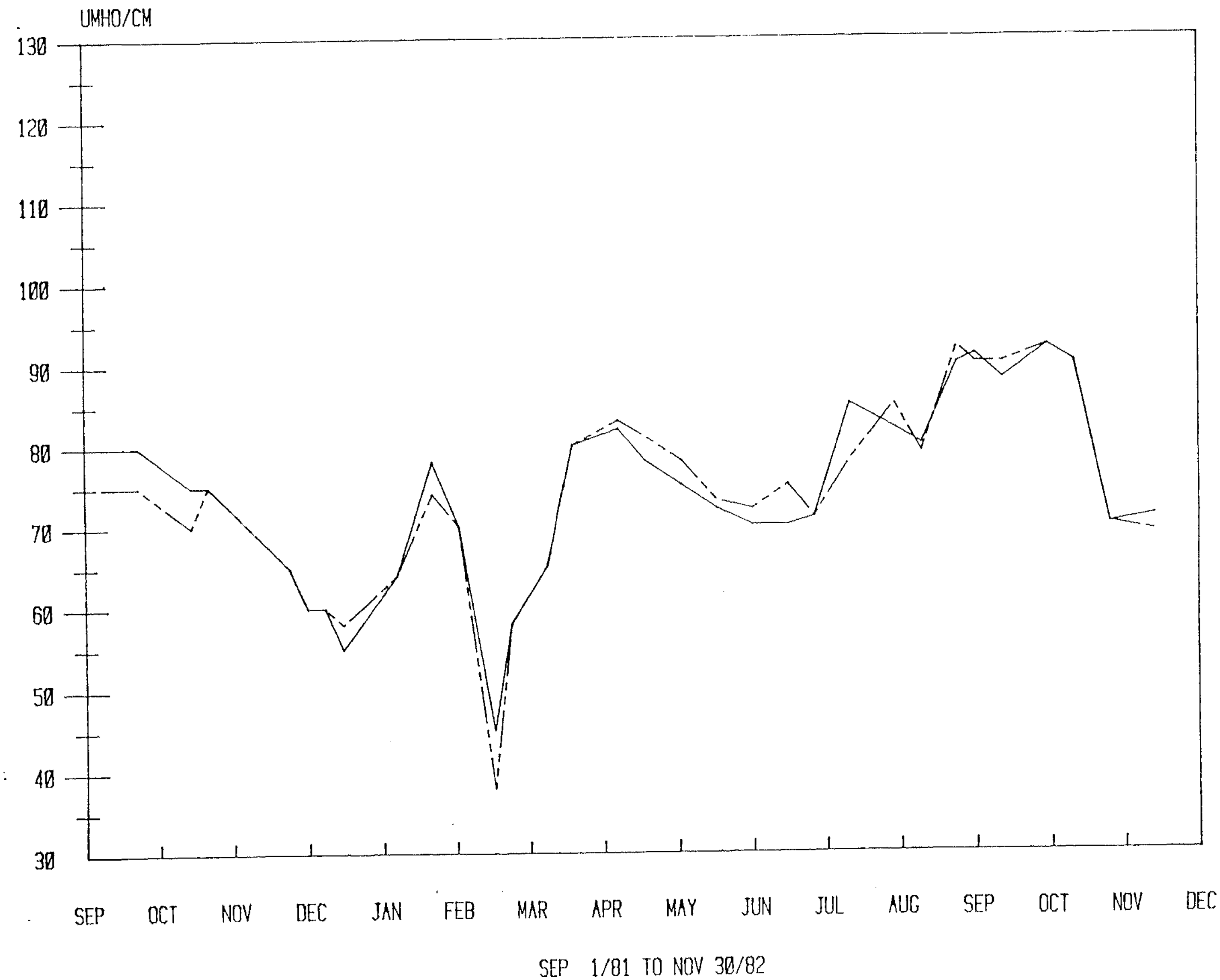


Figure 23 Surface and Depth Comparison of Fraser River Specific Conductance (field) at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

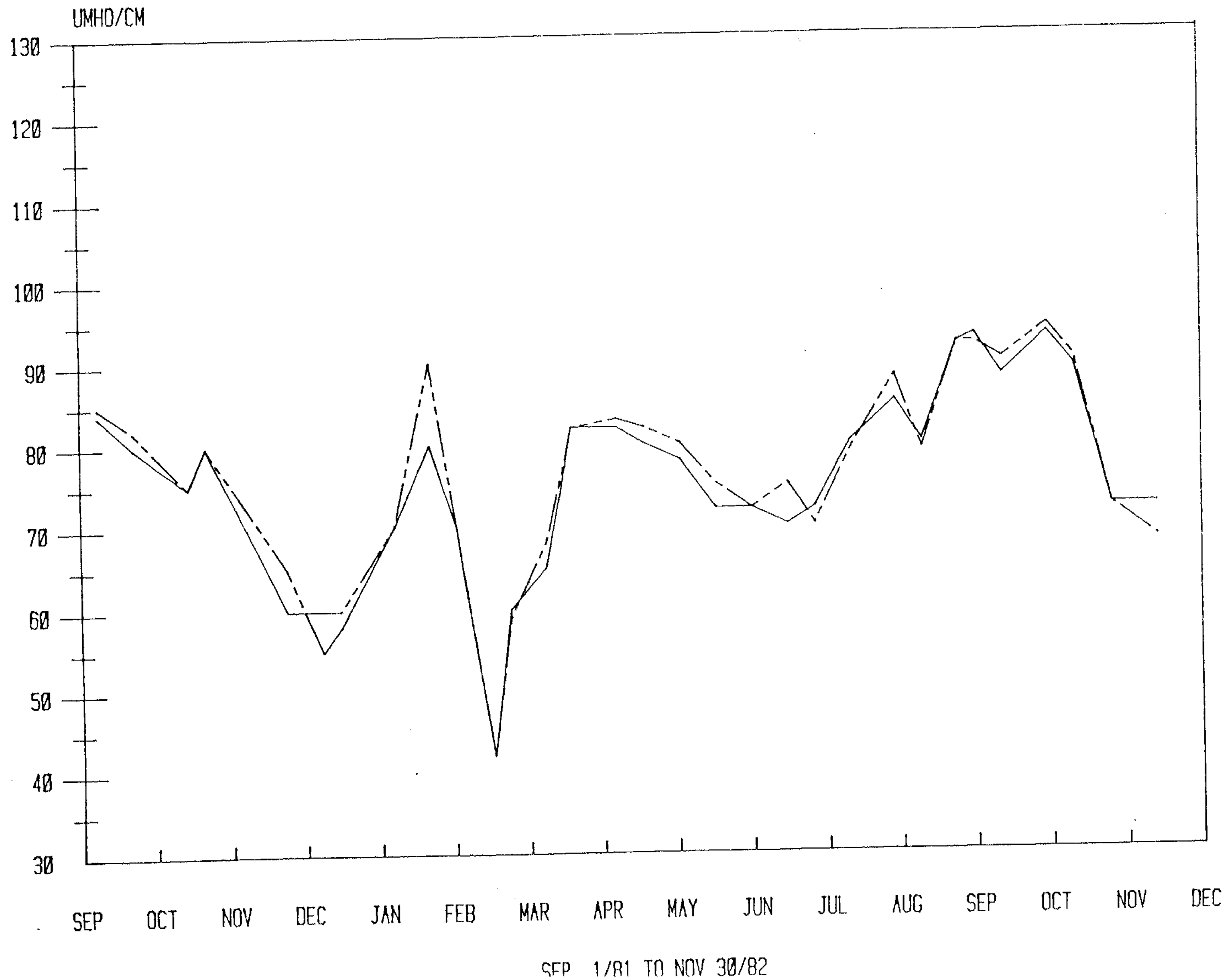


Figure 24 Comparison of Surface Fraser River Specific Conductance (lab) September 1981 to December 1982 (0300124 ———, 0300005 .———.,
0300125 -- ——— --)

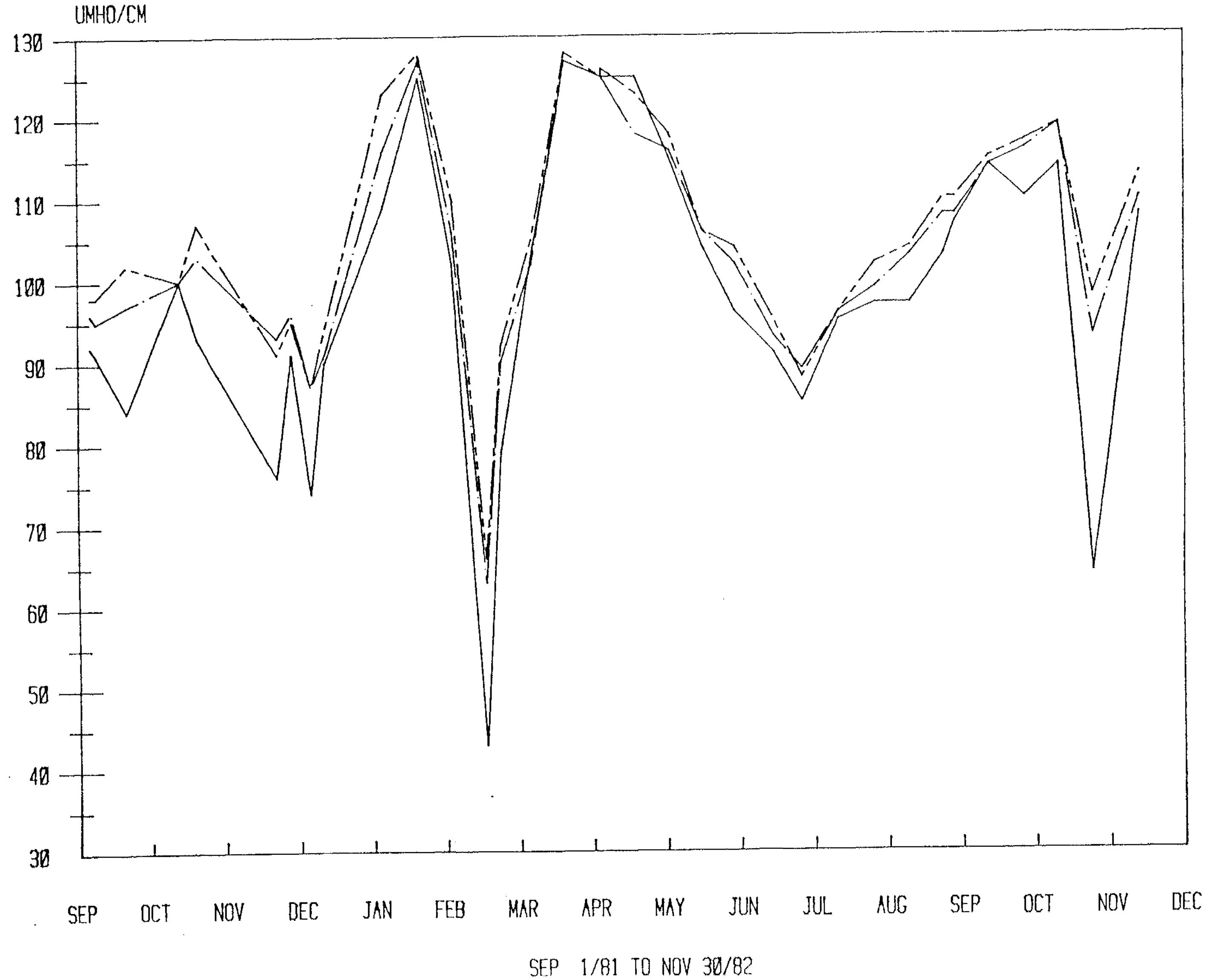


Figure 25 Comparison of Fraser River Specific Conductance (lab) at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 --·——— --)

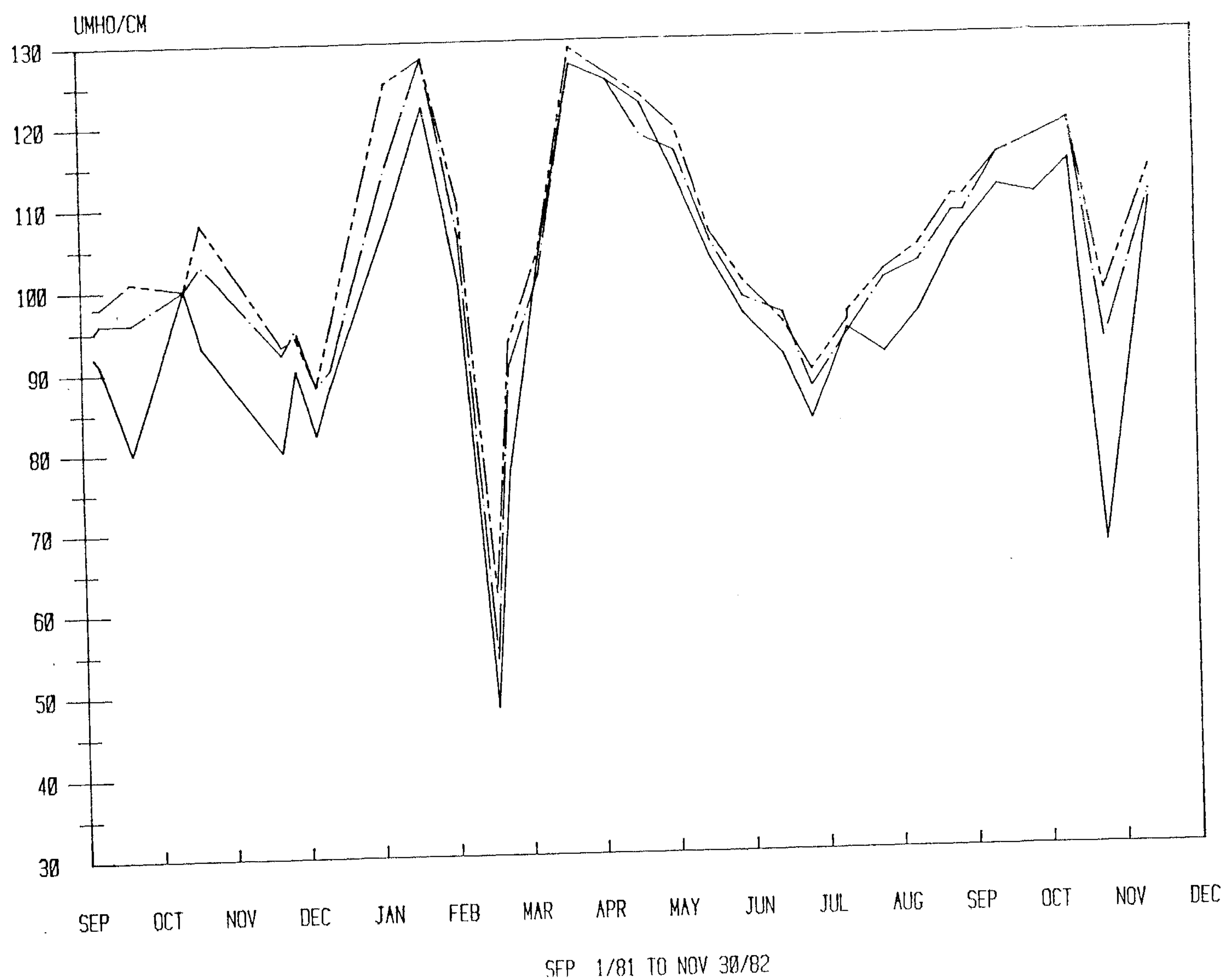


Figure 26 Surface and Depth Comparison of Fraser River Specific Conductance (lab) at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

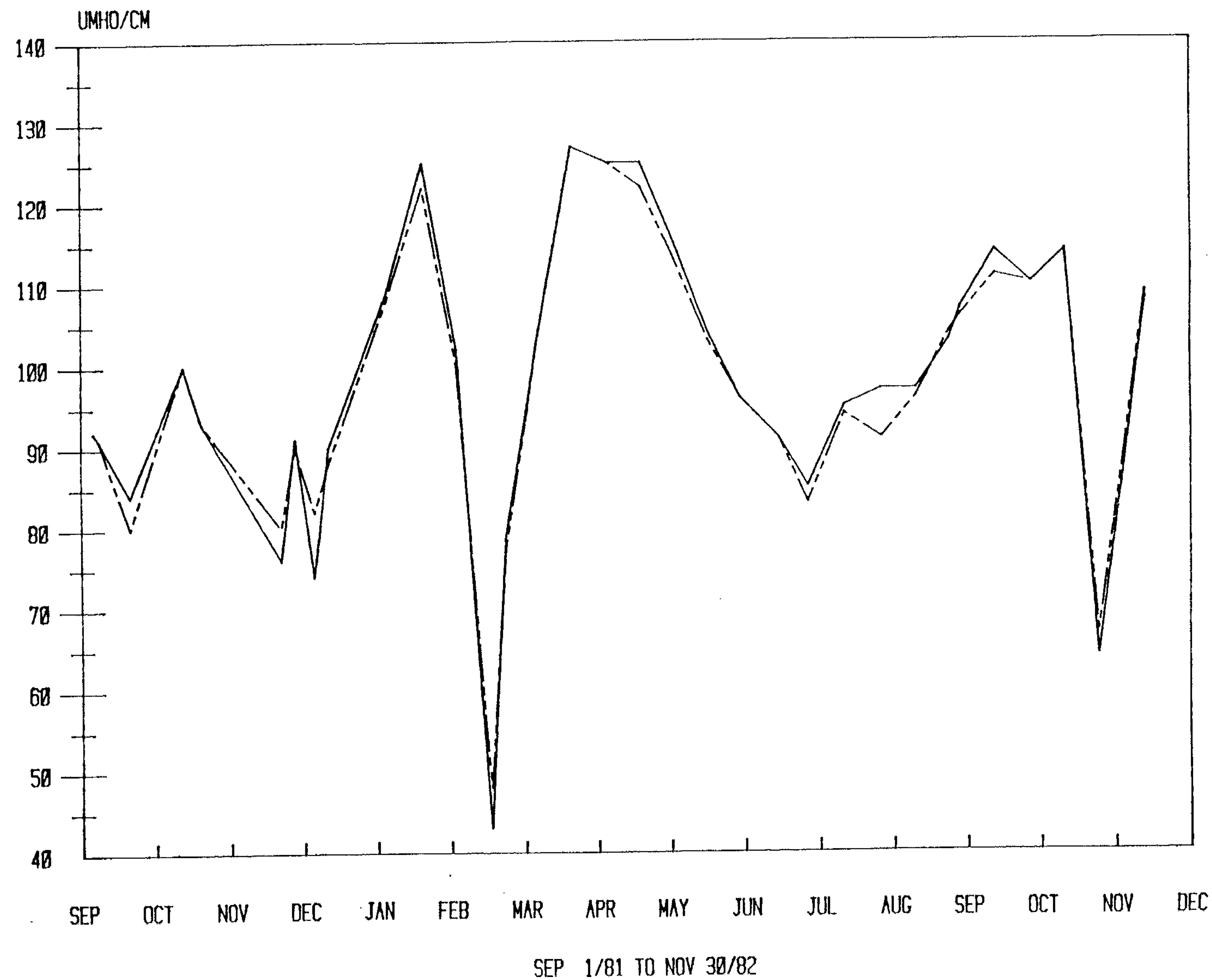


Figure 27 Surface and Depth Comparison of Fraser River Specific Conductance (lab) at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

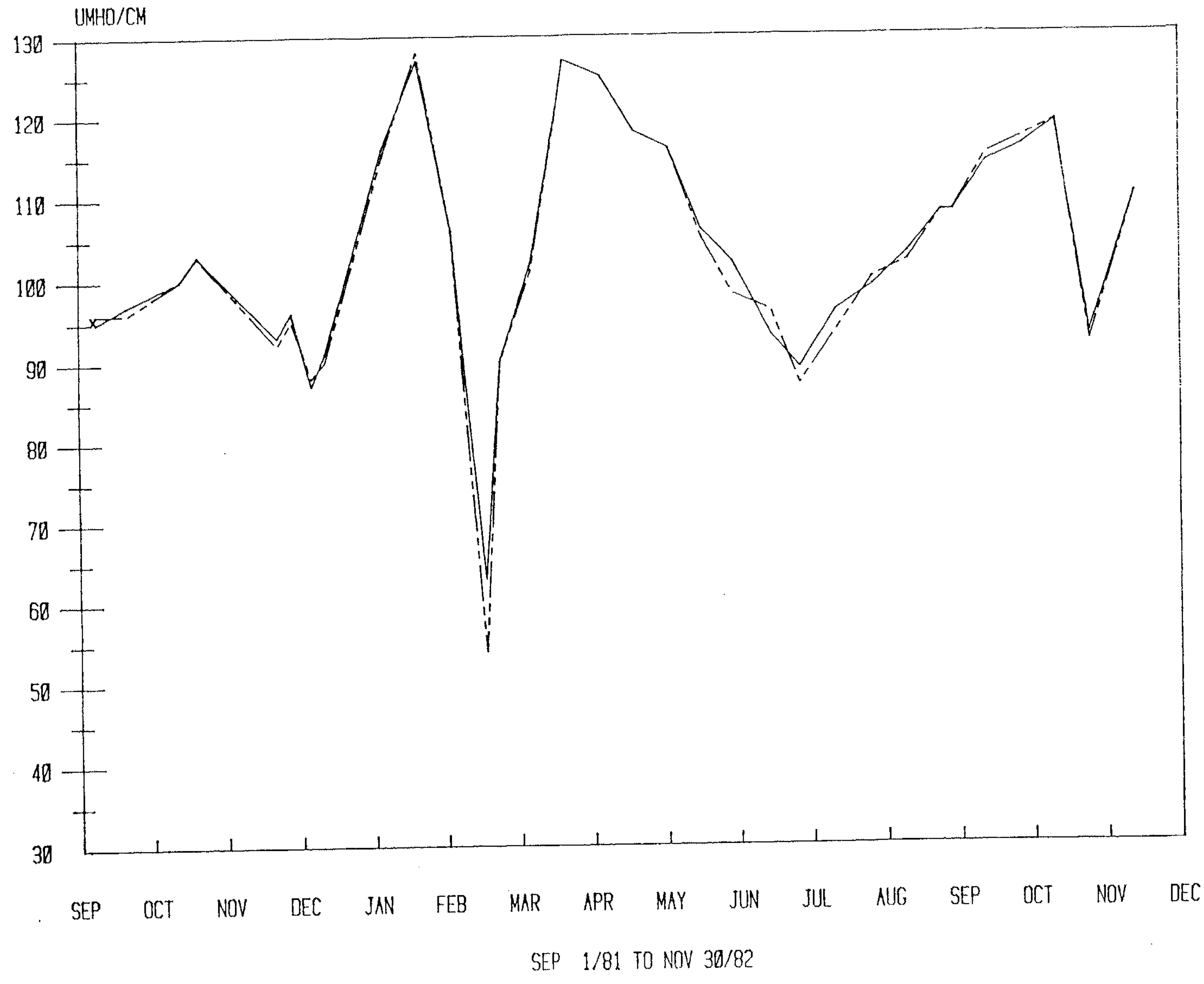


Figure 28 Surface and Depth Comparison of Fraser River Specific Conductance (lab) at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

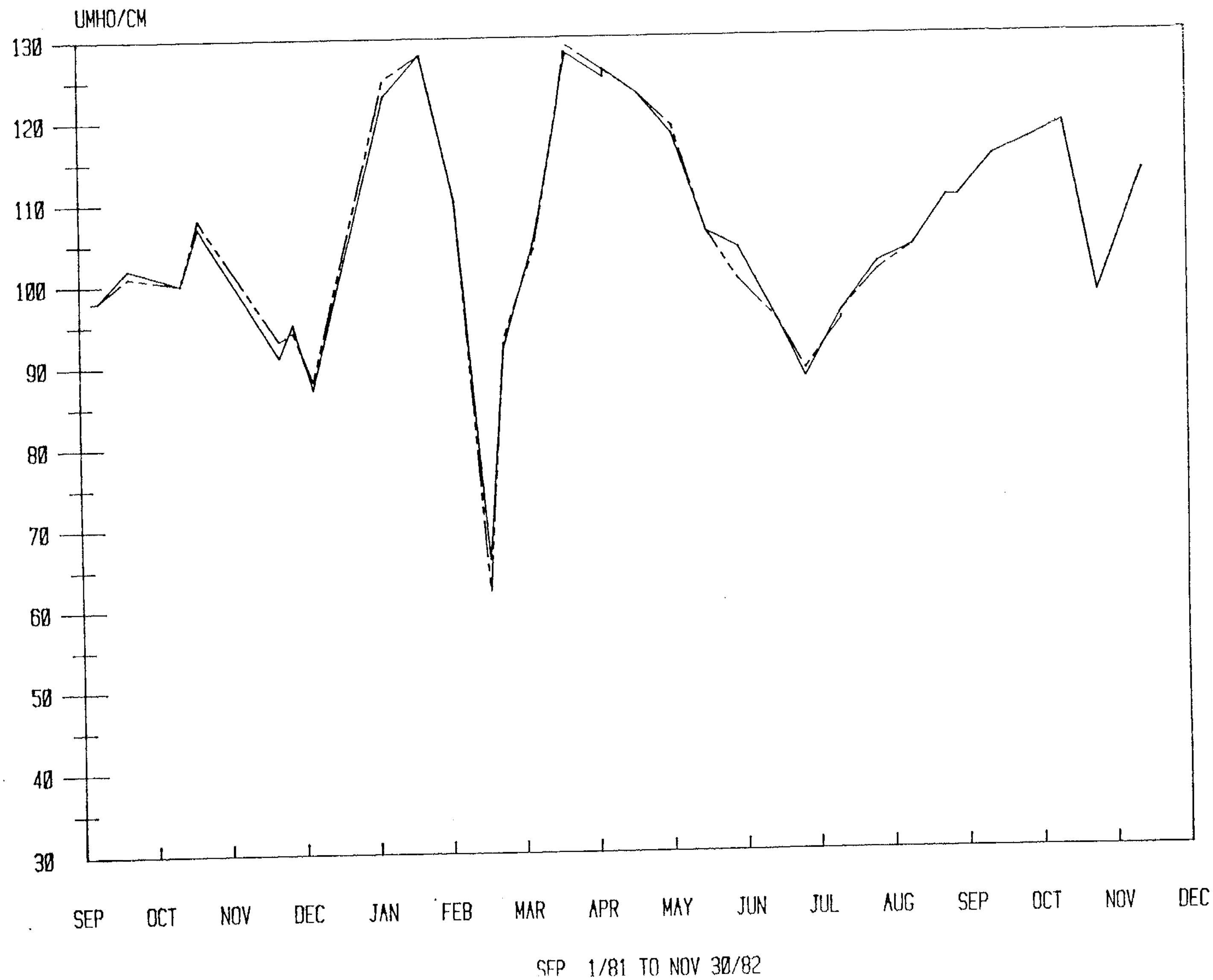


Figure 29 Comparison of Surface Fraser River Orthophosphate Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———.., 0300125 -- ——— --)

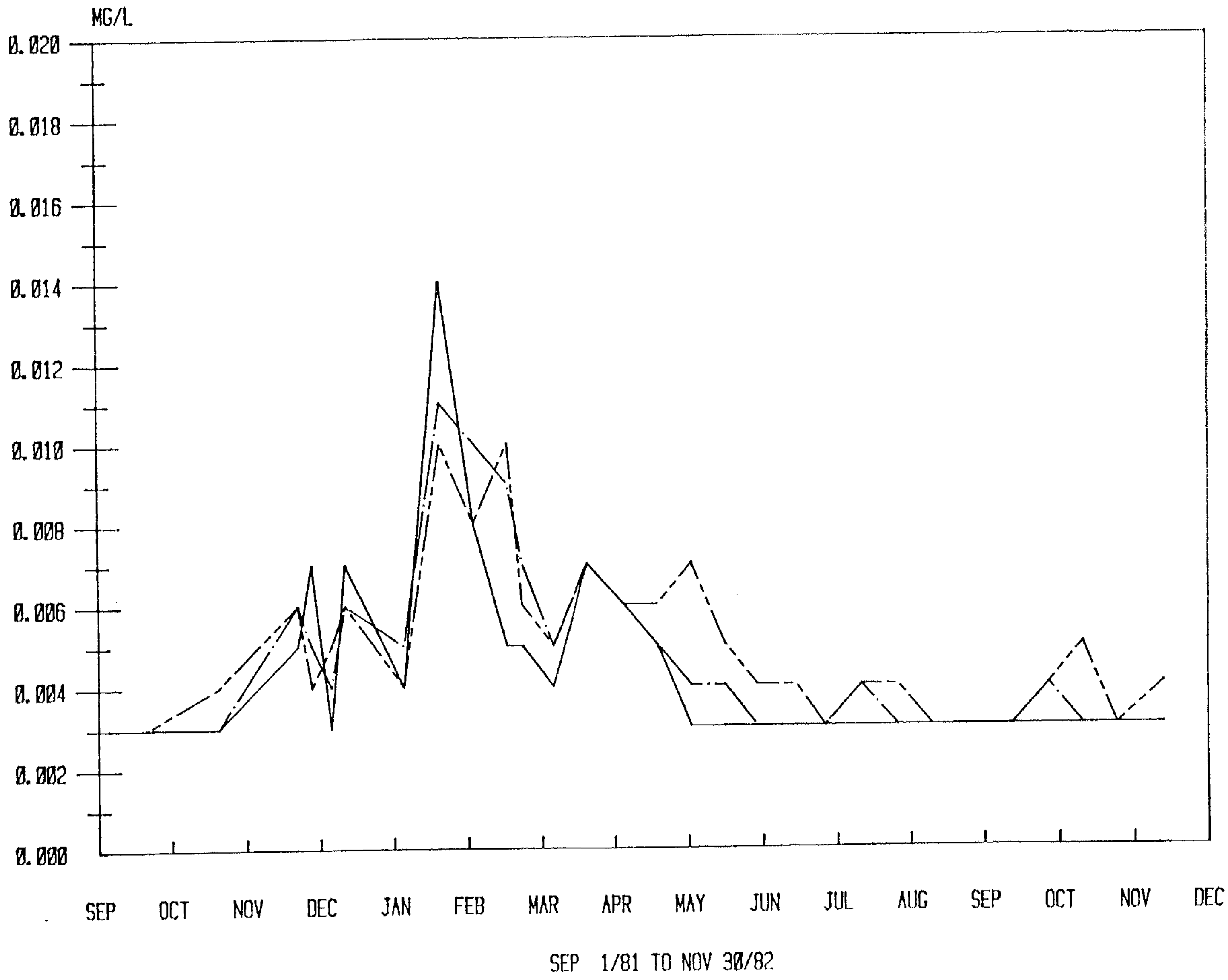


Figure 30 Comparison of Fraser River Orthophosphate Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

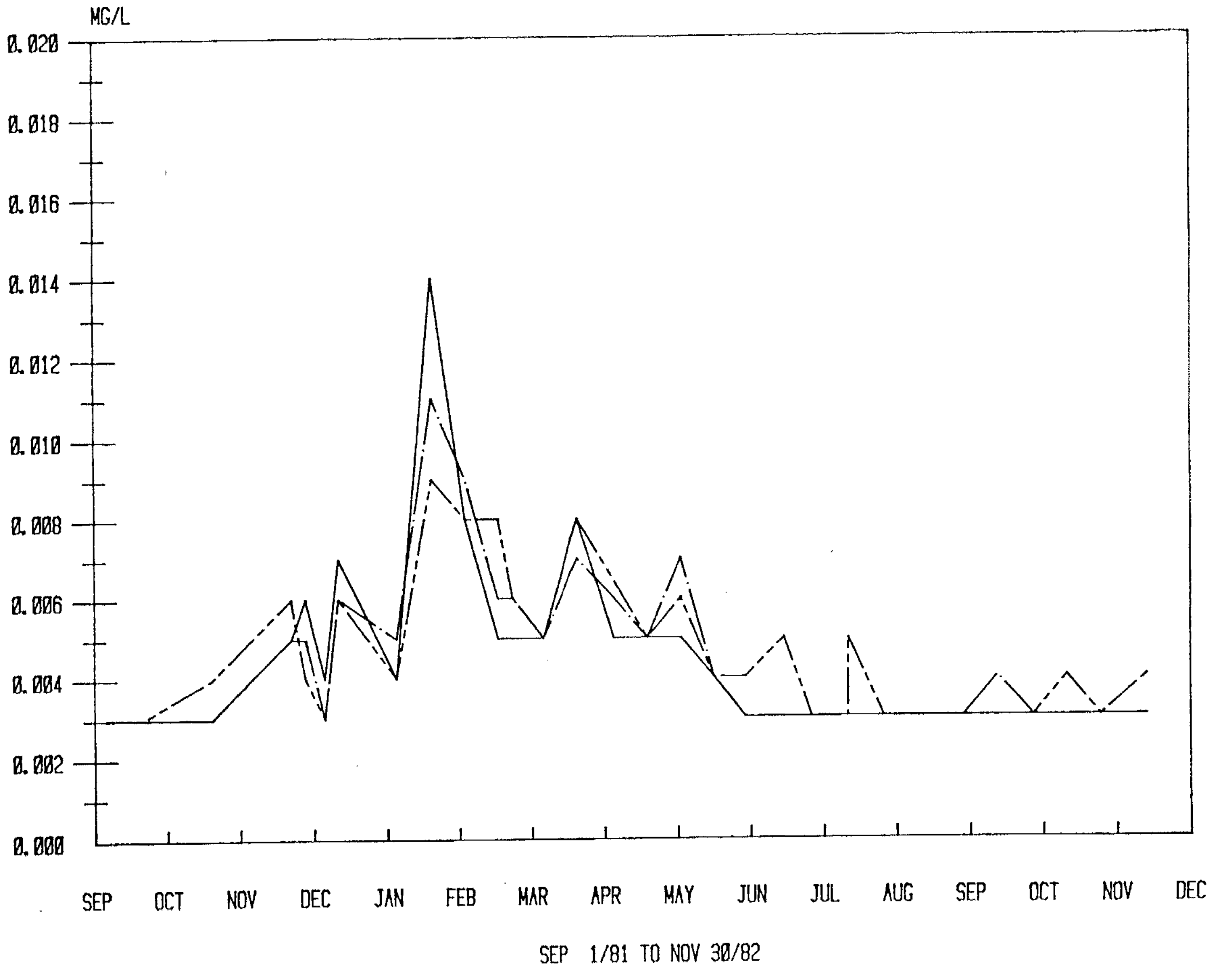


Figure 31 Surface and Depth Comparison of Fraser River Orthophosphate Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

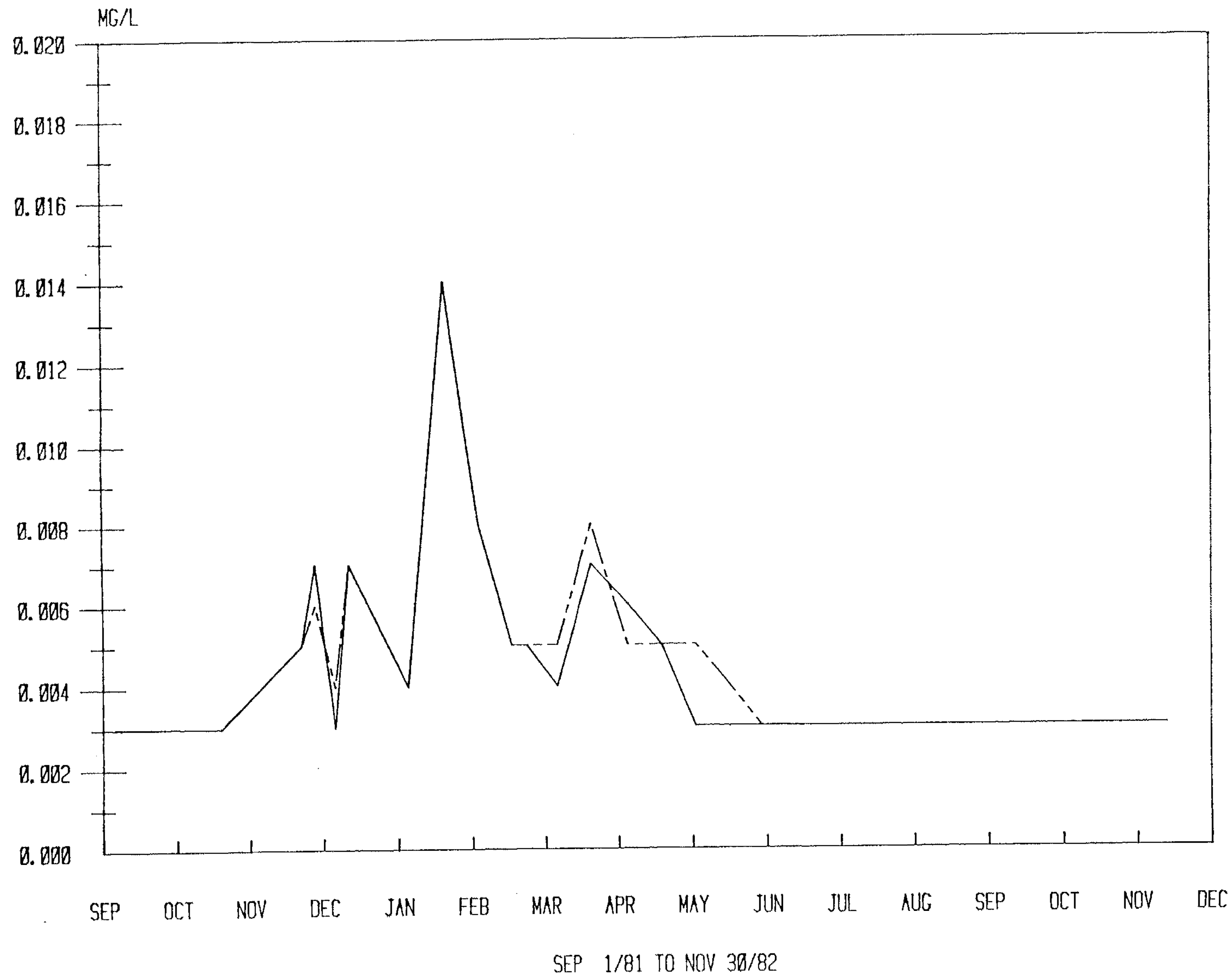


Figure 32 Surface and Depth Comparison of Fraser River Orthophosphate Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

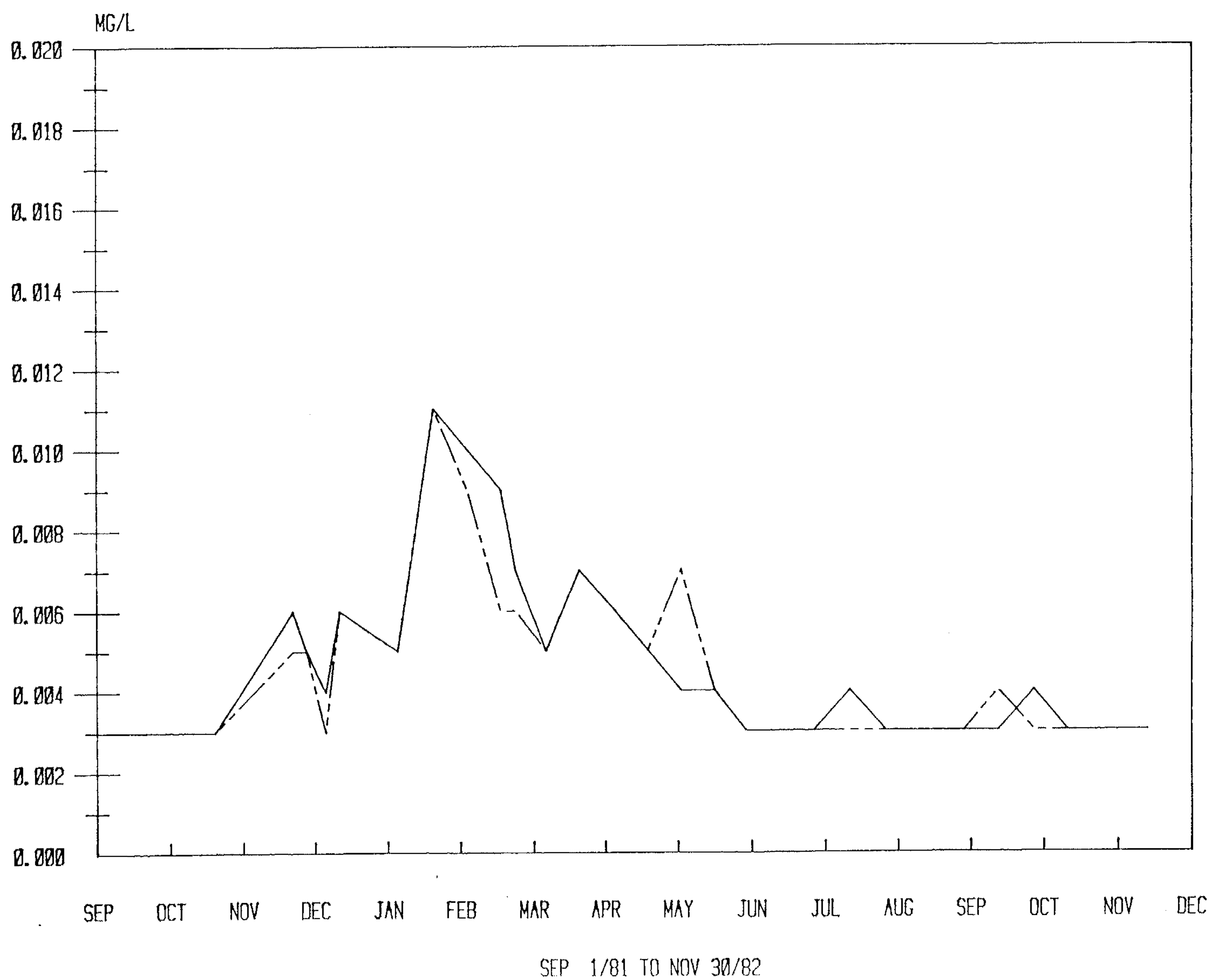


Figure 33 Surface and Depth Comparison of Fraser River Orthophosphate Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

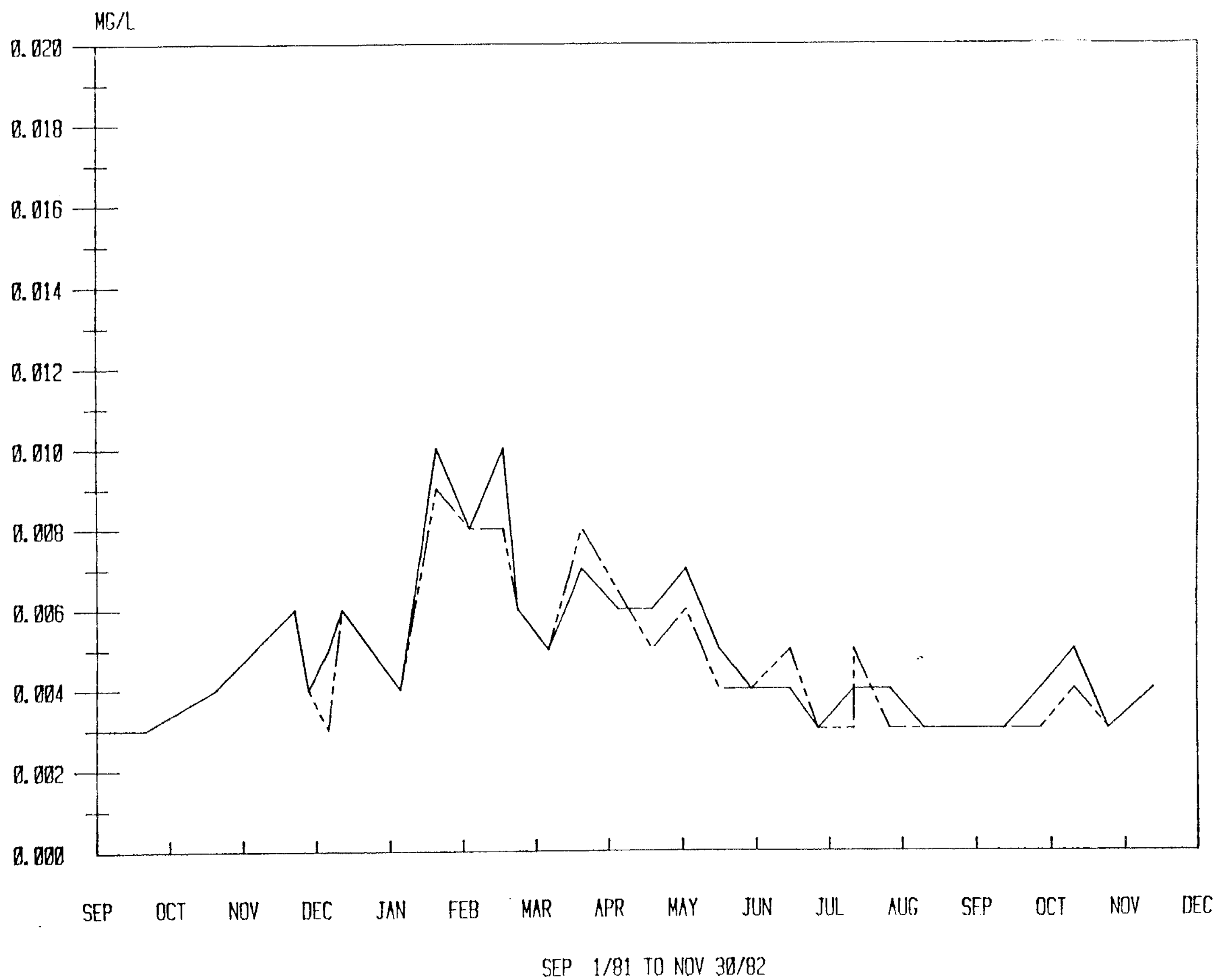


Figure 34 Comparison of Surface Fraser River Dissolved Phosphorus Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

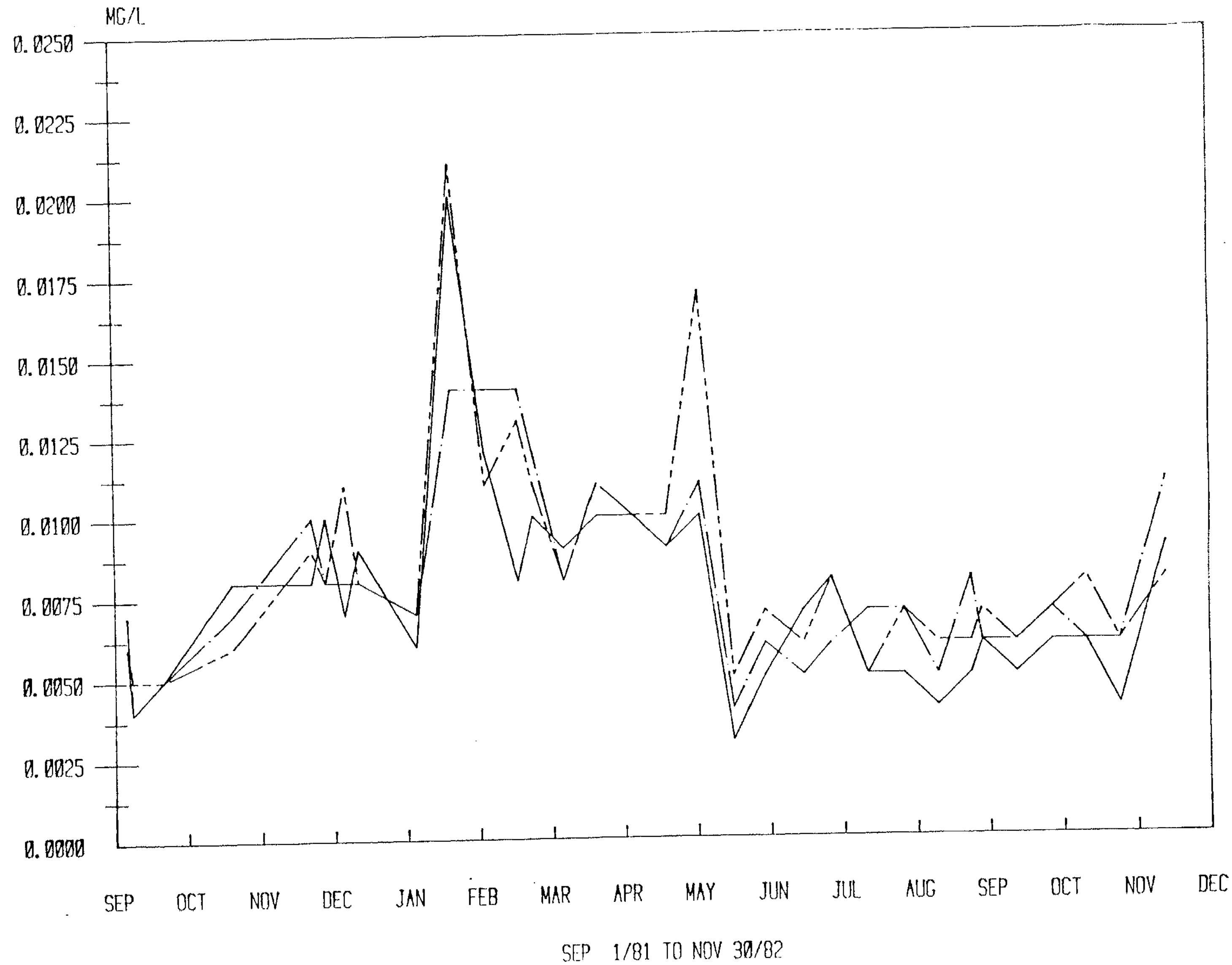


Figure 35 Comparison of Fraser River Dissolved Phosphorus at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

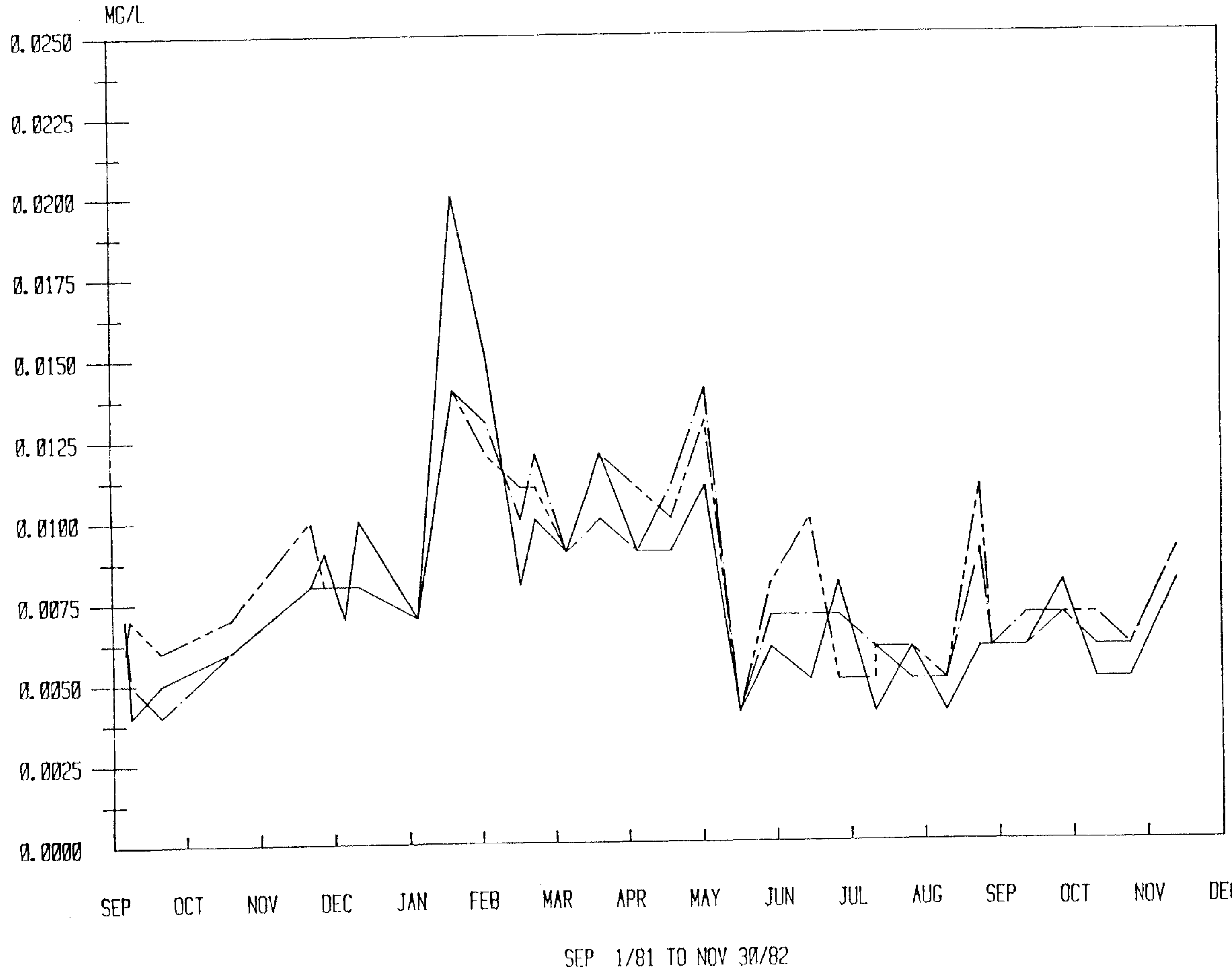


Figure 36 Surface and Depth Comparison of Fraser River Dissolved Phosphorus Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

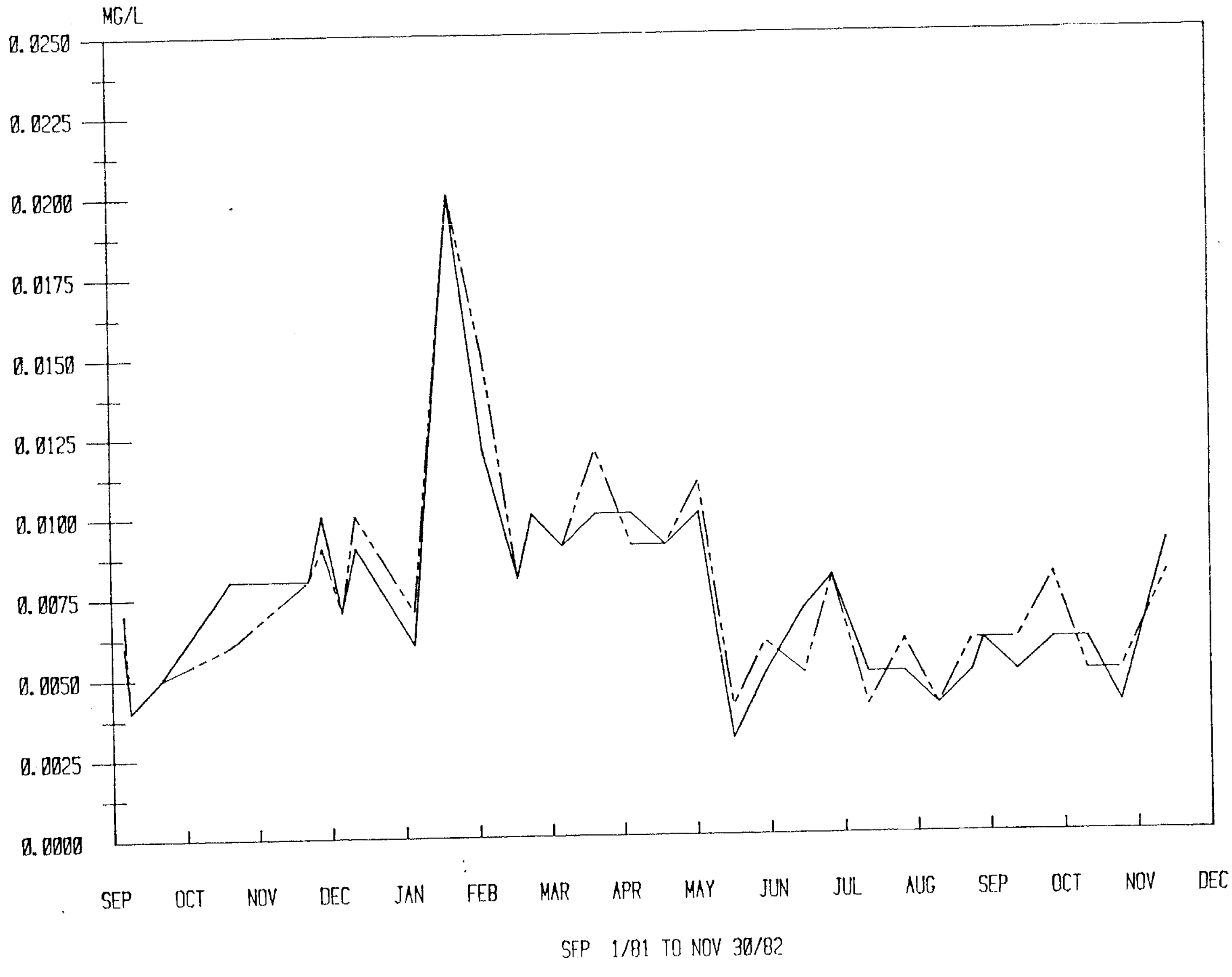


Figure 37 Surface and Depth Comparison of Fraser River Dissolved Phosphorus Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

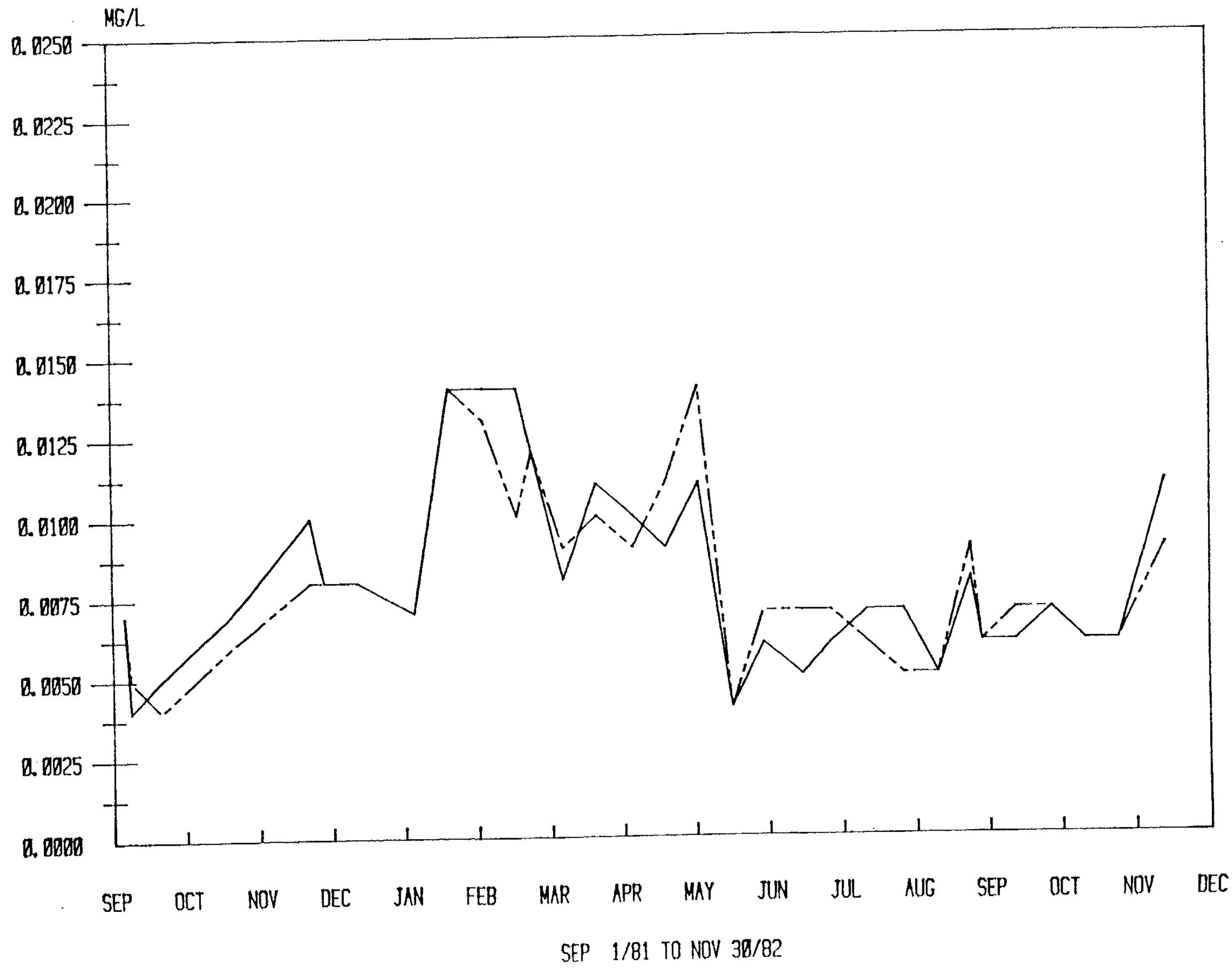


Figure 38 Surface and Depth Comparison of Fraser River Dissolved Phosphorus Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

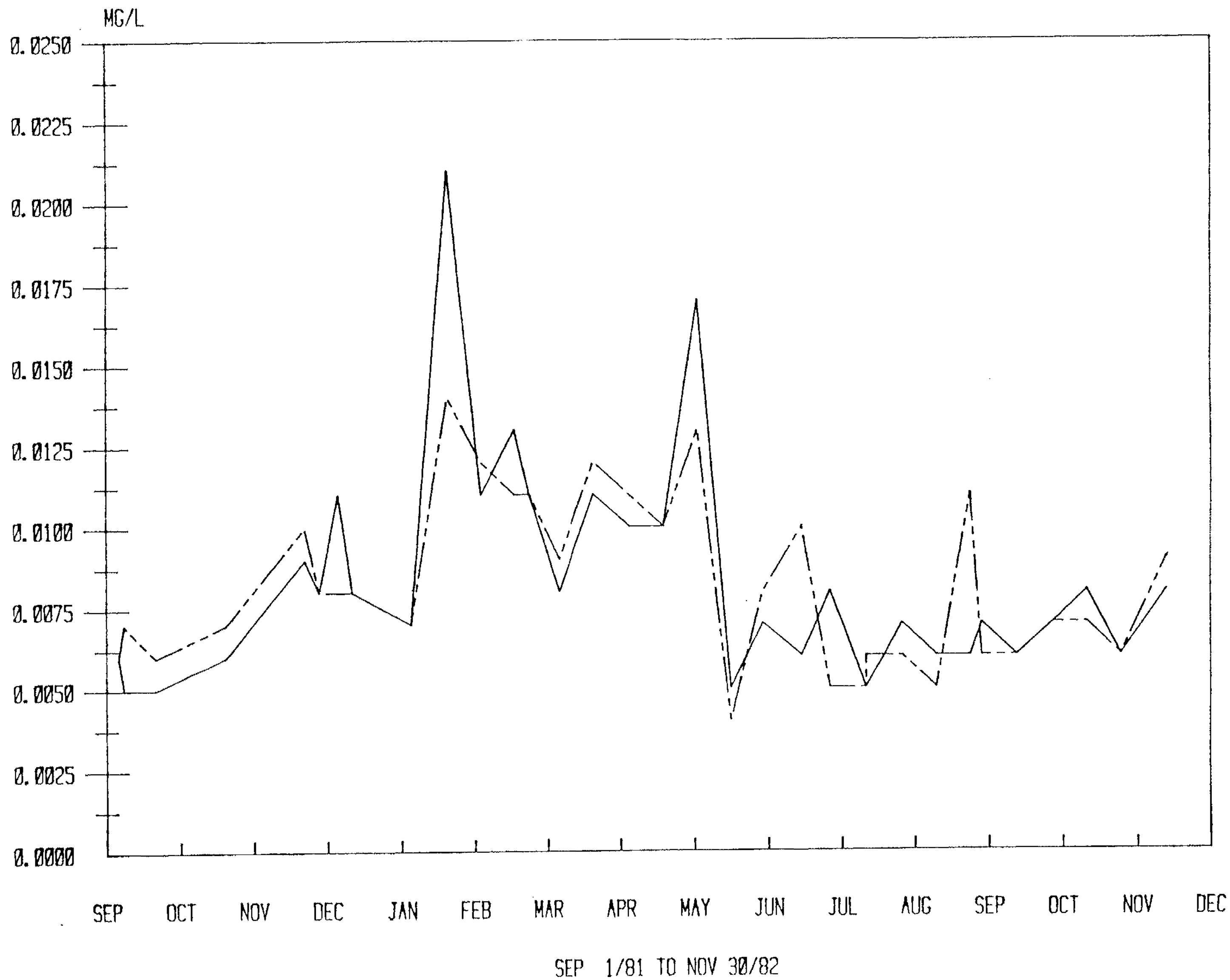


Figure 39 Comparison of Surface Fraser River Total Phosphorus Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

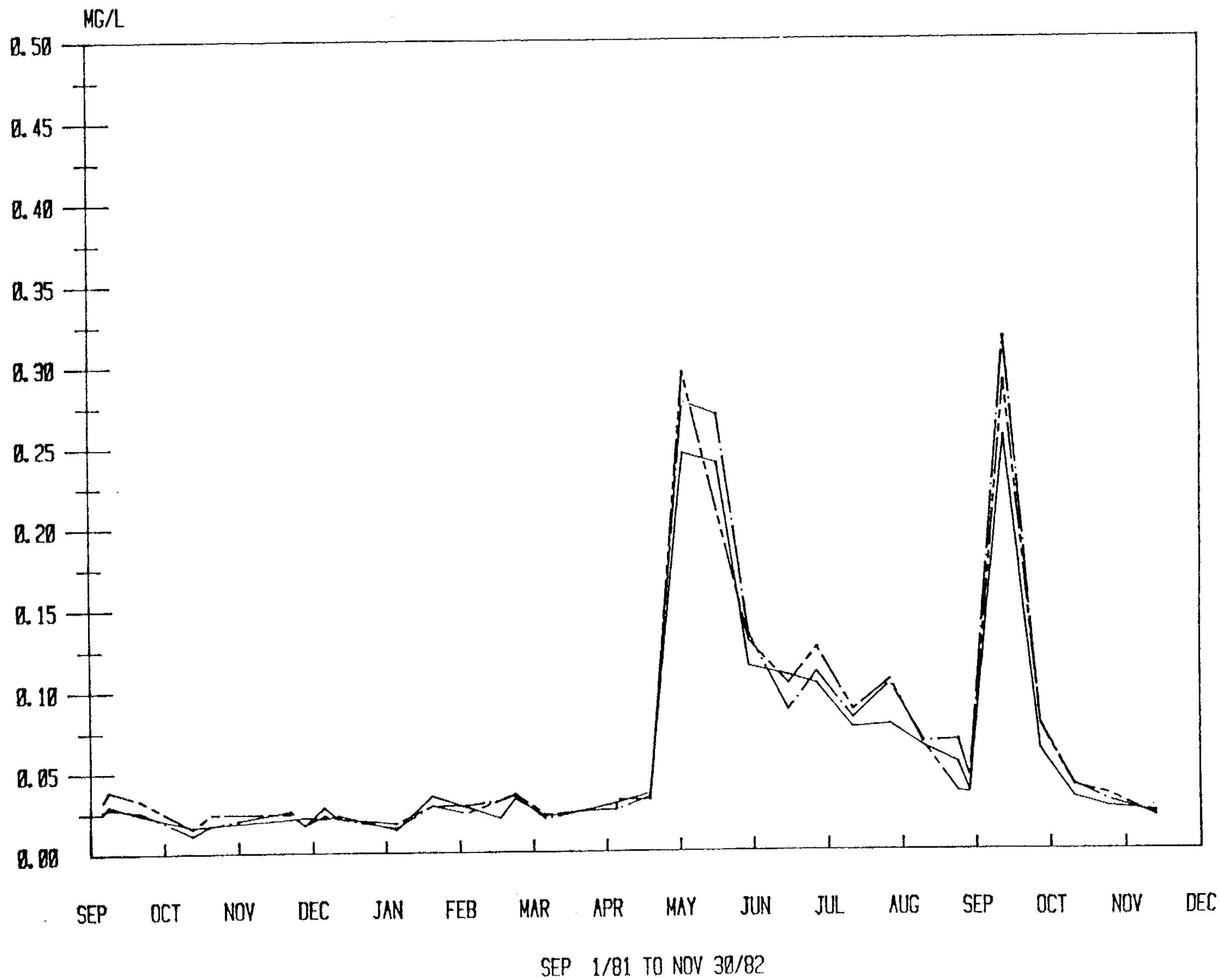


Figure 40 Comparison of Fraser River Total Phosphorus Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———.., 0300125 -- ——— --)

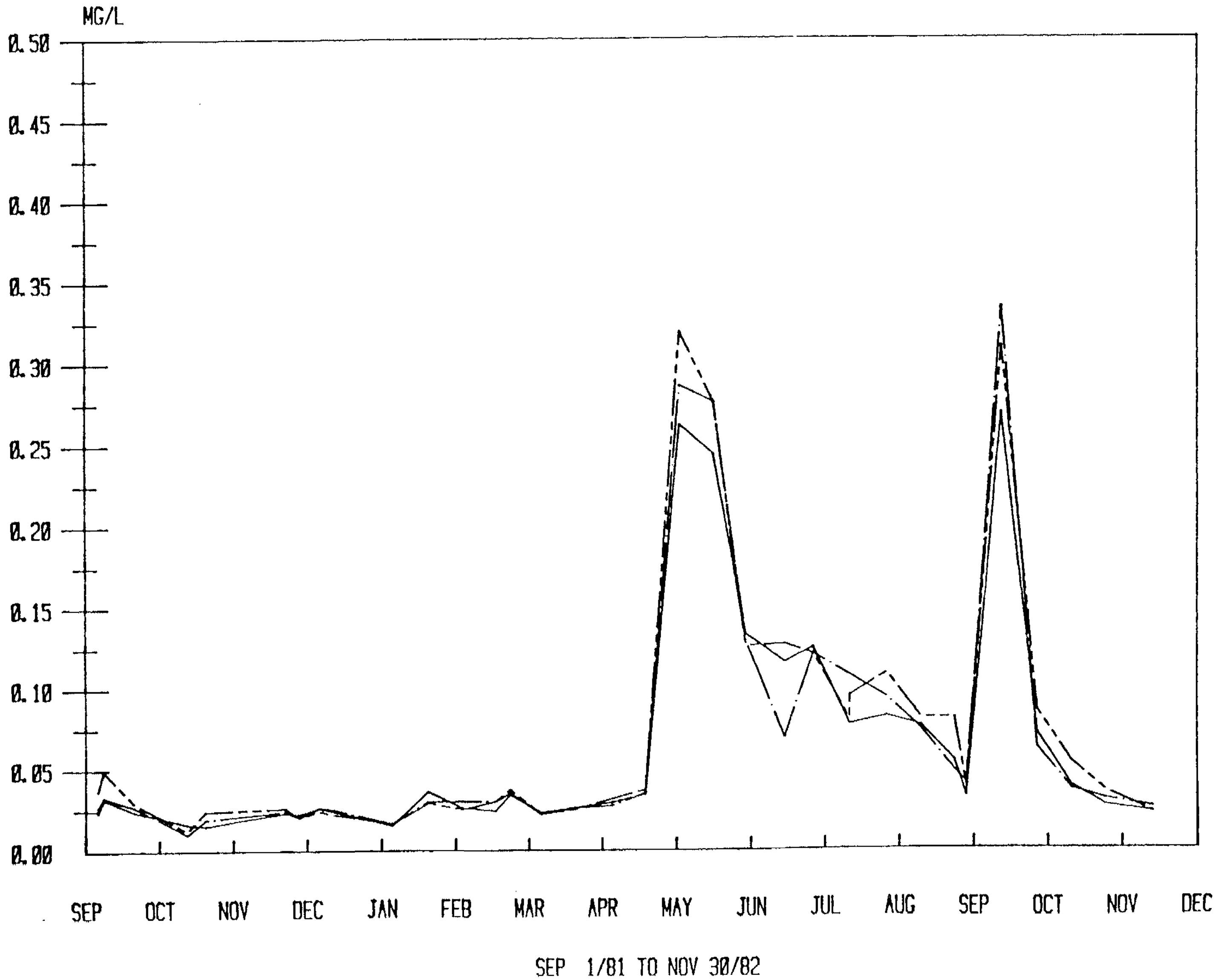


Figure 41 Surface and Depth Comparison of Fraser River Total Phosphorus Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

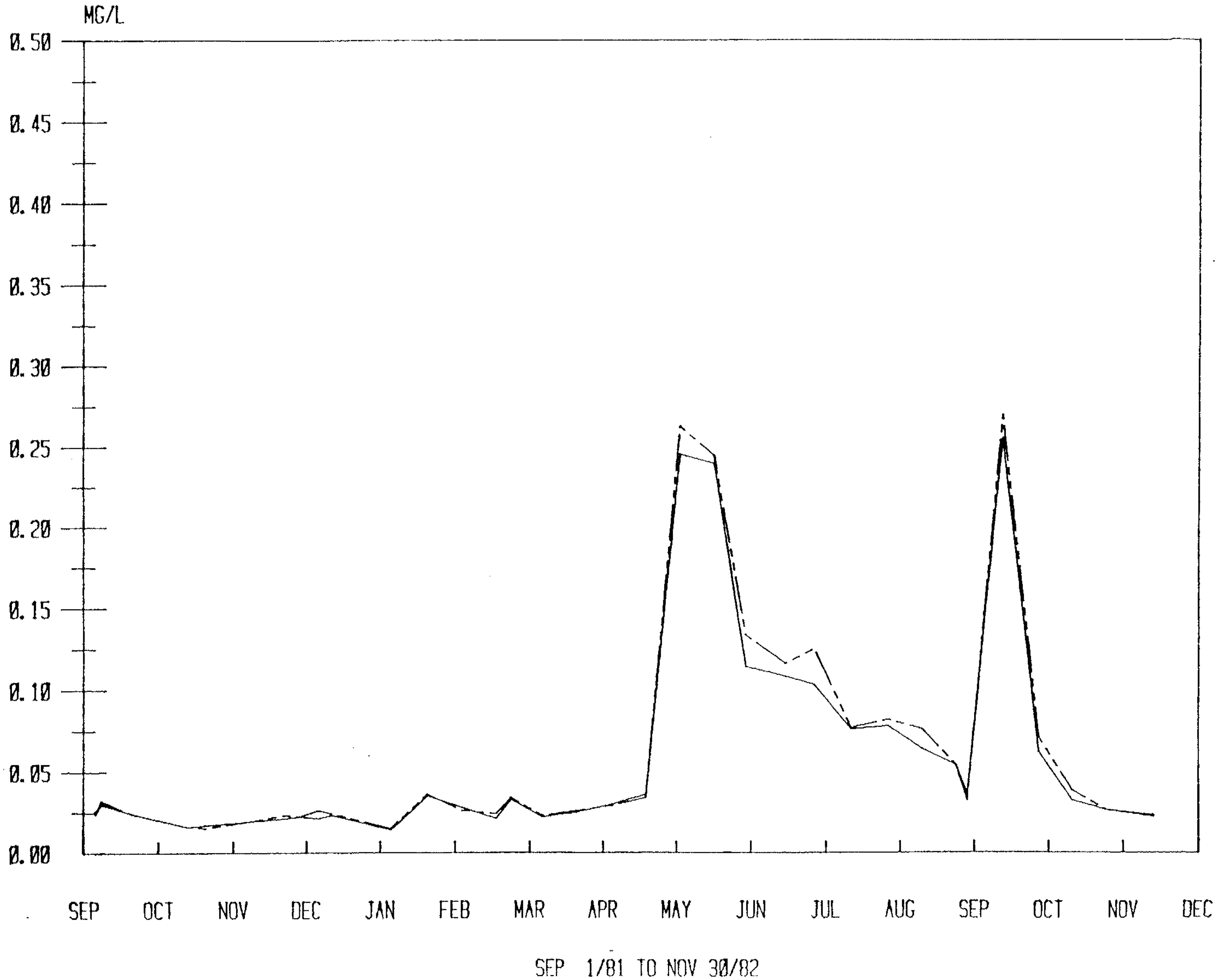


Figure 42 Surface and Depth Comparison of Fraser River Total Phosphorus Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

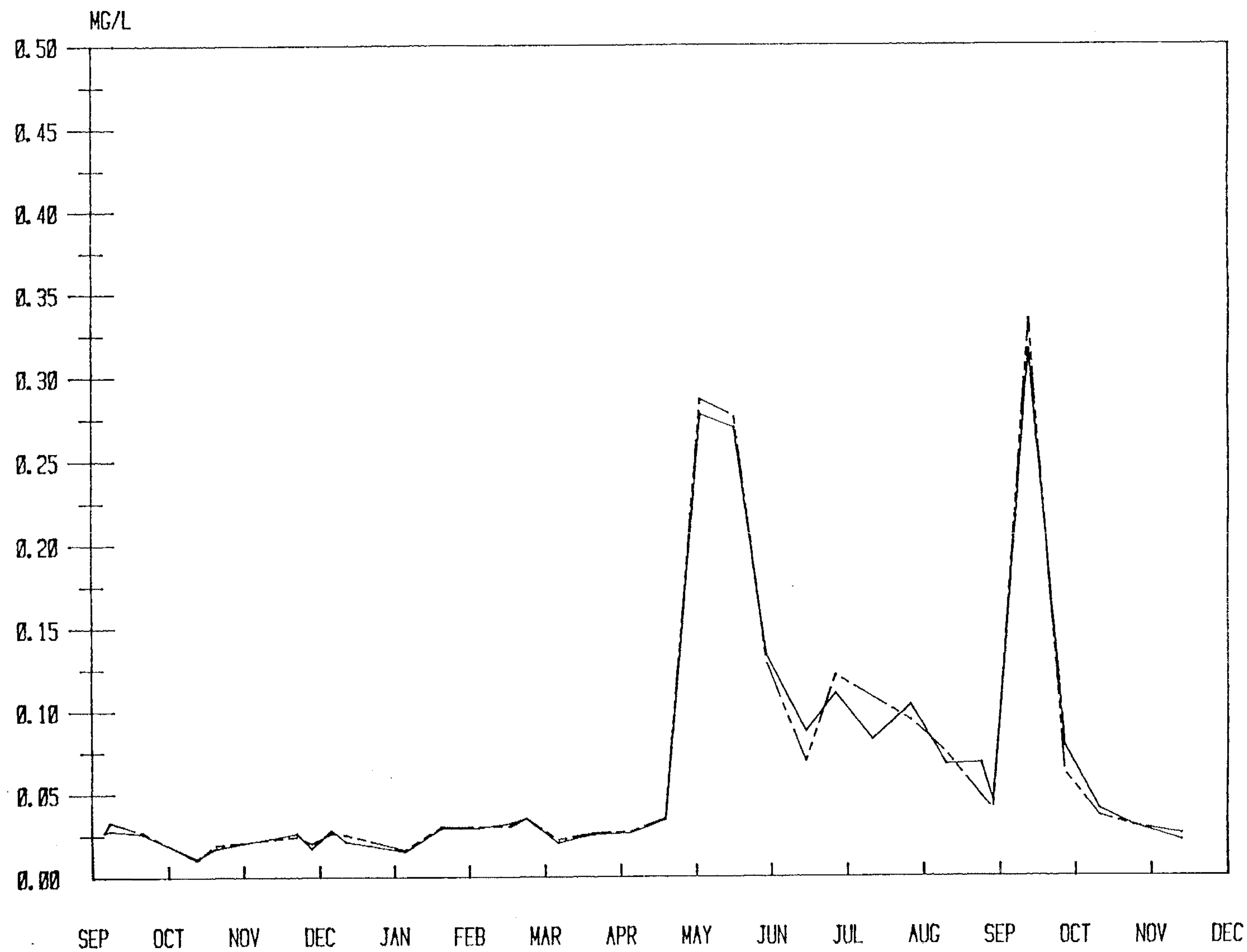


Figure 43 Surface and Depth Comparison of Fraser River Total Phosphorus Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

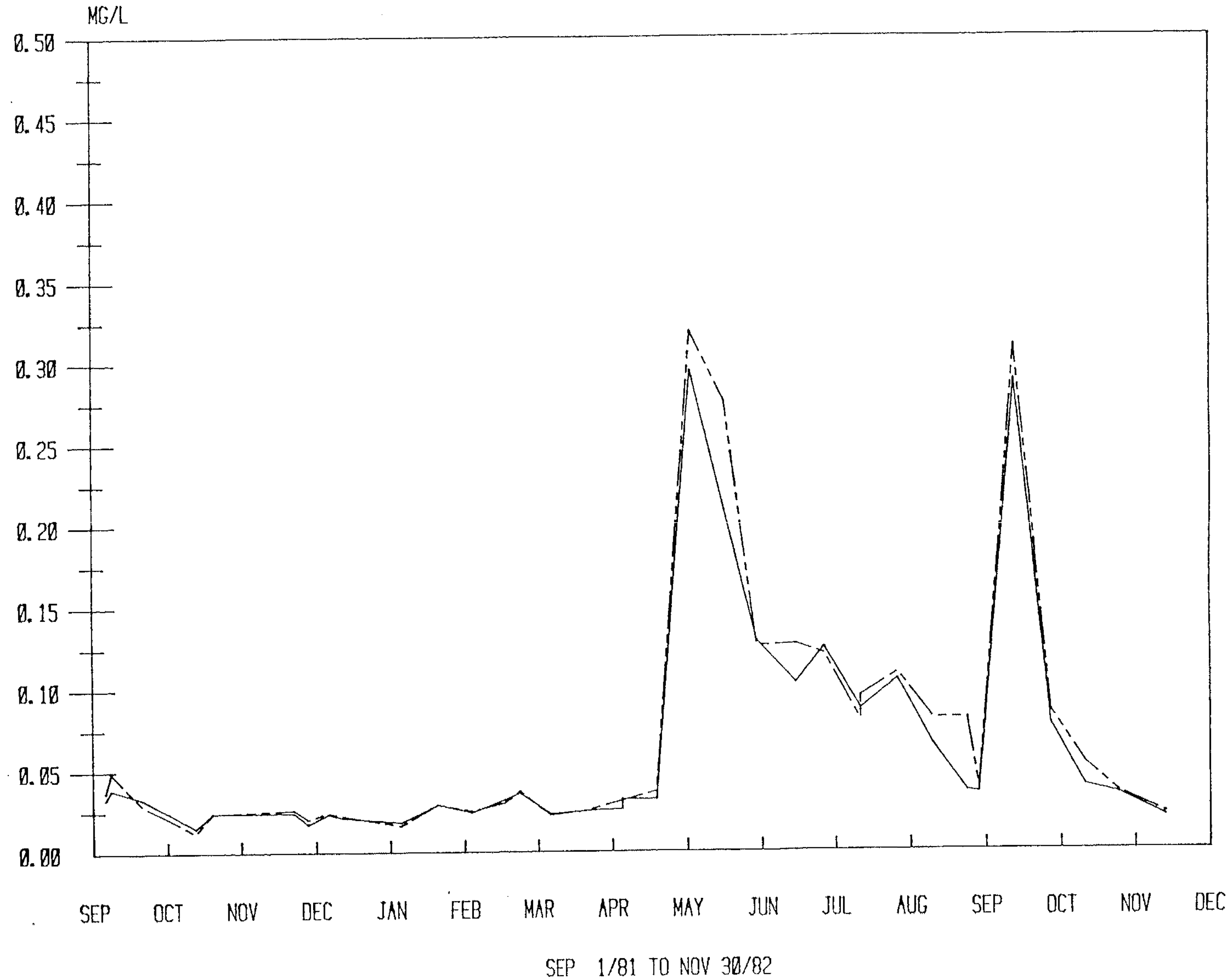


Figure 44 Comparison of Surface Fraser River Ammonia Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

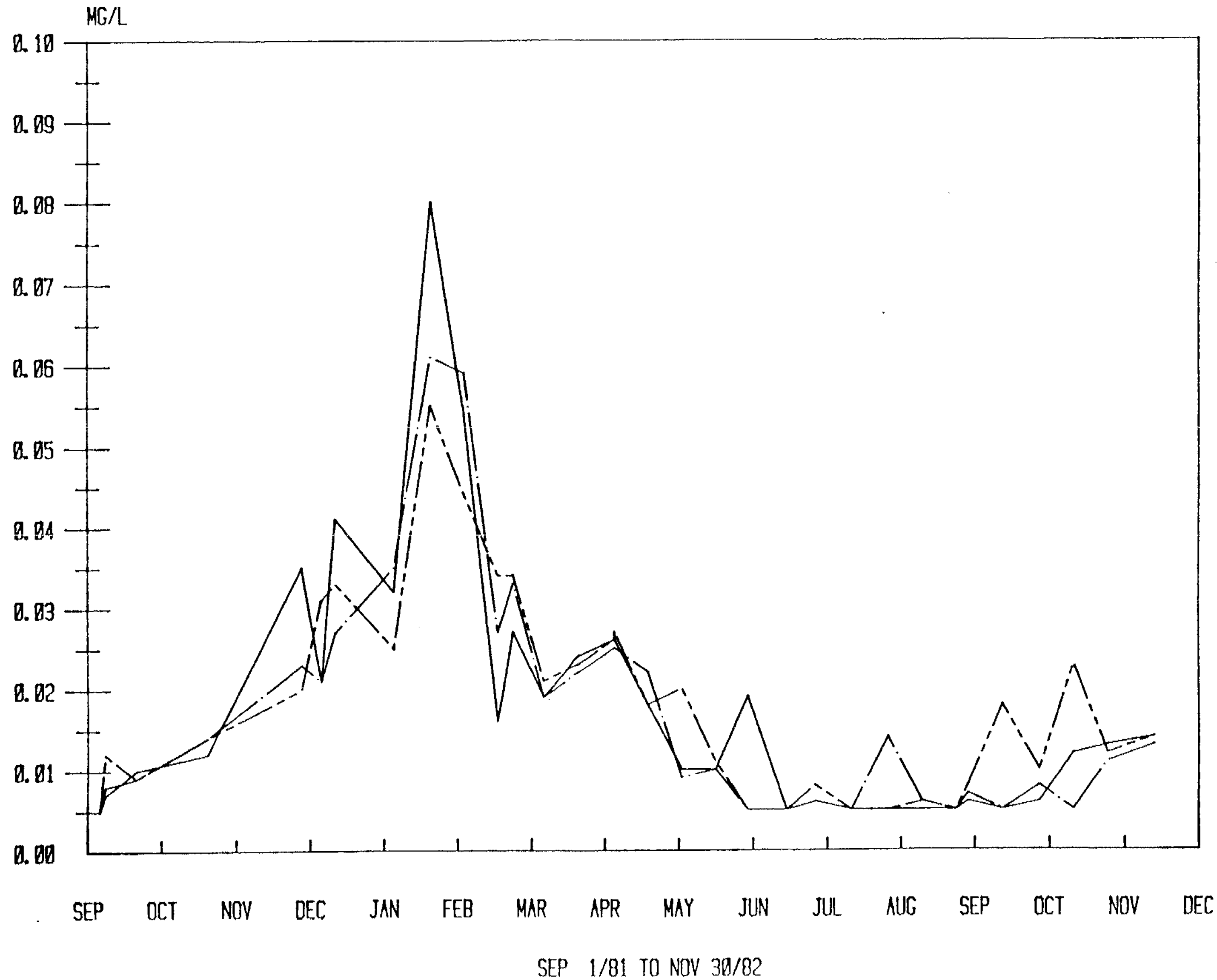


Figure 45 Comparison of Fraser River Ammonia Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

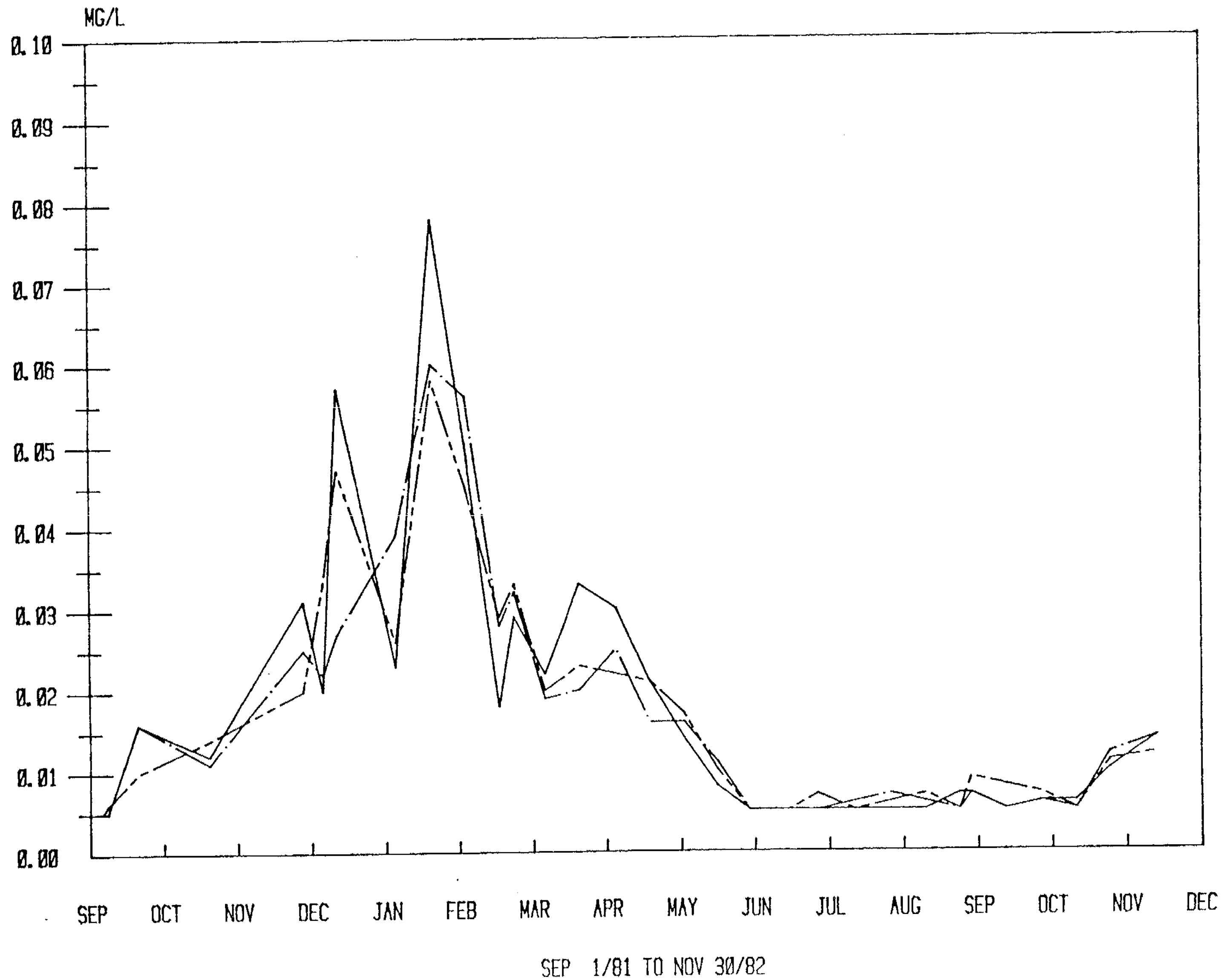


Figure 46 Surface and Depth Comparison of Fraser River Ammonia Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

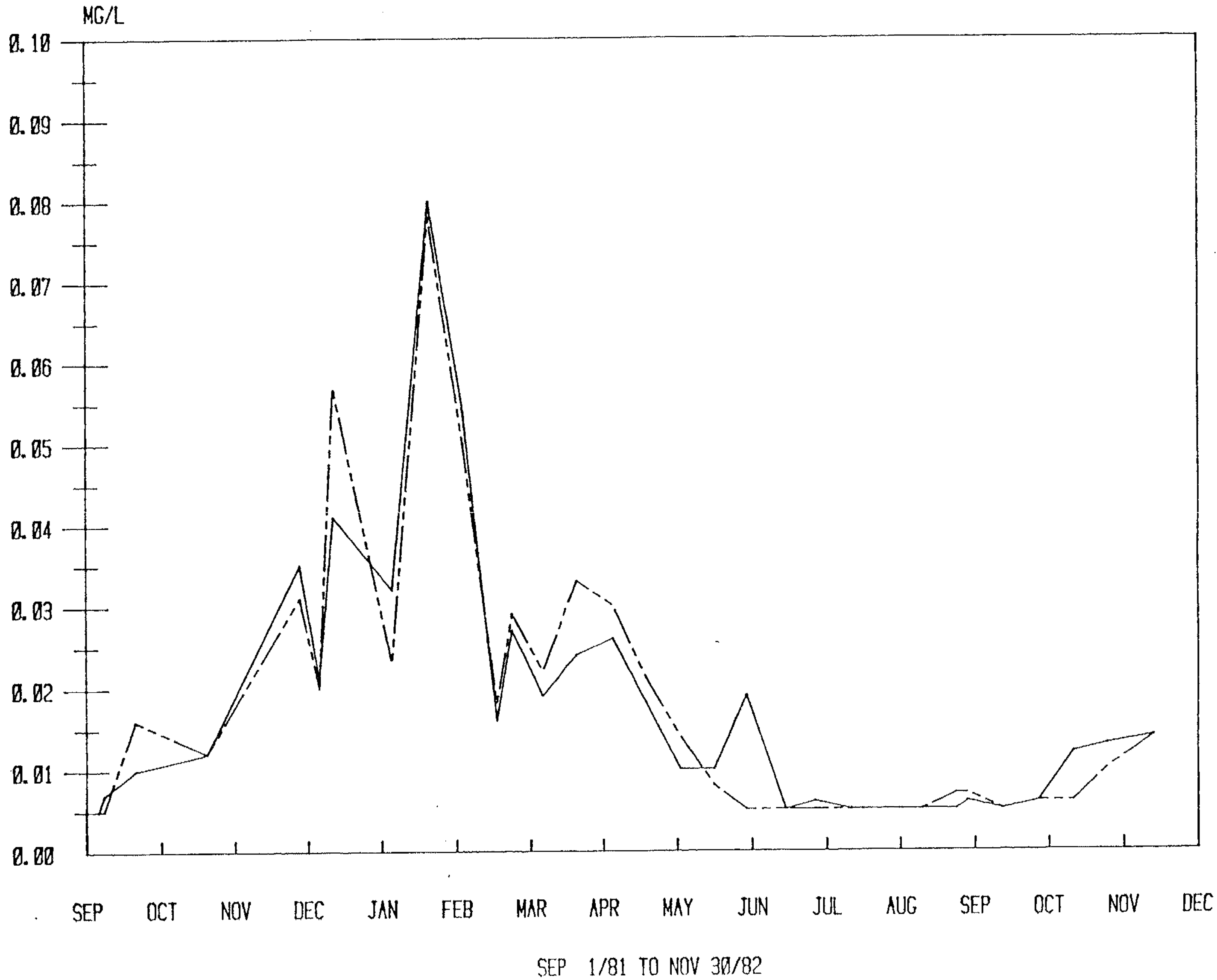


Figure 47 Surface and Depth Comparison of Fraser River Ammonia Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

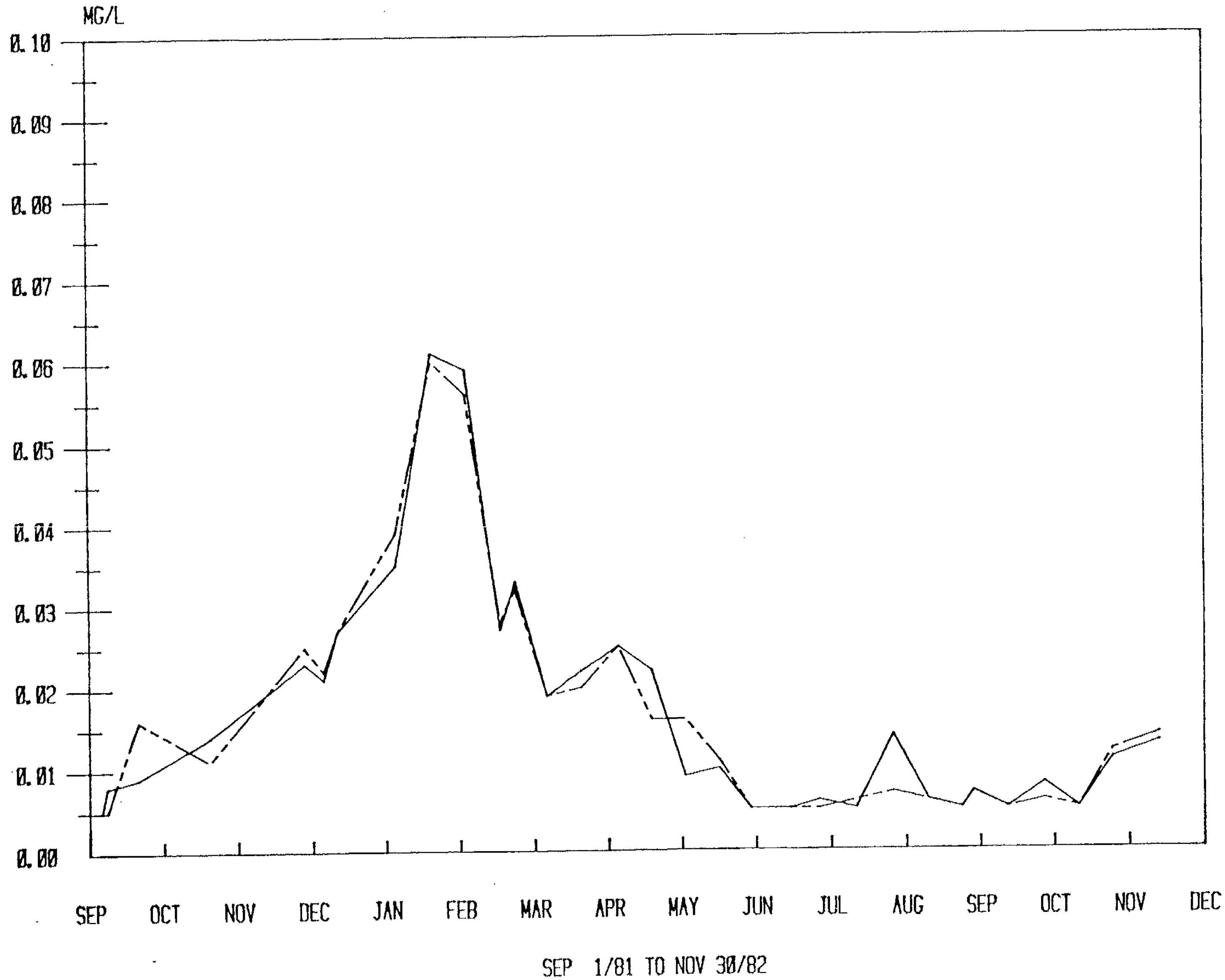


Figure 48 Surface and Depth Comparison of Fraser River Ammonia Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

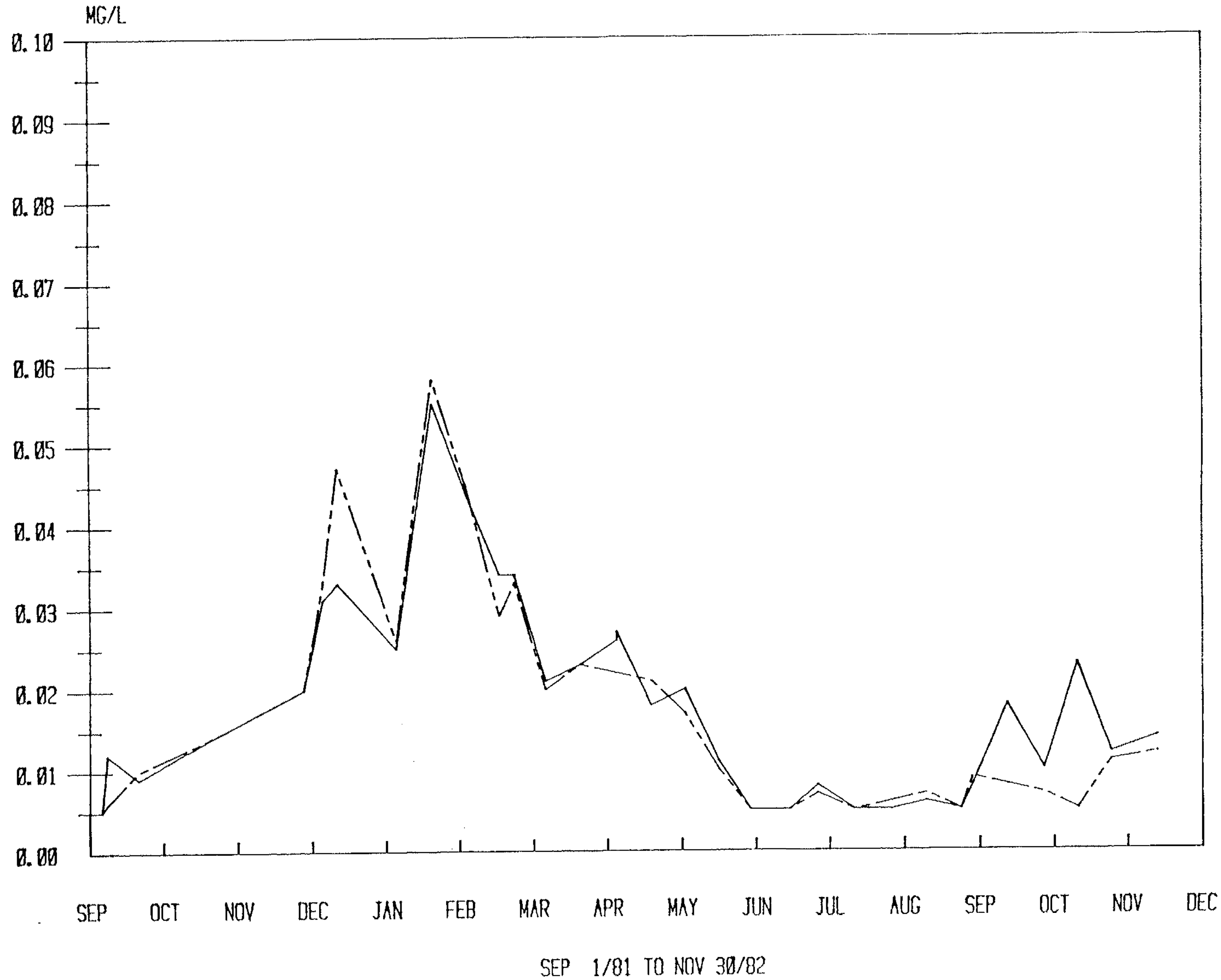


Figure 49 Comparison of Surface Fraser River Dissolved Nitrate + Nitrite Concentrations, September 1981 to December 1982 (0300124 ———. 0300005 .———., 0300125 -- ——— --)

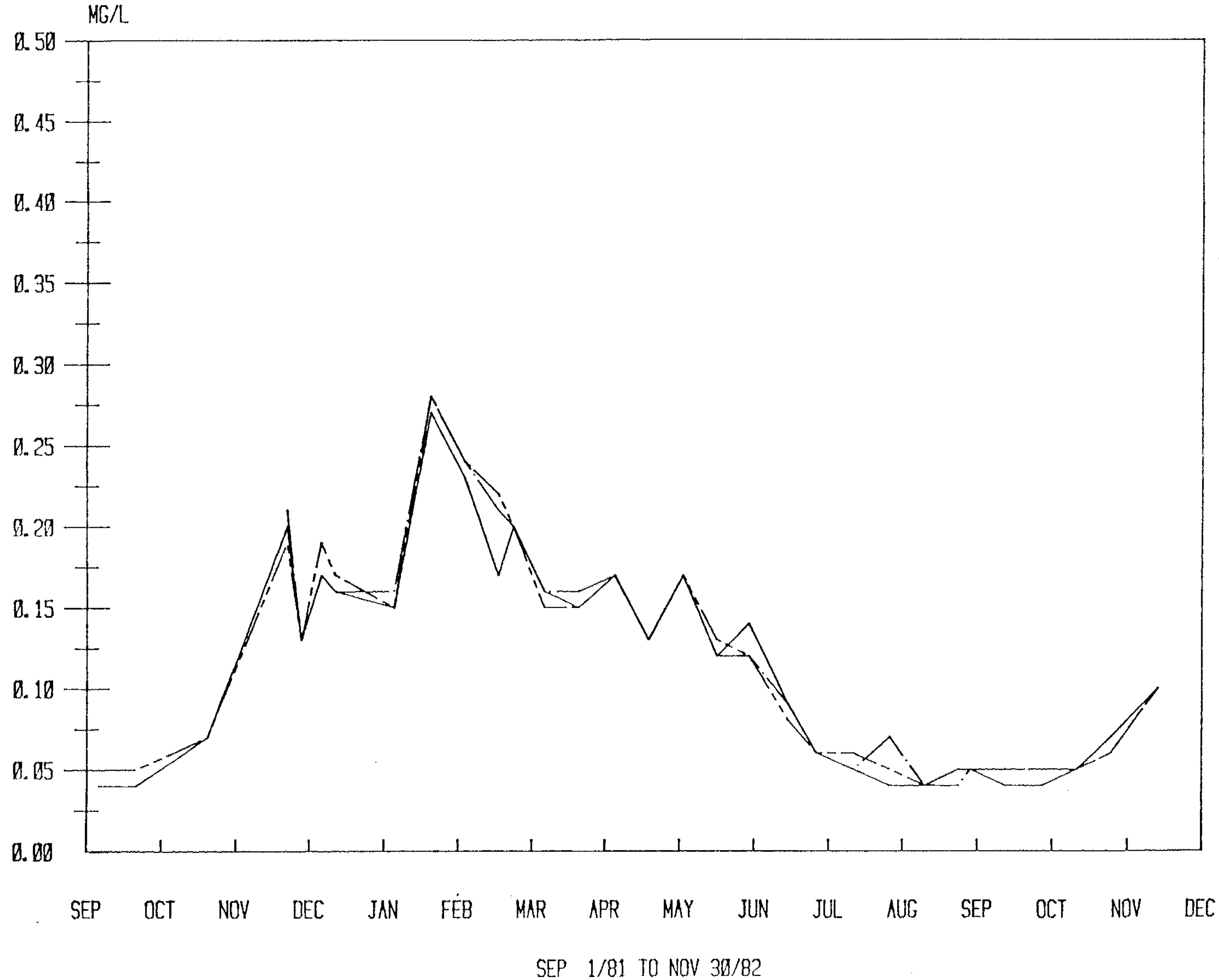


Figure 50 Comparison of Fraser River Dissolved Nitrate + Nitrite Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

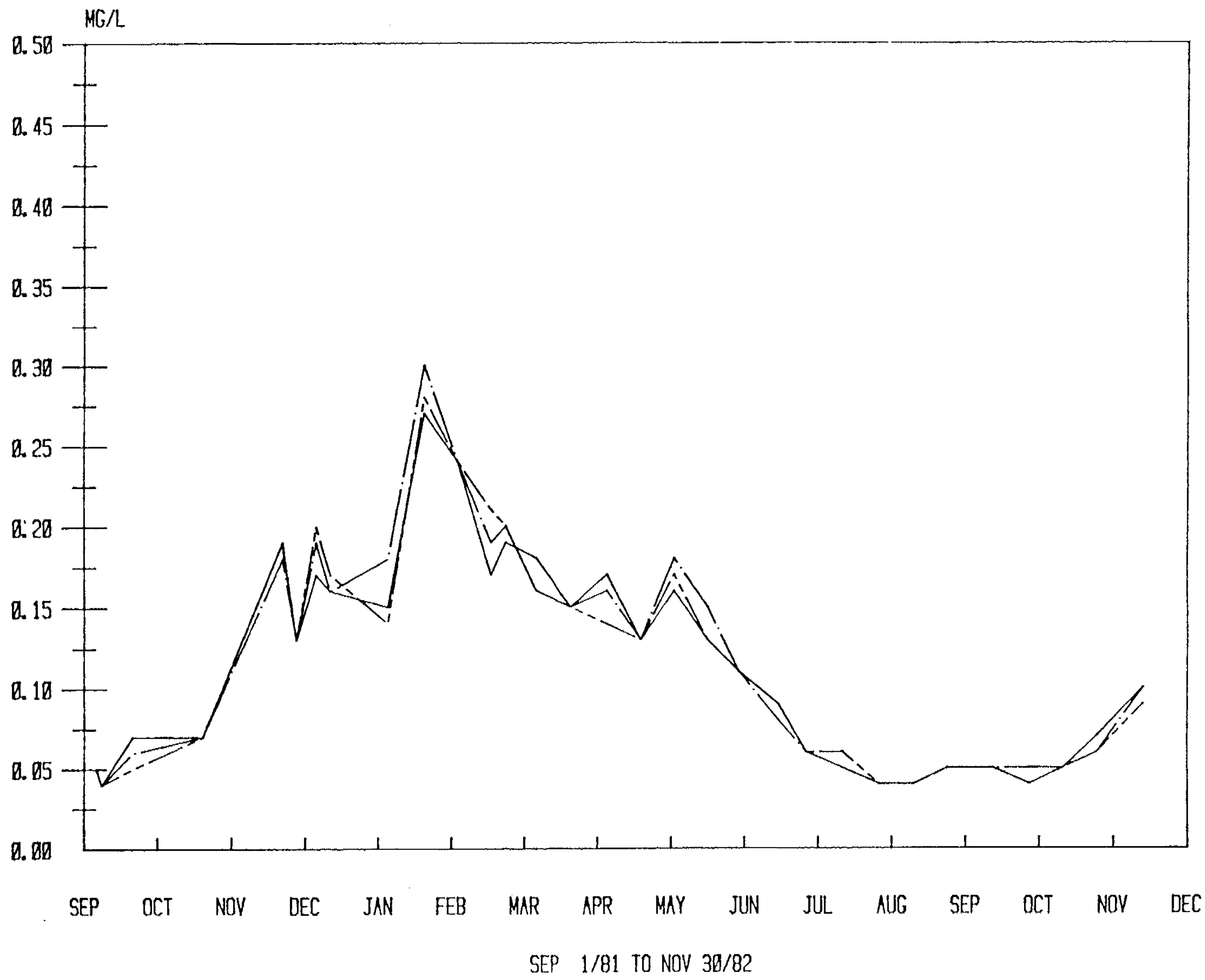


Figure 51 Surface and Depth Comparison of Fraser River Dissolved Nitrate + Nitrite Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

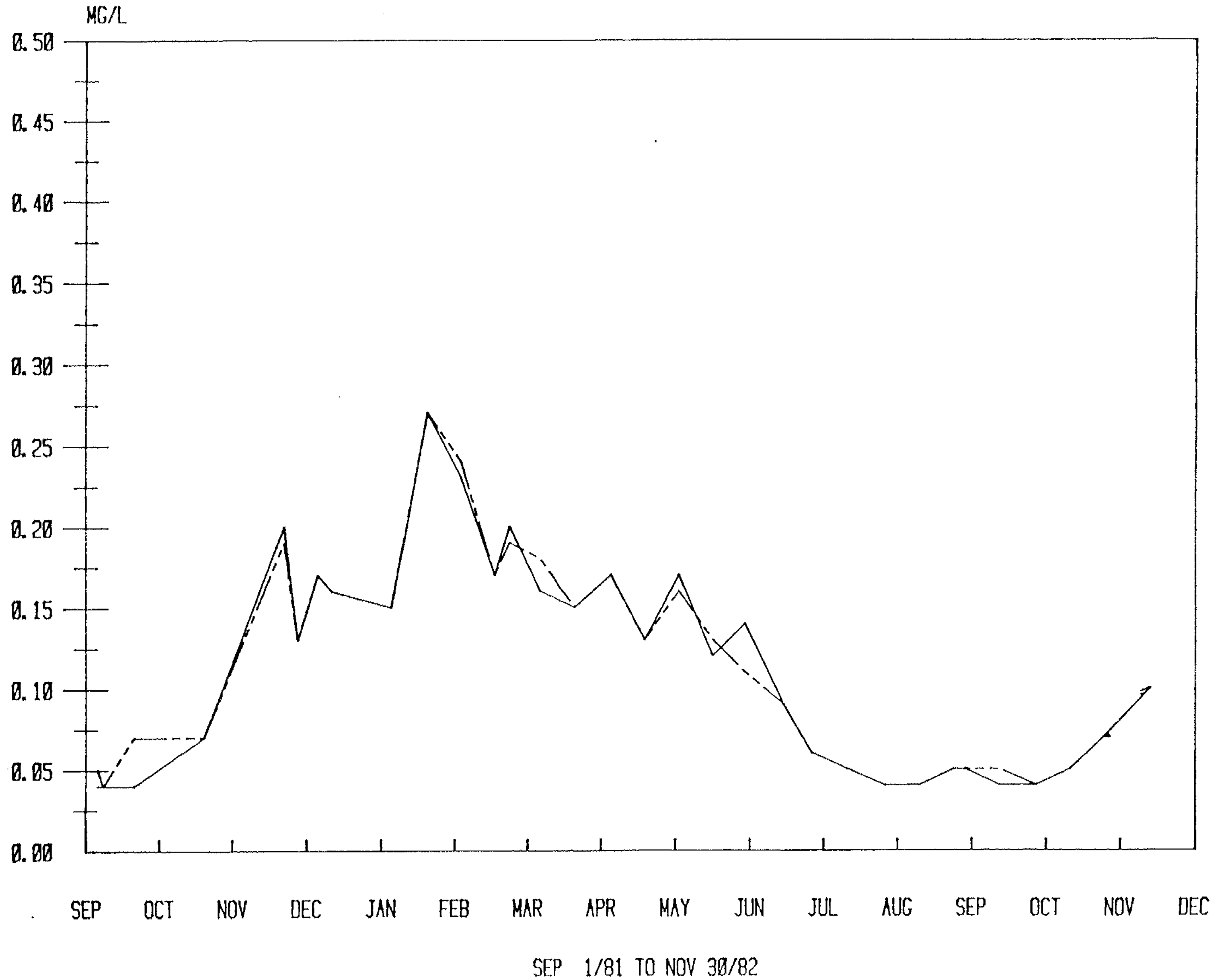


Figure 52 Surface and Depth Comparison of Fraser River Dissolved Nitrate + Nitrite Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

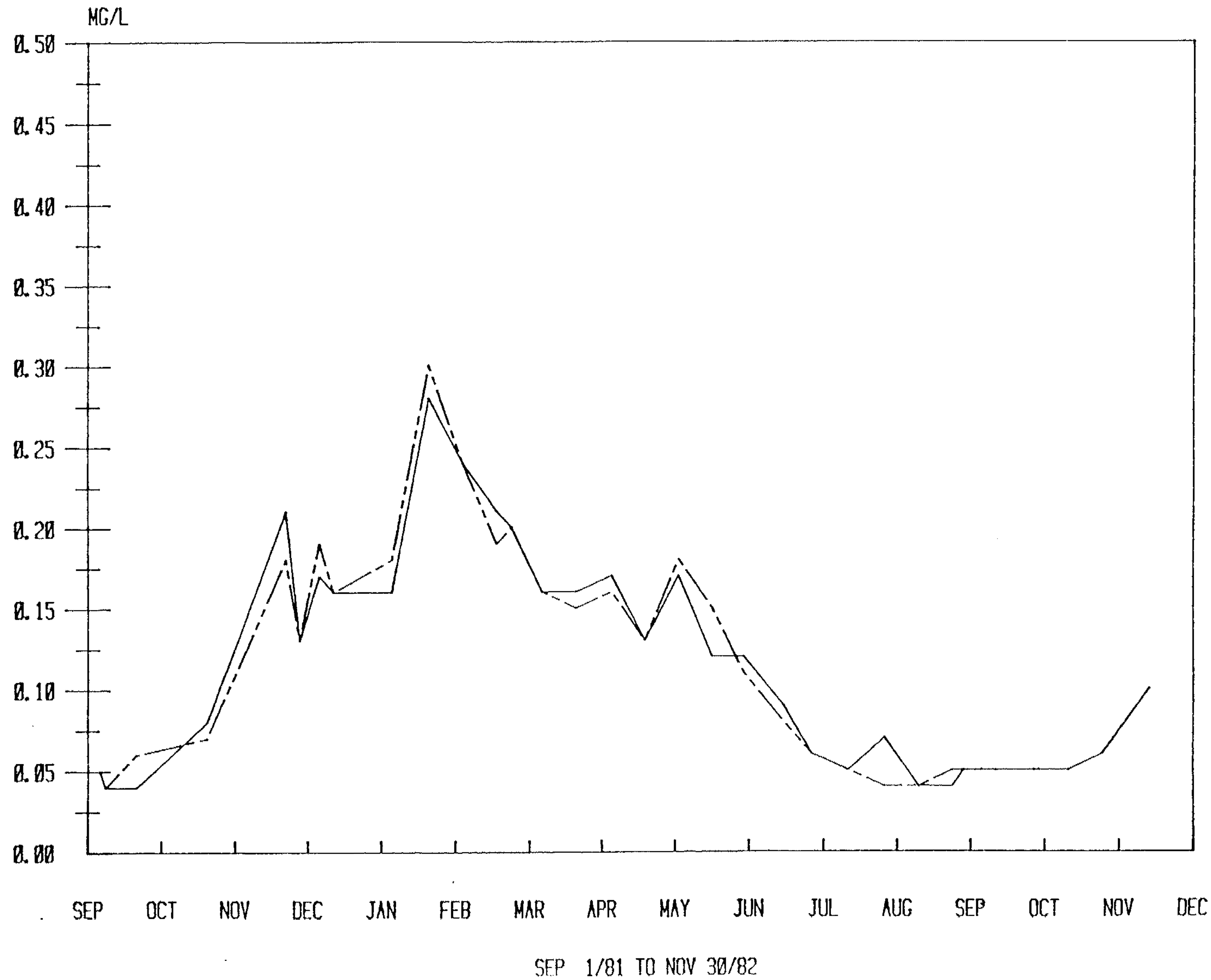


Figure 53 Surface and Depth Comparison of Fraser River Dissolved Nitrate + Nitrite Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

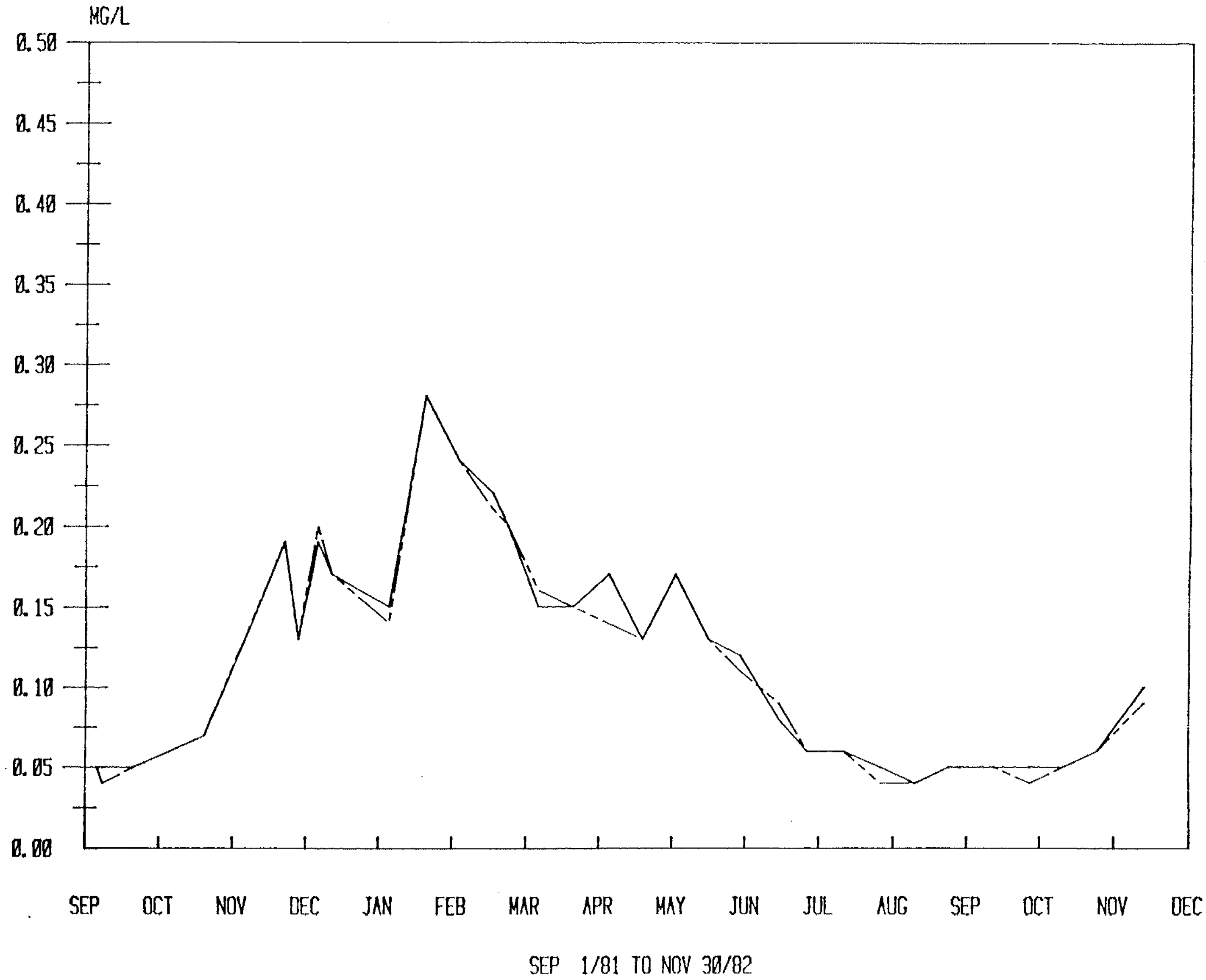


Figure 54 Comparison of Surface Fraser River Kjeldahl Nitrogen Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

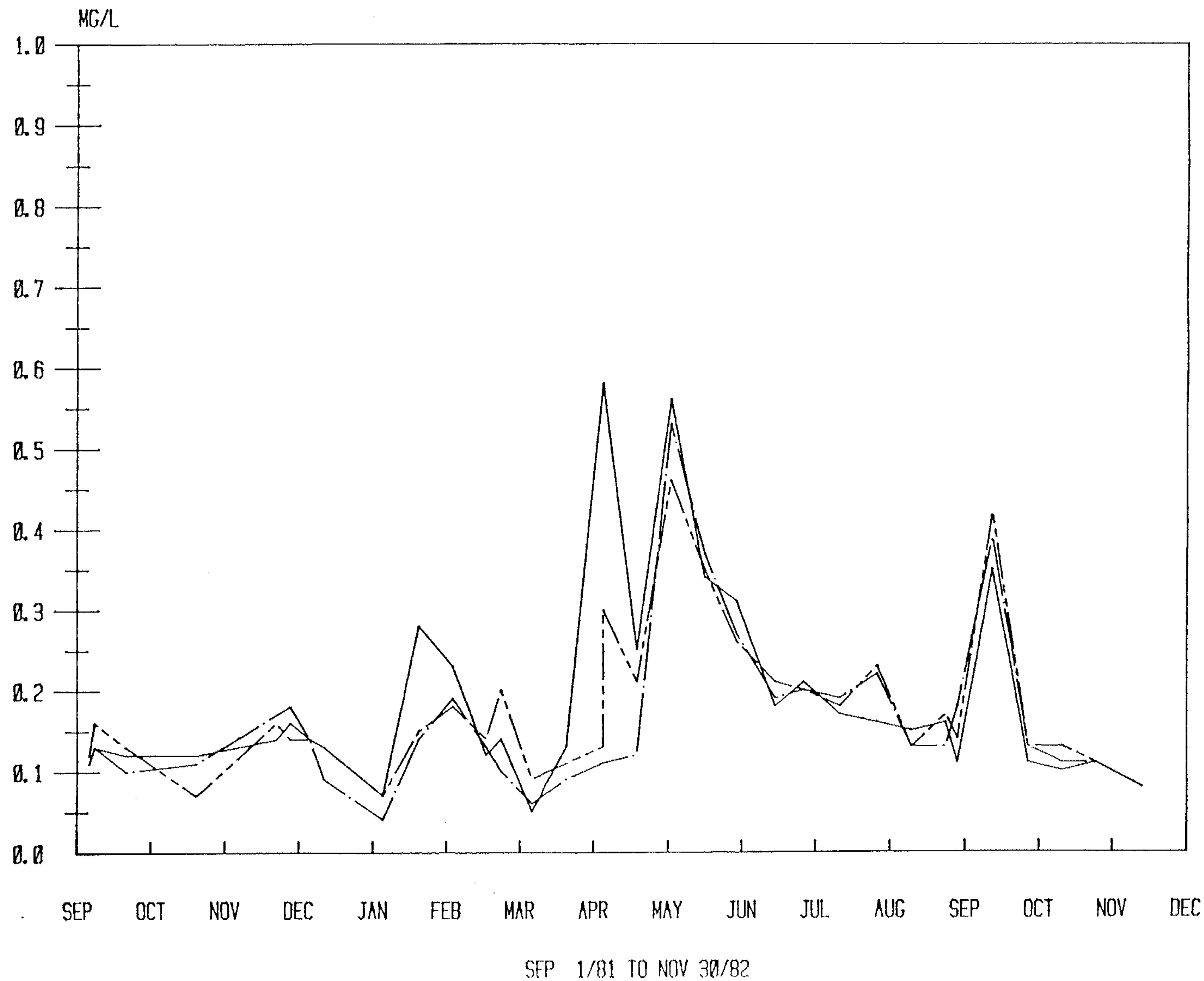


Figure 55 Comparison of Fraser River Kjeldahl Nitrogen Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

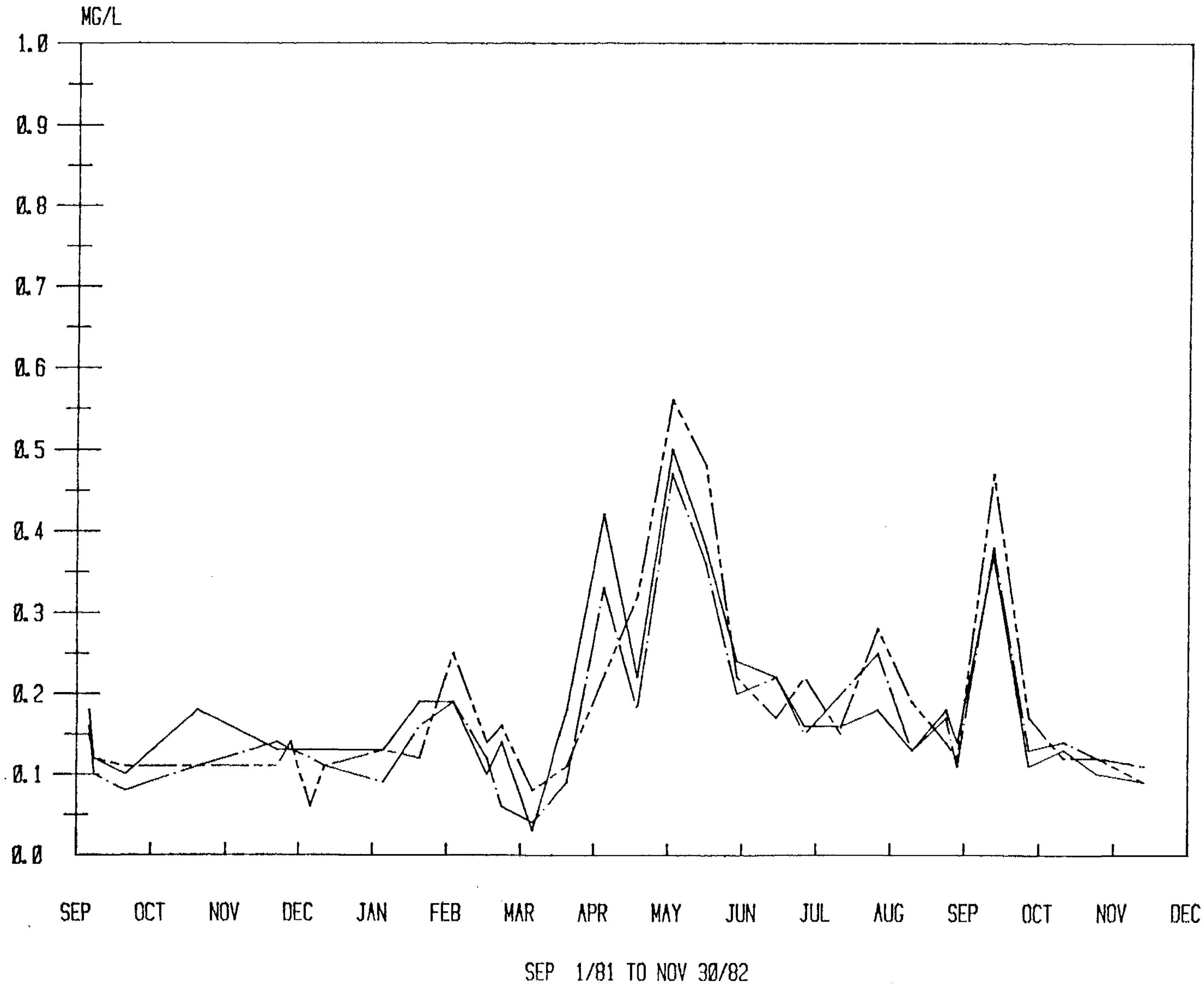


Figure 56 Surface and Depth Comparison of Fraser River Kjeldahl Nitrogen Concentration at the North Sampling Location, September 1982 to December 1982 (0300124, 0.m ———, 9.m -- ——— --)

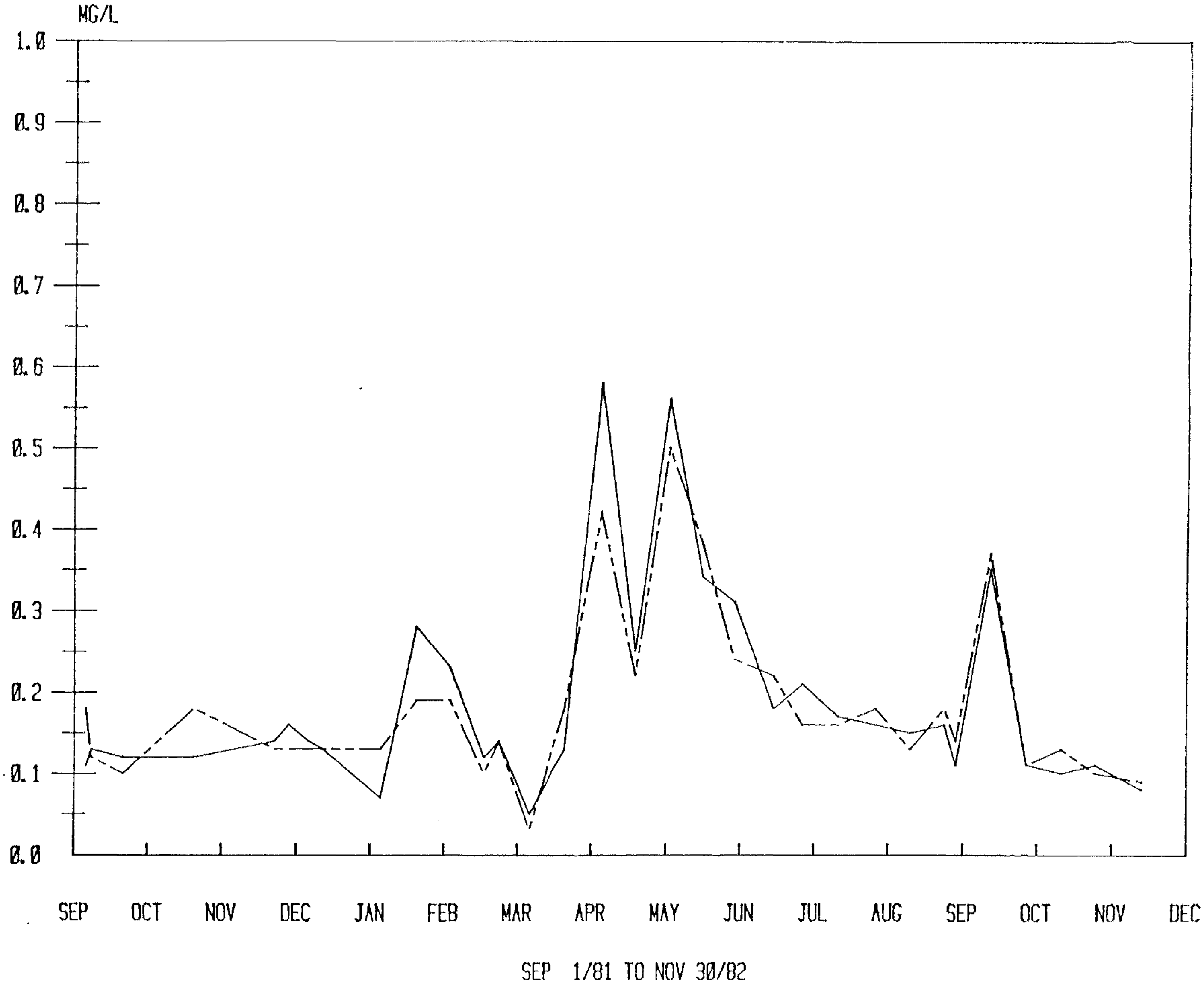


Figure 57 Surface and Depth Comparison of Fraser River Kjeldahl Nitrogen Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

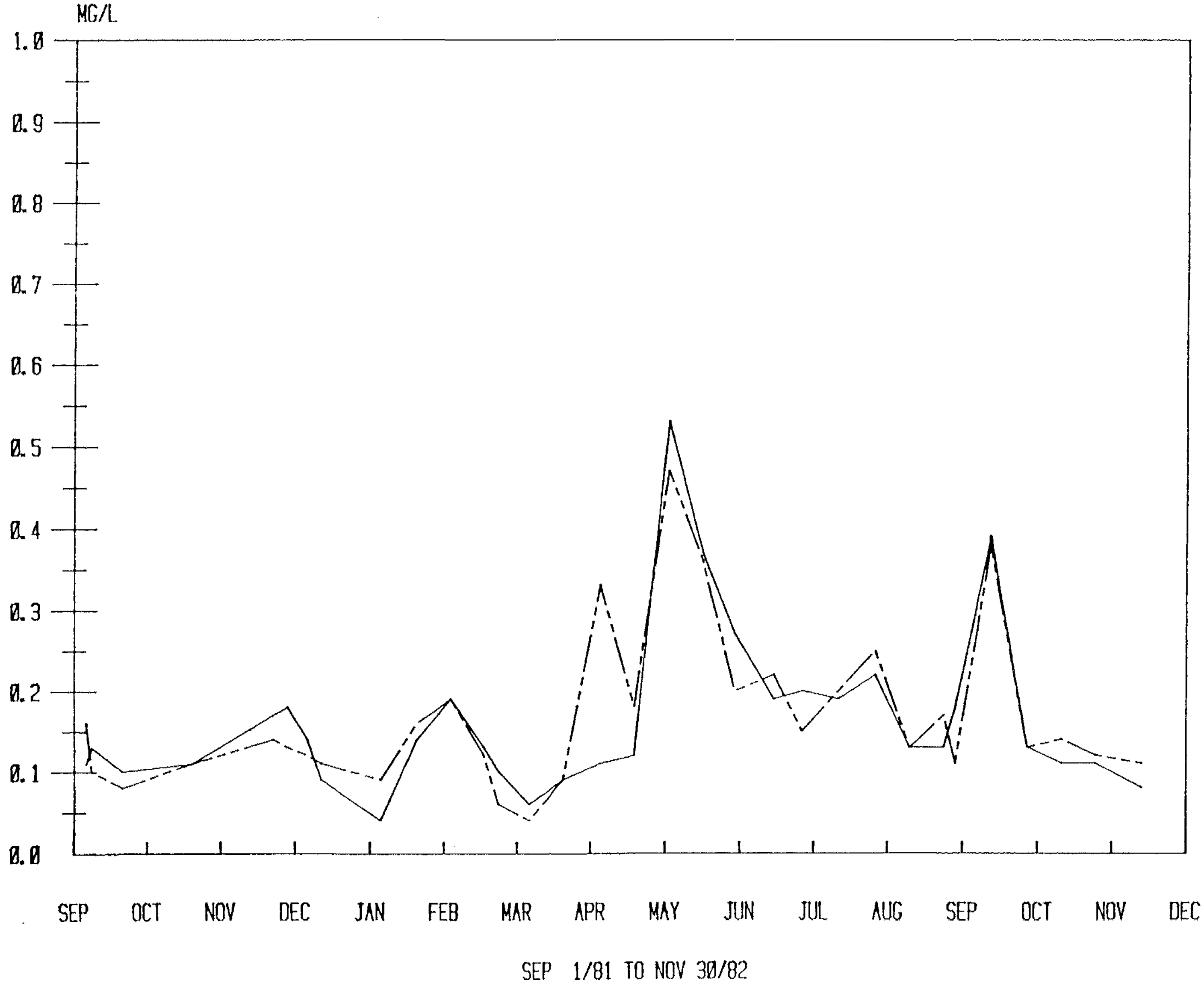


Figure 58 Surface and Depth Comparison of Fraser River Kjeldahl Nitrogen Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

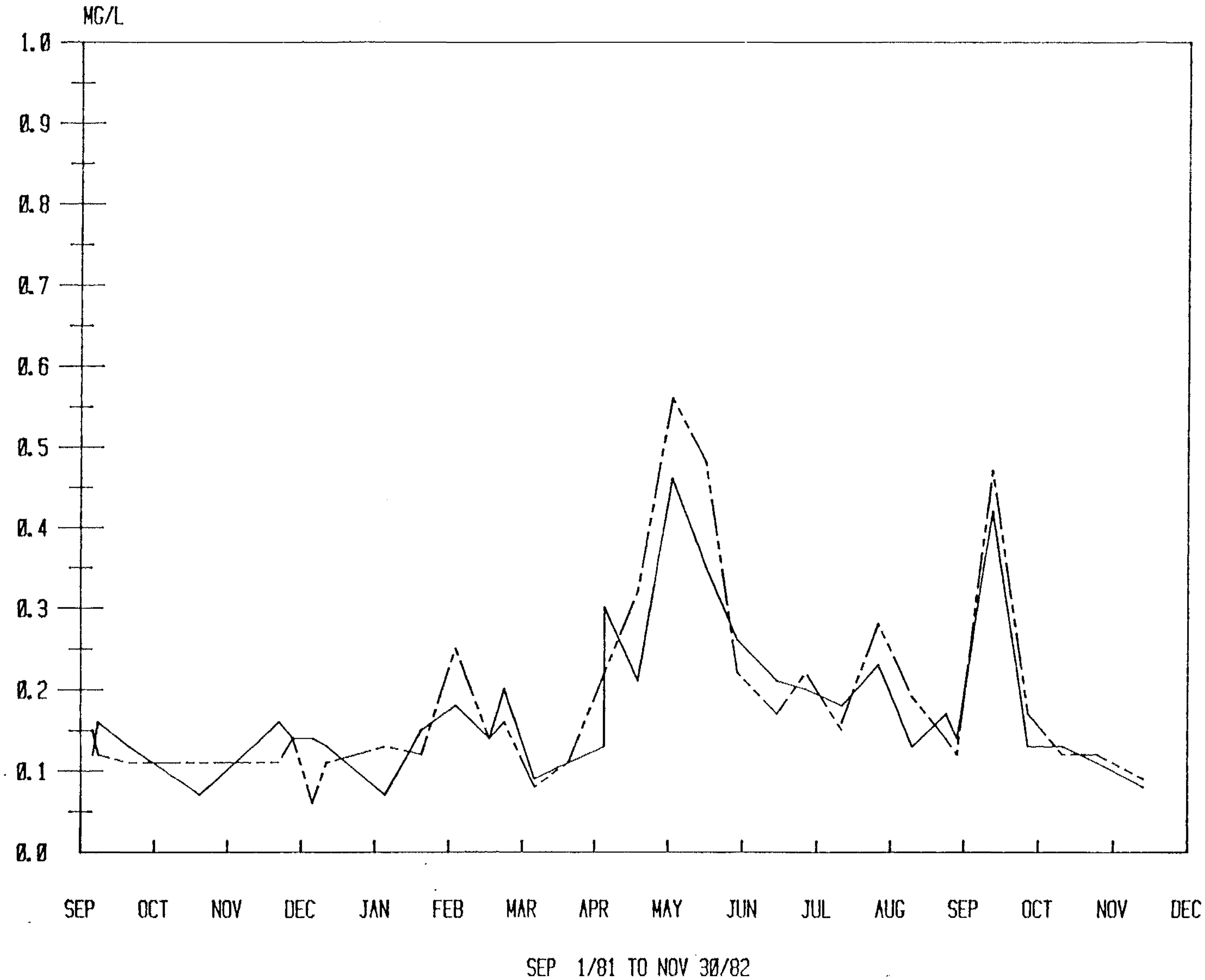


Figure 59 Comparison of Surface Fraser River Total Nitrogen Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

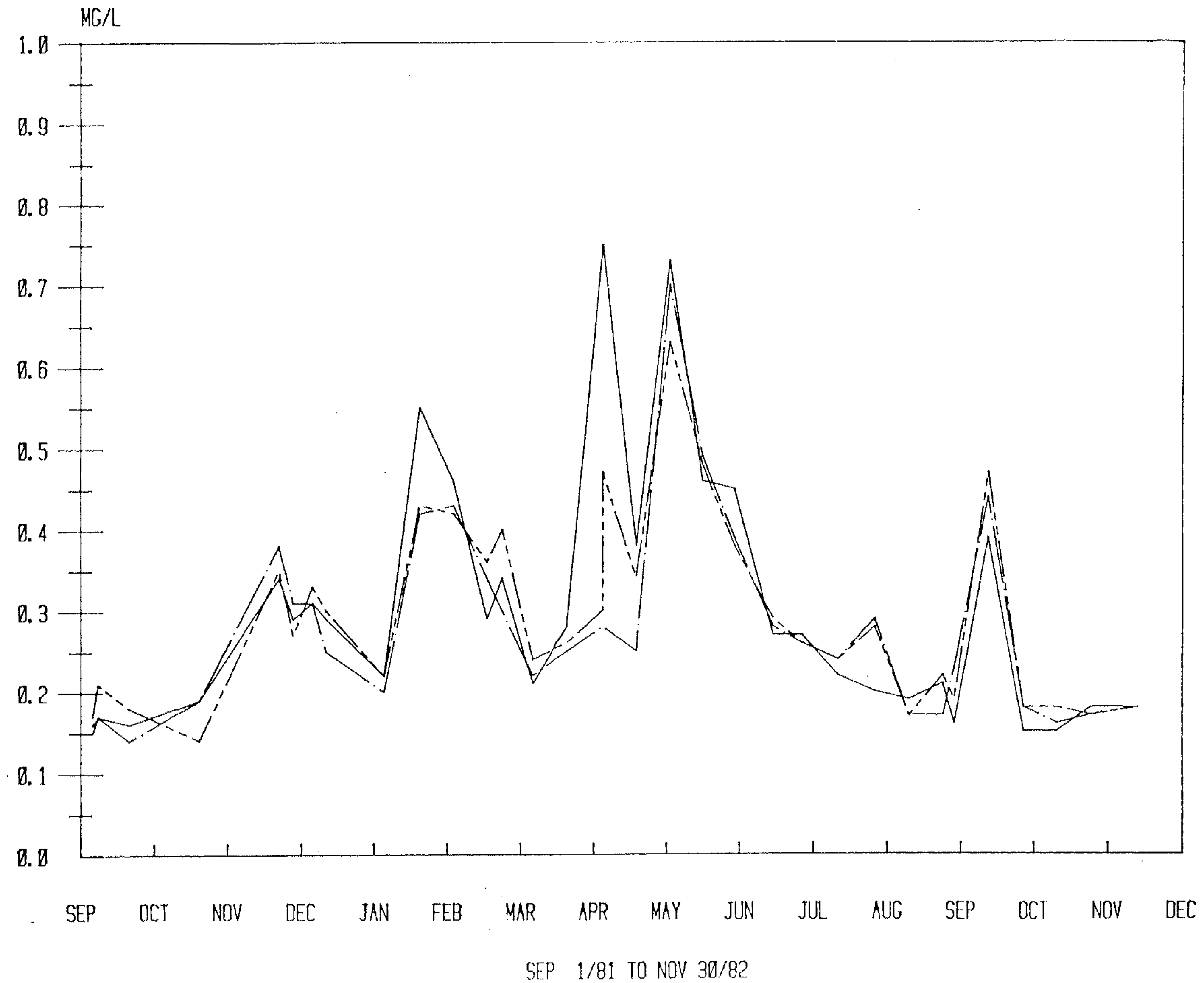


Figure 60 Comparison of Fraser River Total Nitrogen Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

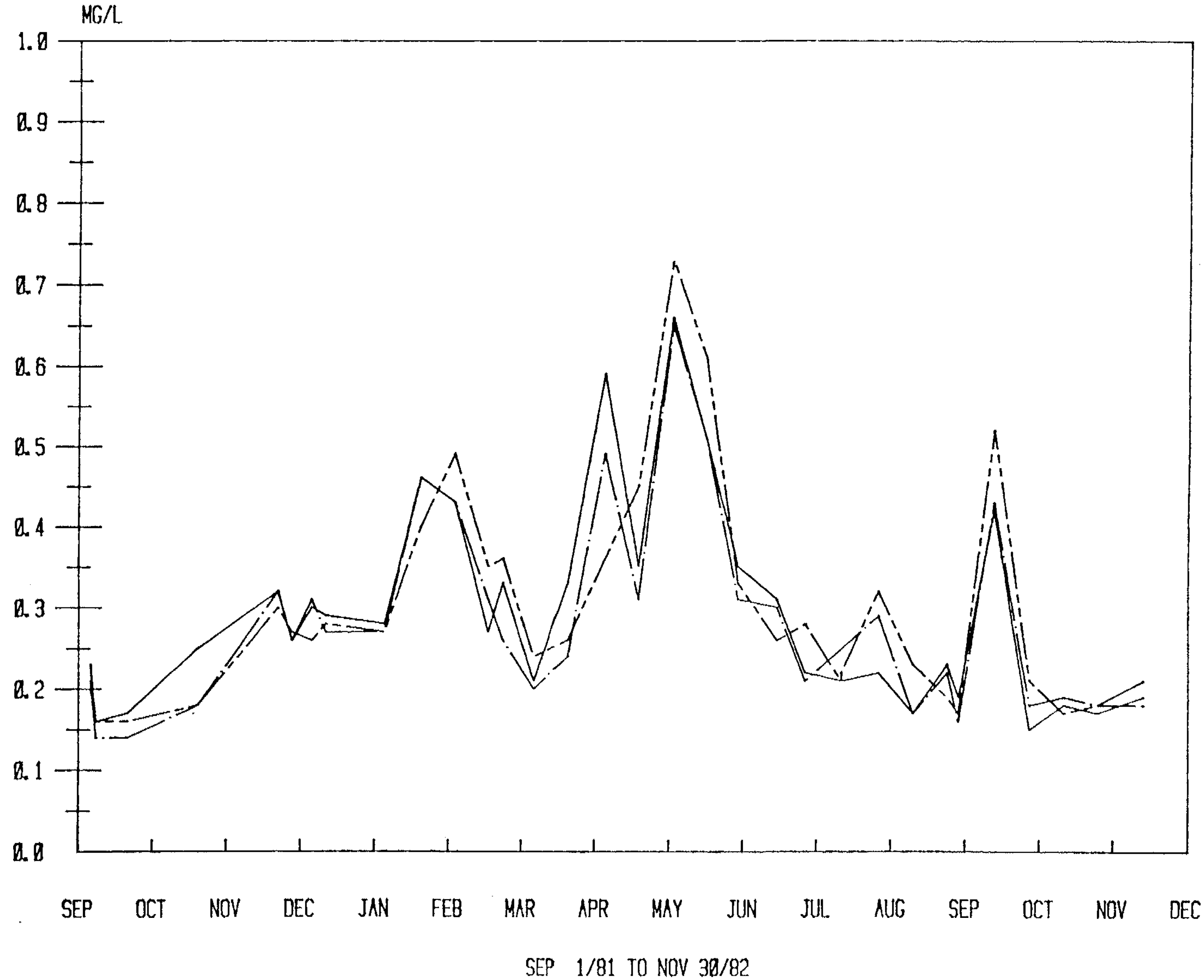


Figure 61 Surface and Depth Comparison of Fraser River Total Nitrogen Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

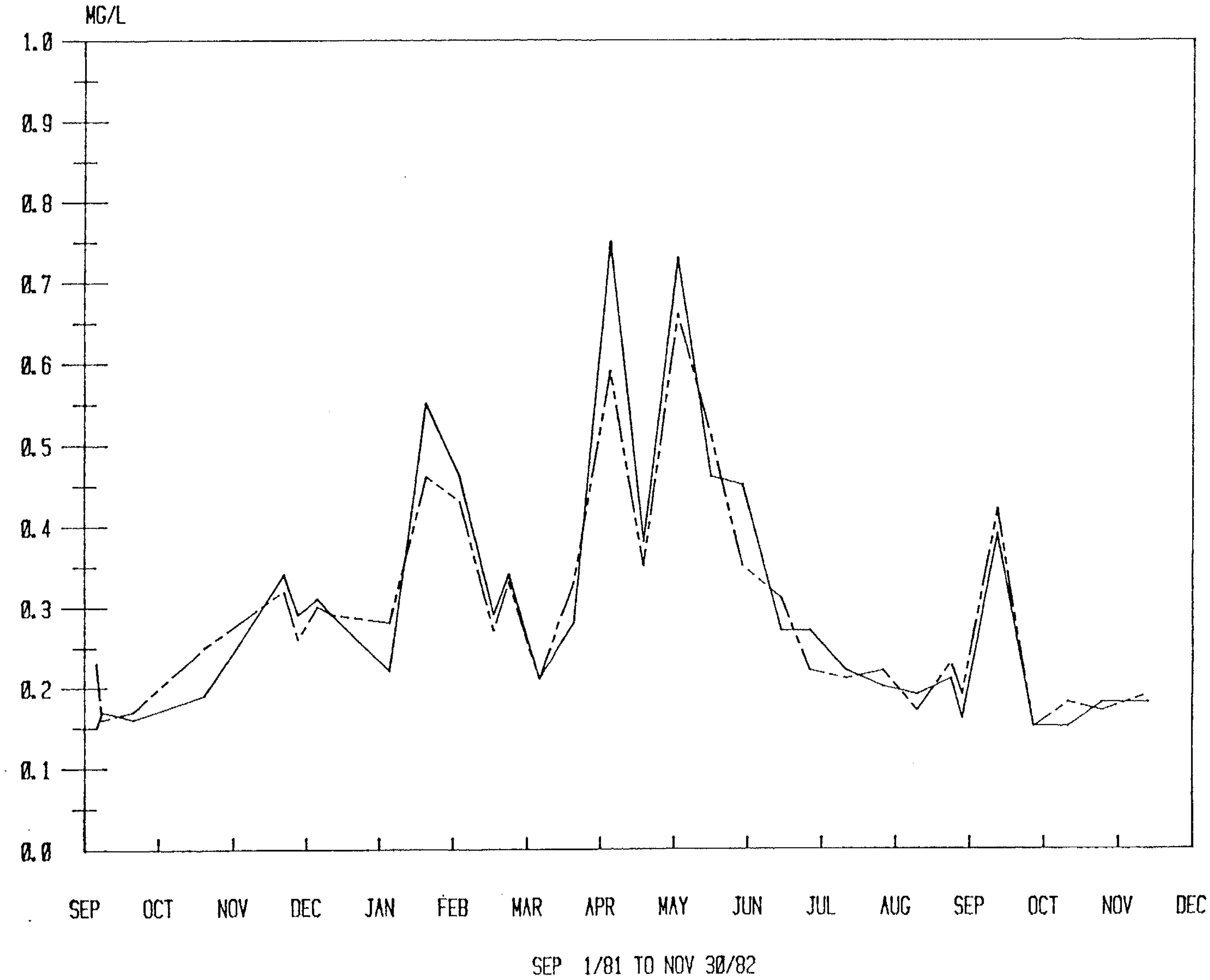


Figure 62 Surface and Depth Comparison of Fraser River Total Nitrogen Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0,m ———, 7.m -- —— --)

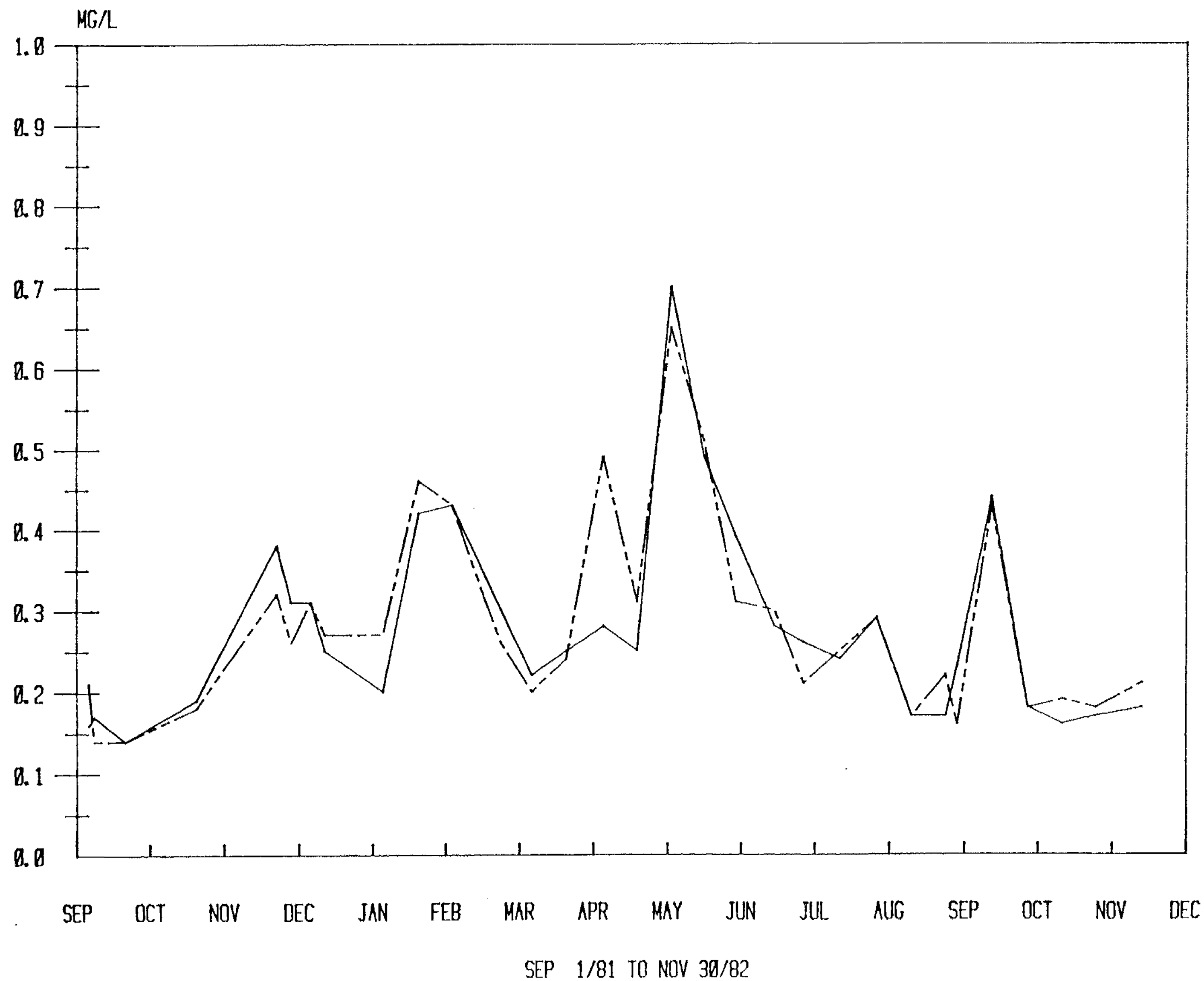


Figure 63 Surface and Depth Comparison of Fraser River Total Nitrogen Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

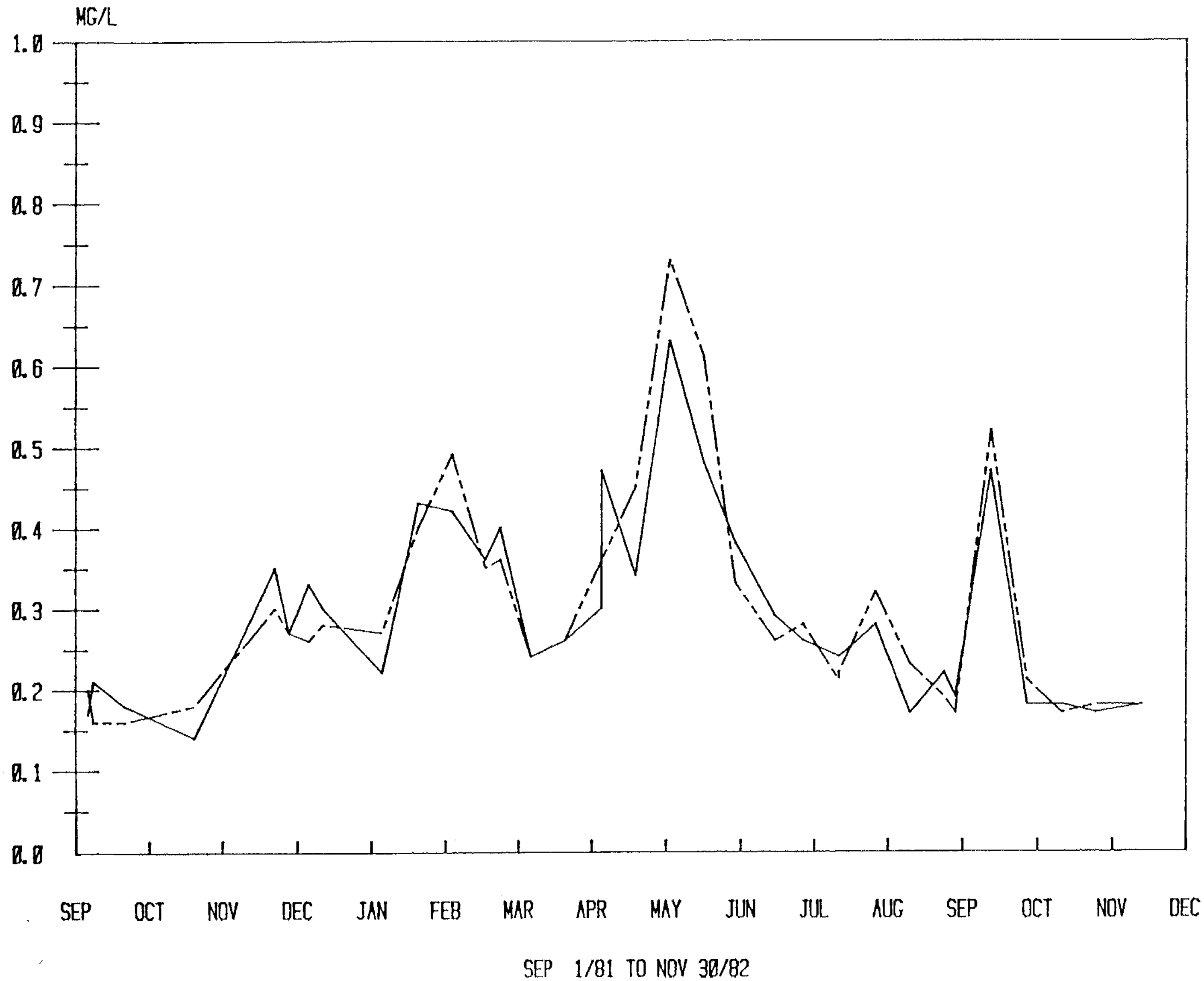


Figure 64 Comparison of Surface Fraser River Silica Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

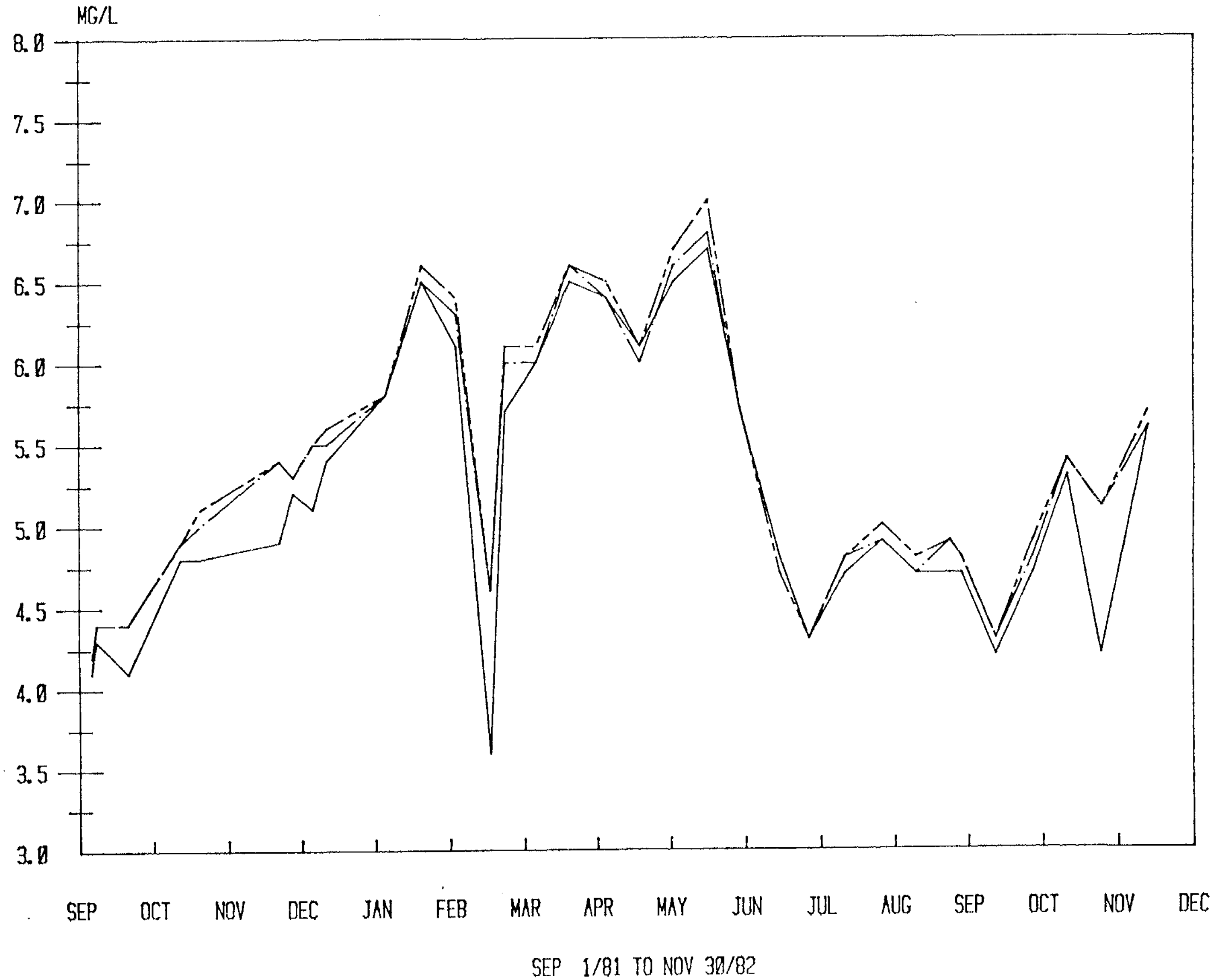


Figure 65 Comparison of Fraser River Silica Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

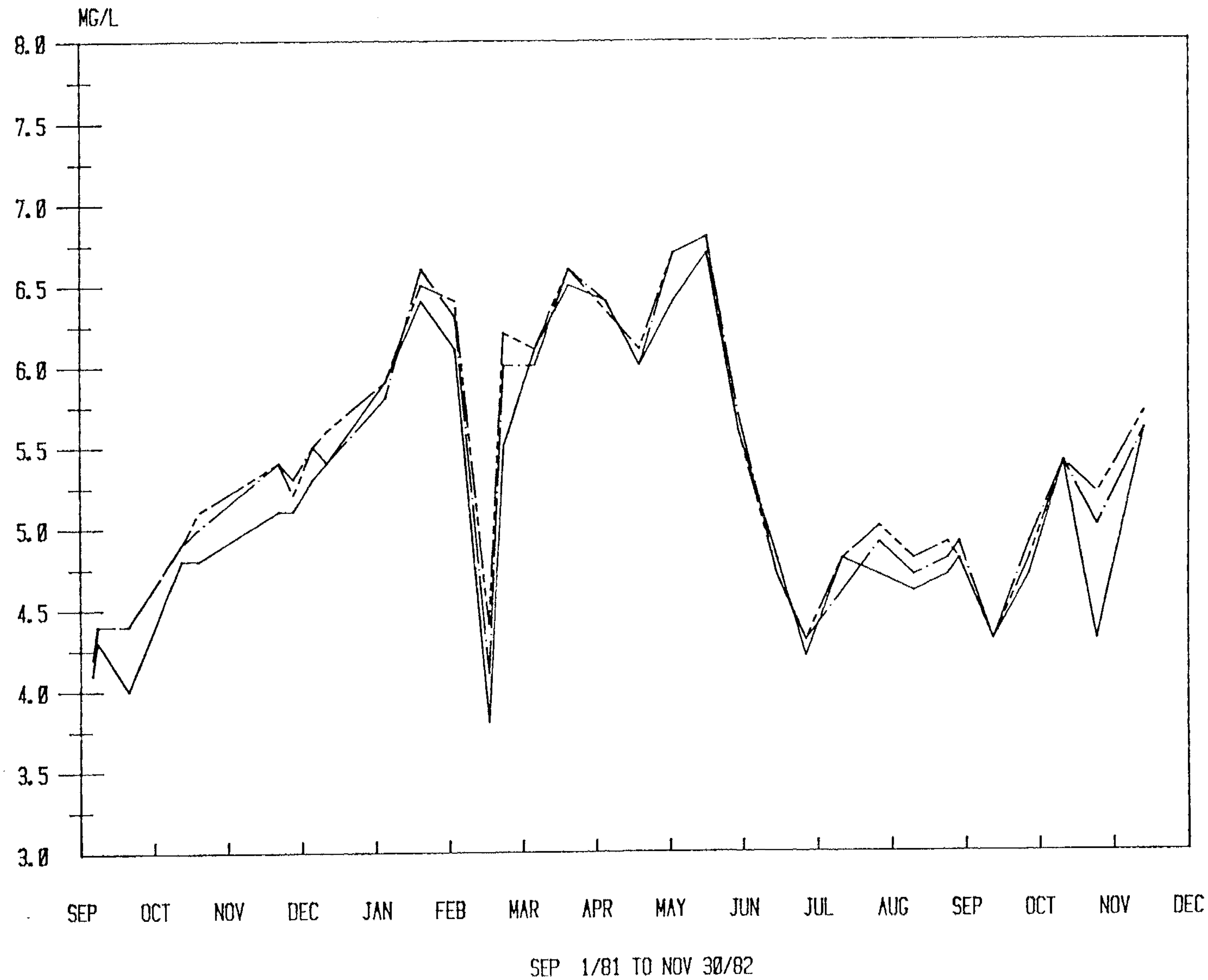


Figure 66 Surface and Depth Comparison of Fraser River Silica Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

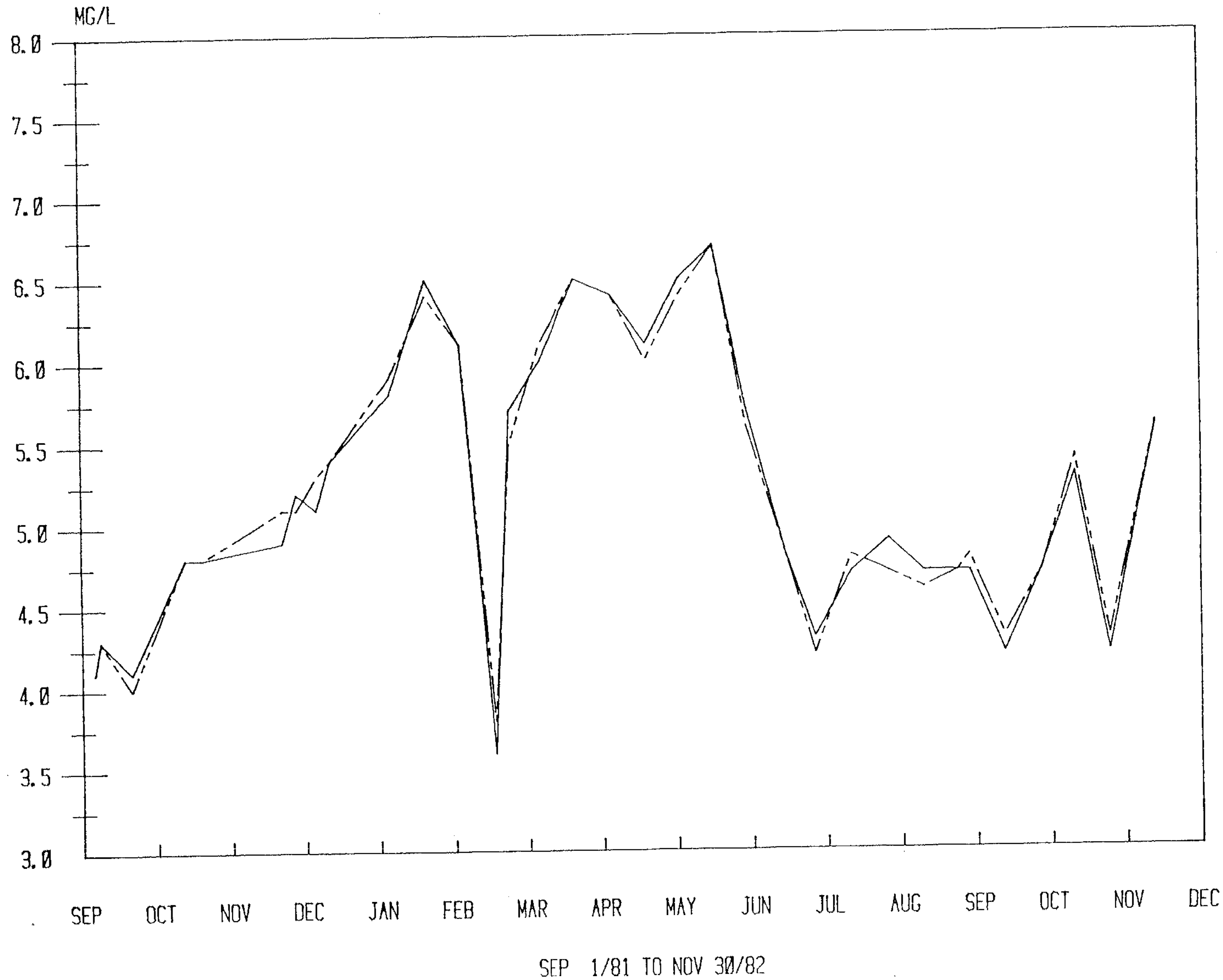


Figure 67 Surface and Depth Comparison of Fraser River Silica Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

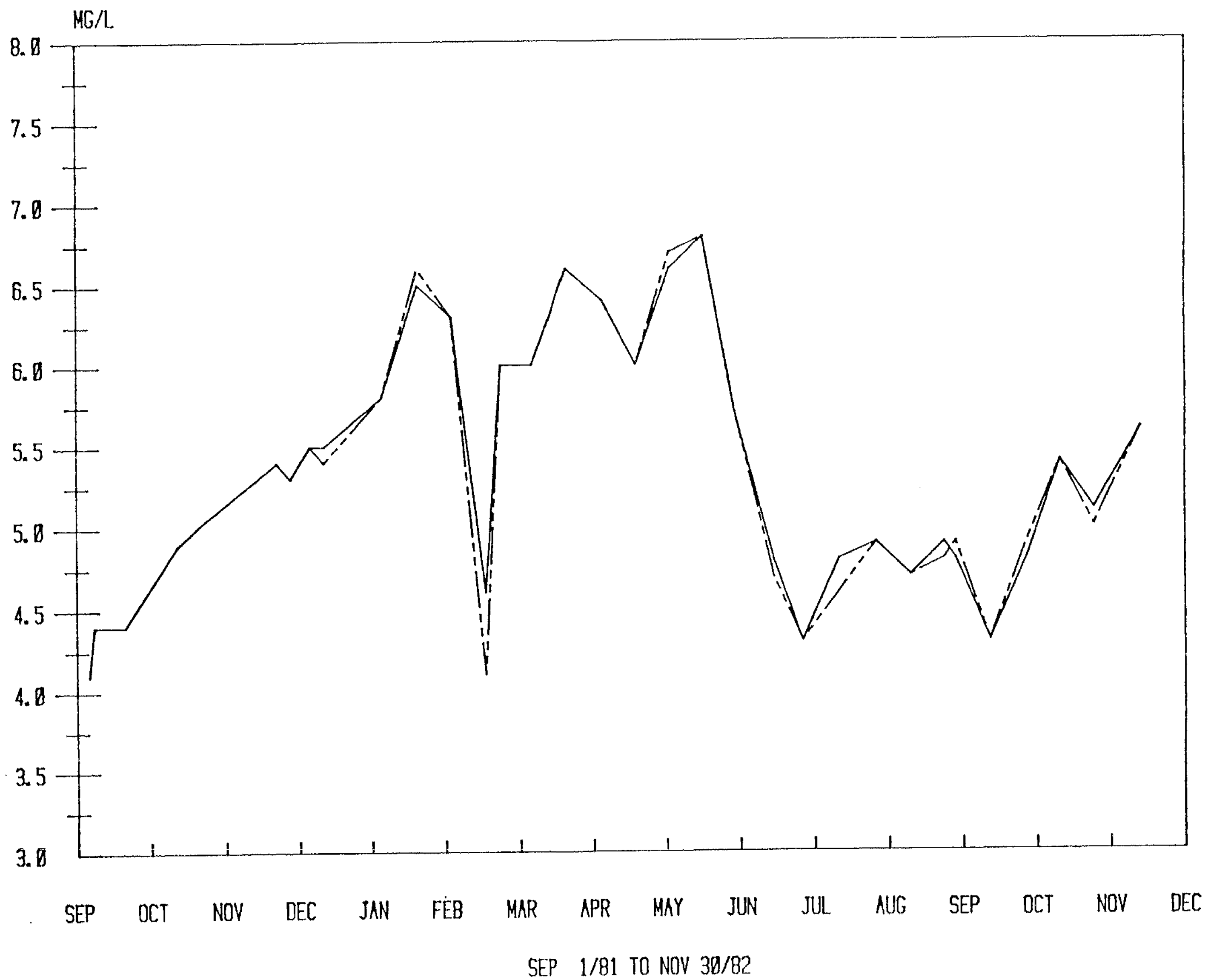


Figure 68 Surface and Depth Comparison of Fraser River Silica Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

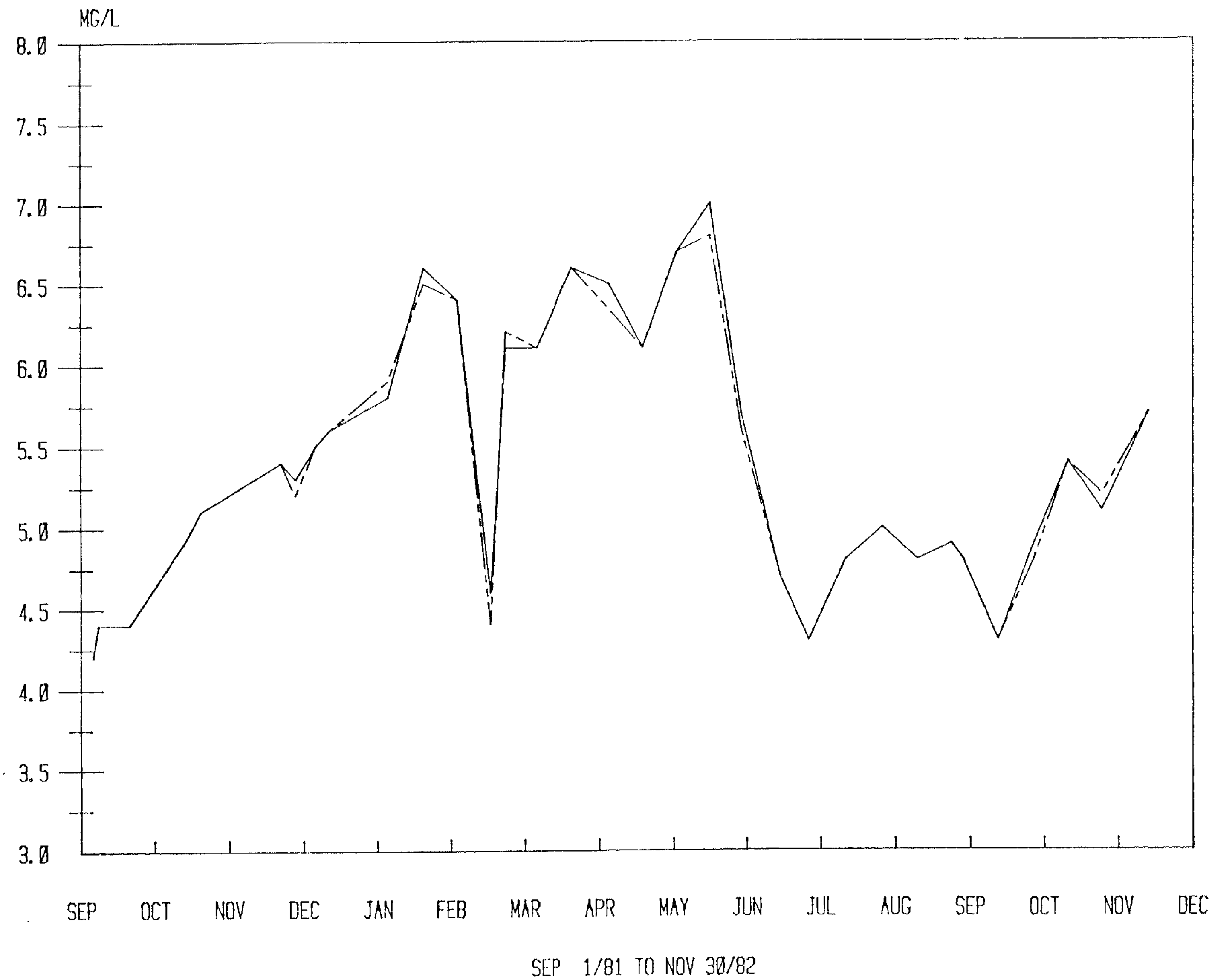


Figure 69 Comparison of Surface Fraser River Non-filterable Residue Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

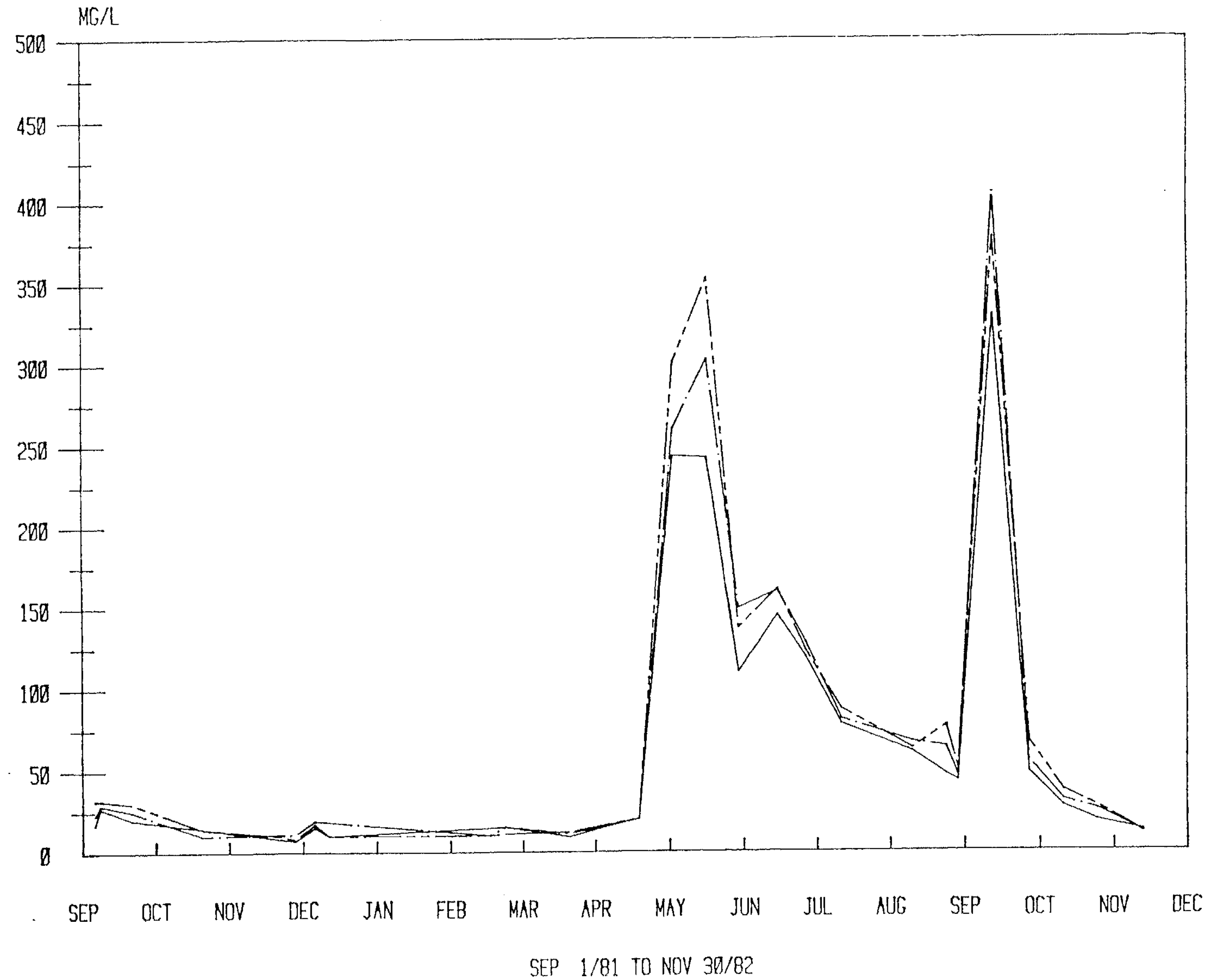


Figure 70 Comparison of Fraser River Non-filterable Residue Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

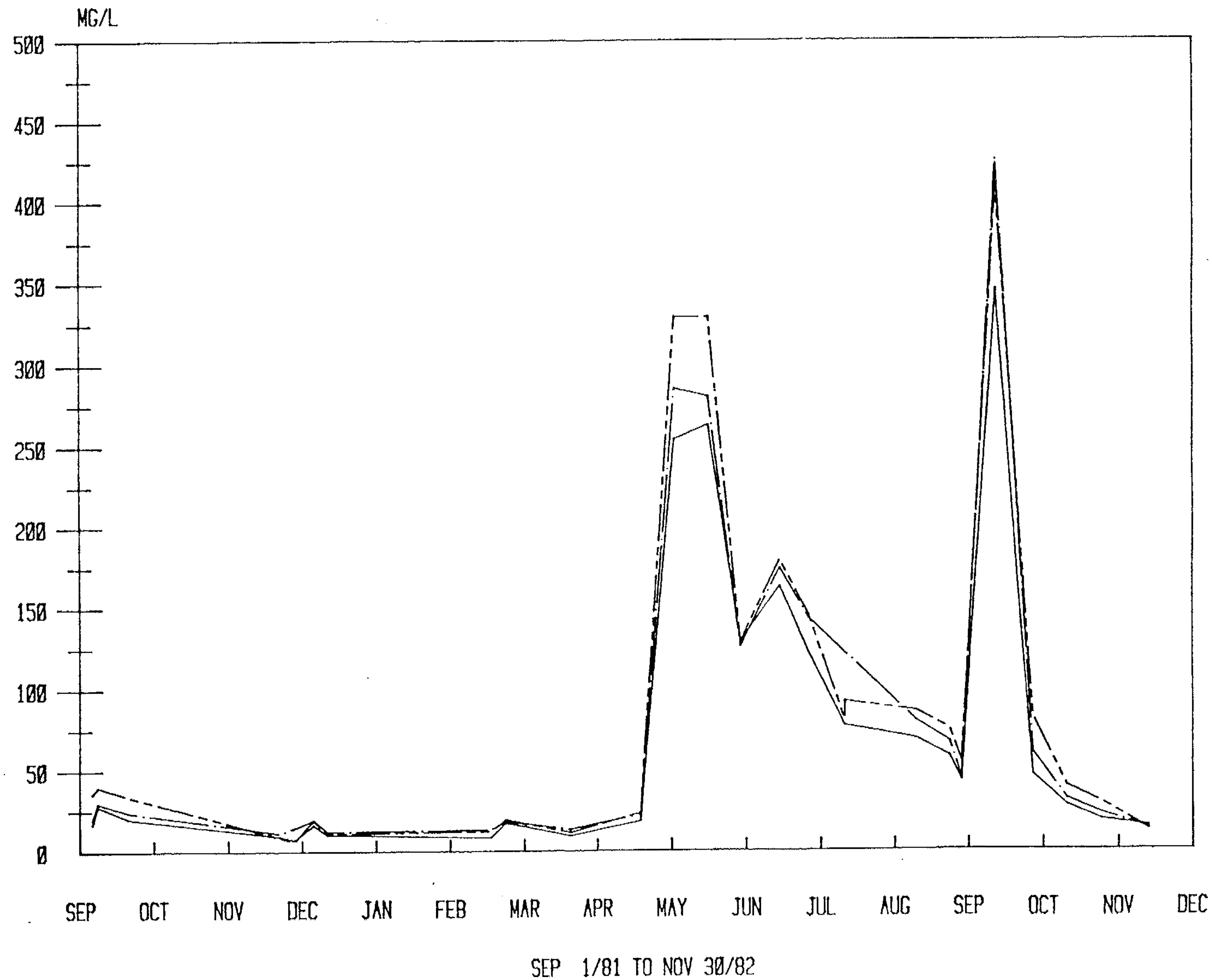


Figure 71 Surface and Depth Comparison of Fraser River Non-filterable Residue Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

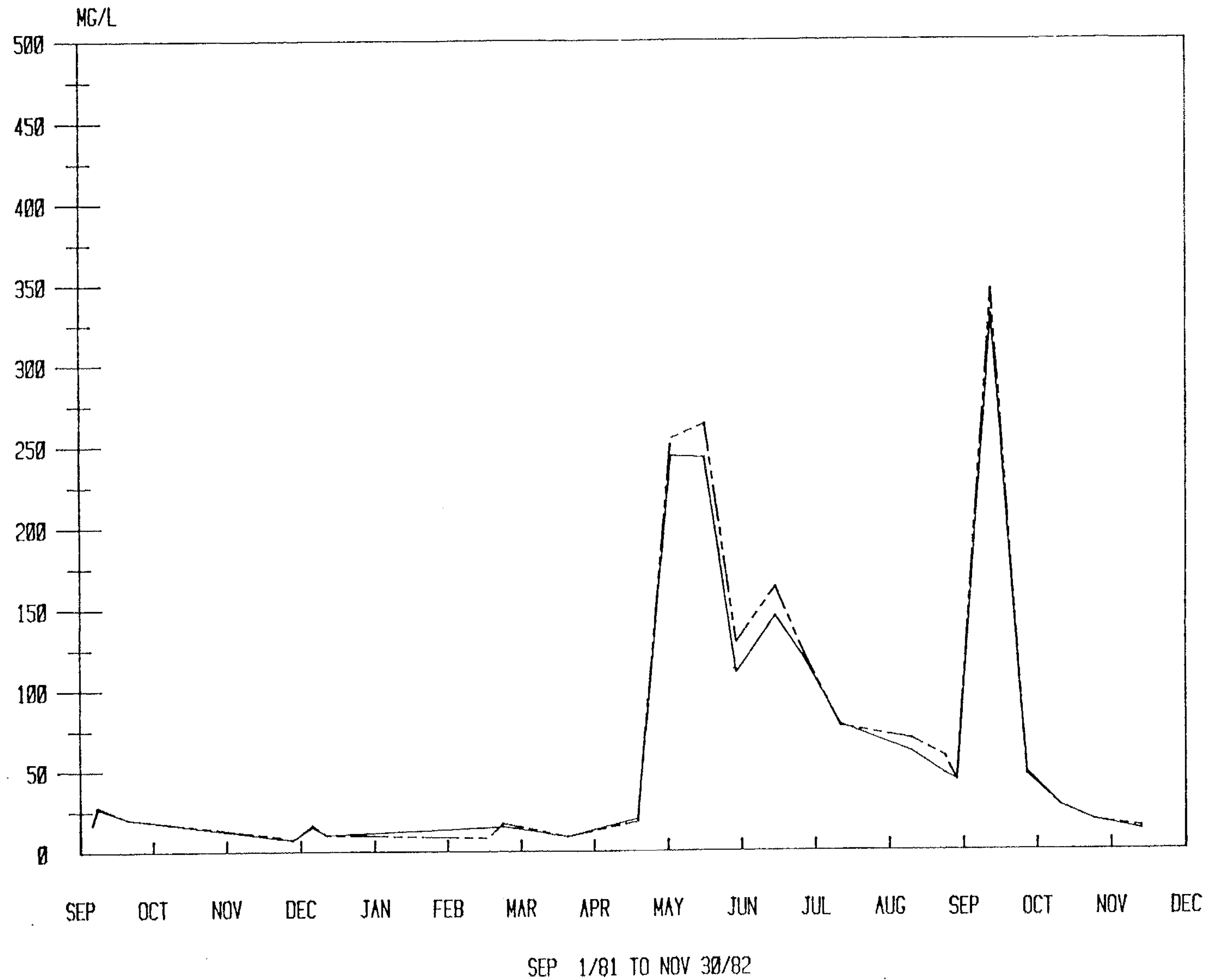


Figure 72 Surface and Depth Comparison of Fraser River Non-filterable Residue Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

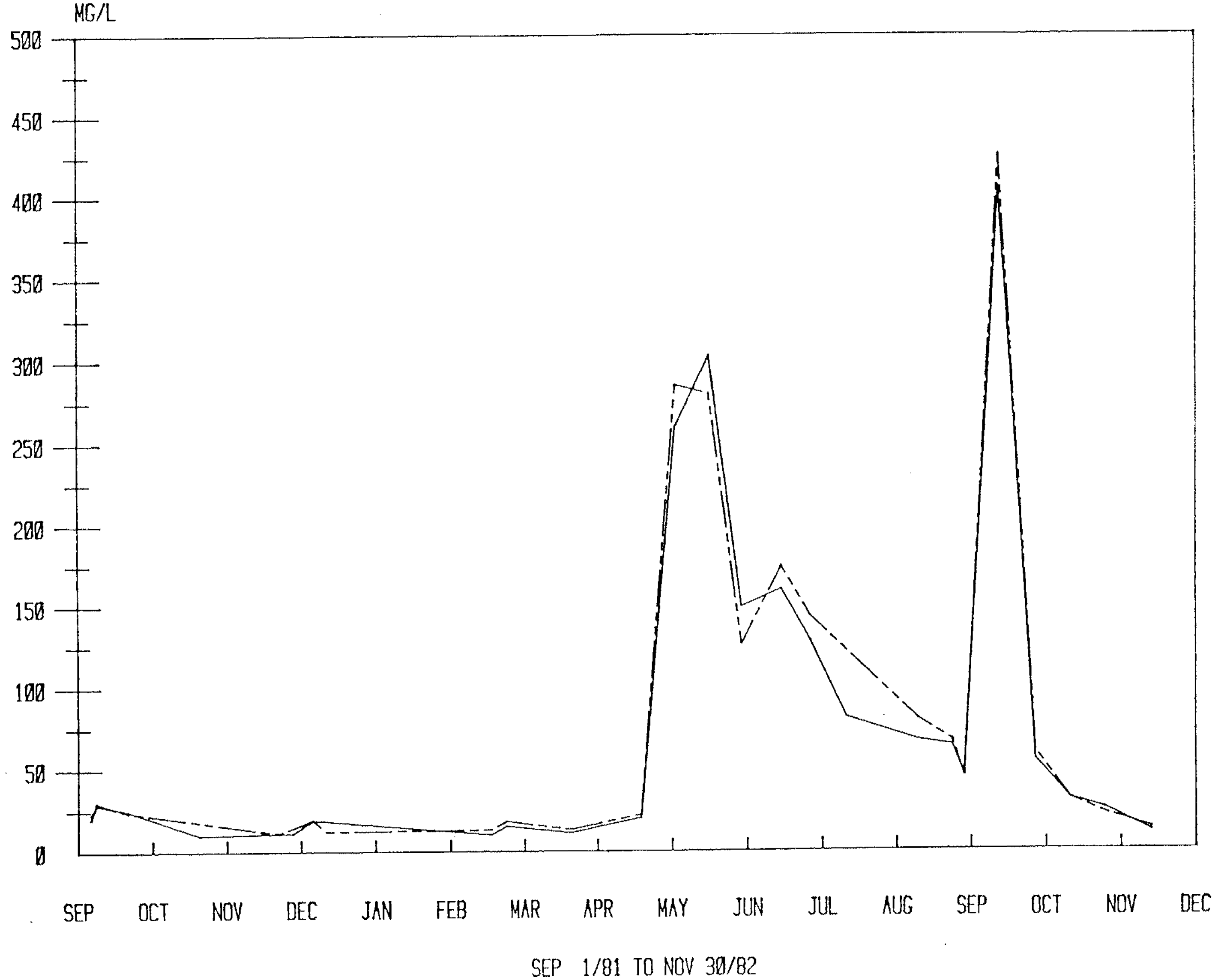


Figure 73 Surface and Depth Comparison of Fraser River Non-filterable Residue Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

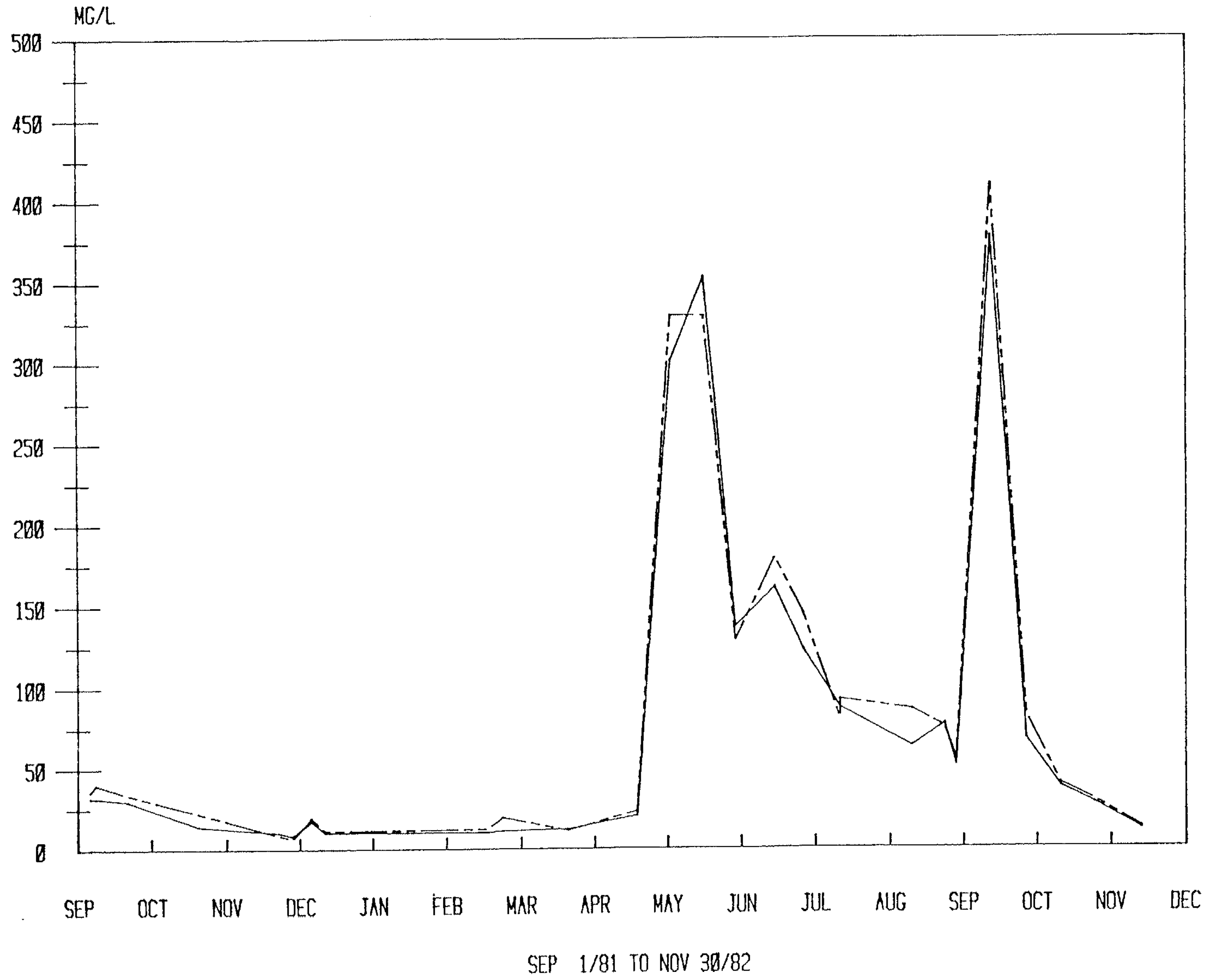


Figure 74 Comparison of Surface Fraser River Total Residue Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

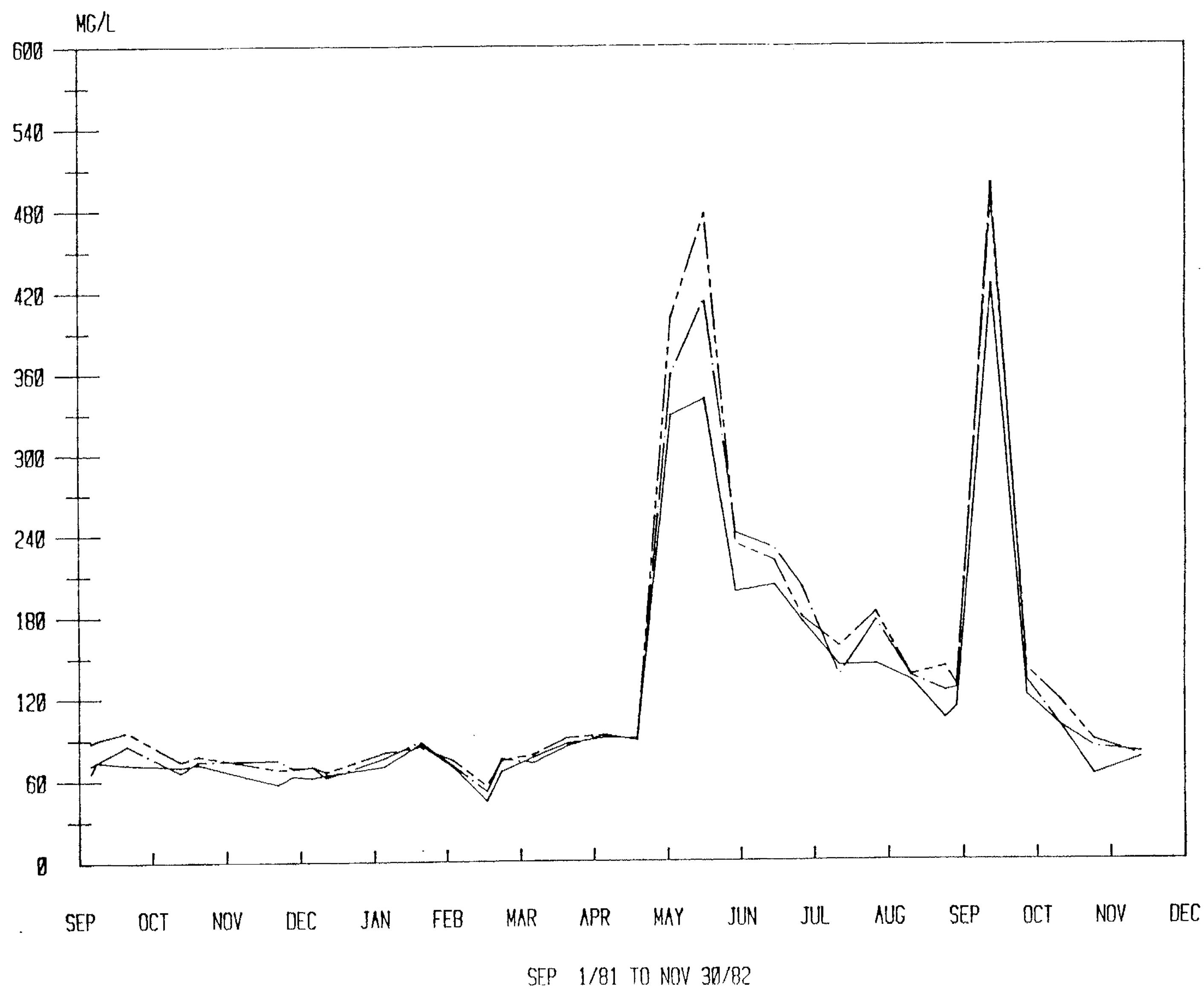


Figure 75 Comparison of Fraser River Total Residue Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

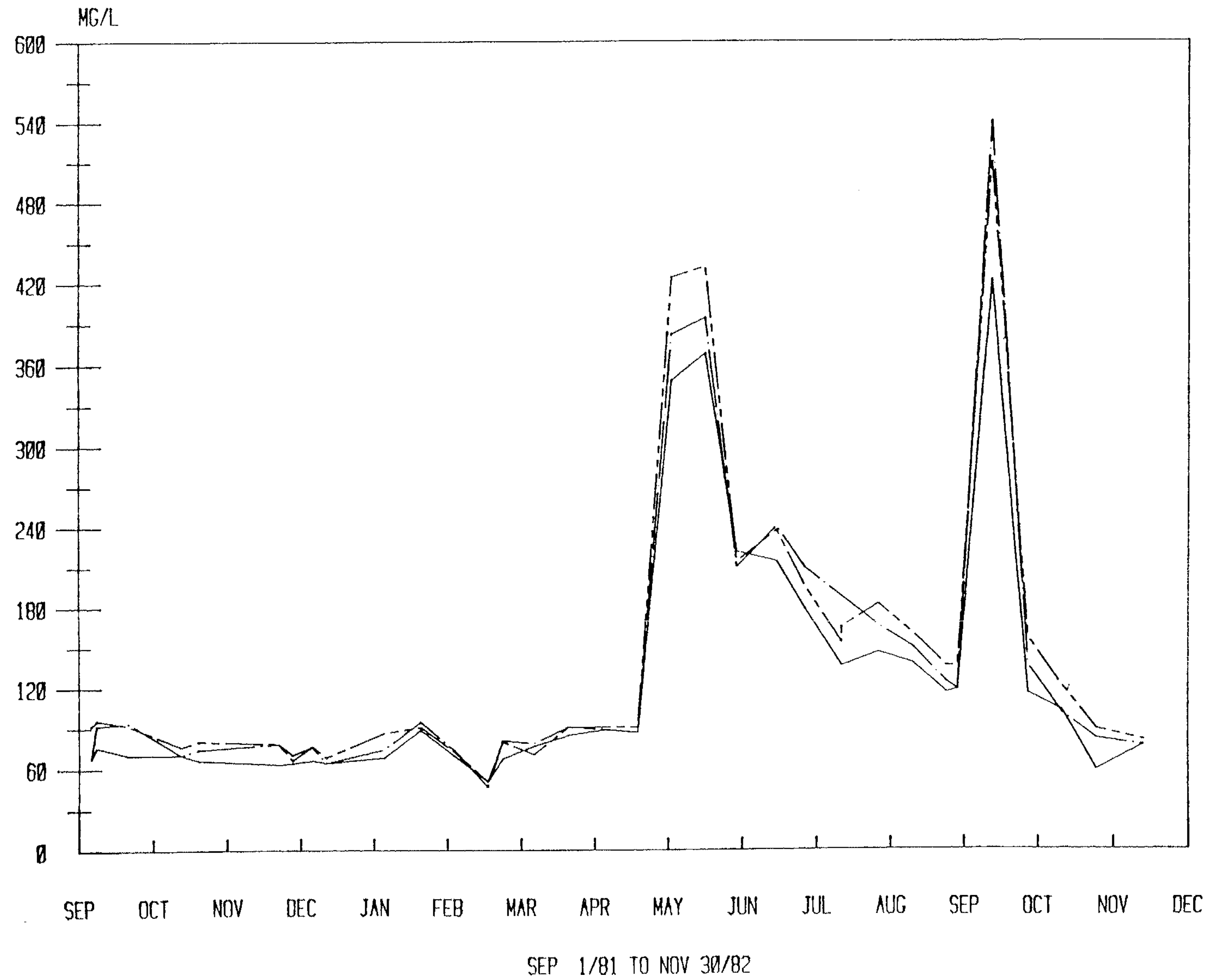


Figure 76 Surface and Depth Comparison of Fraser River Total Residue Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

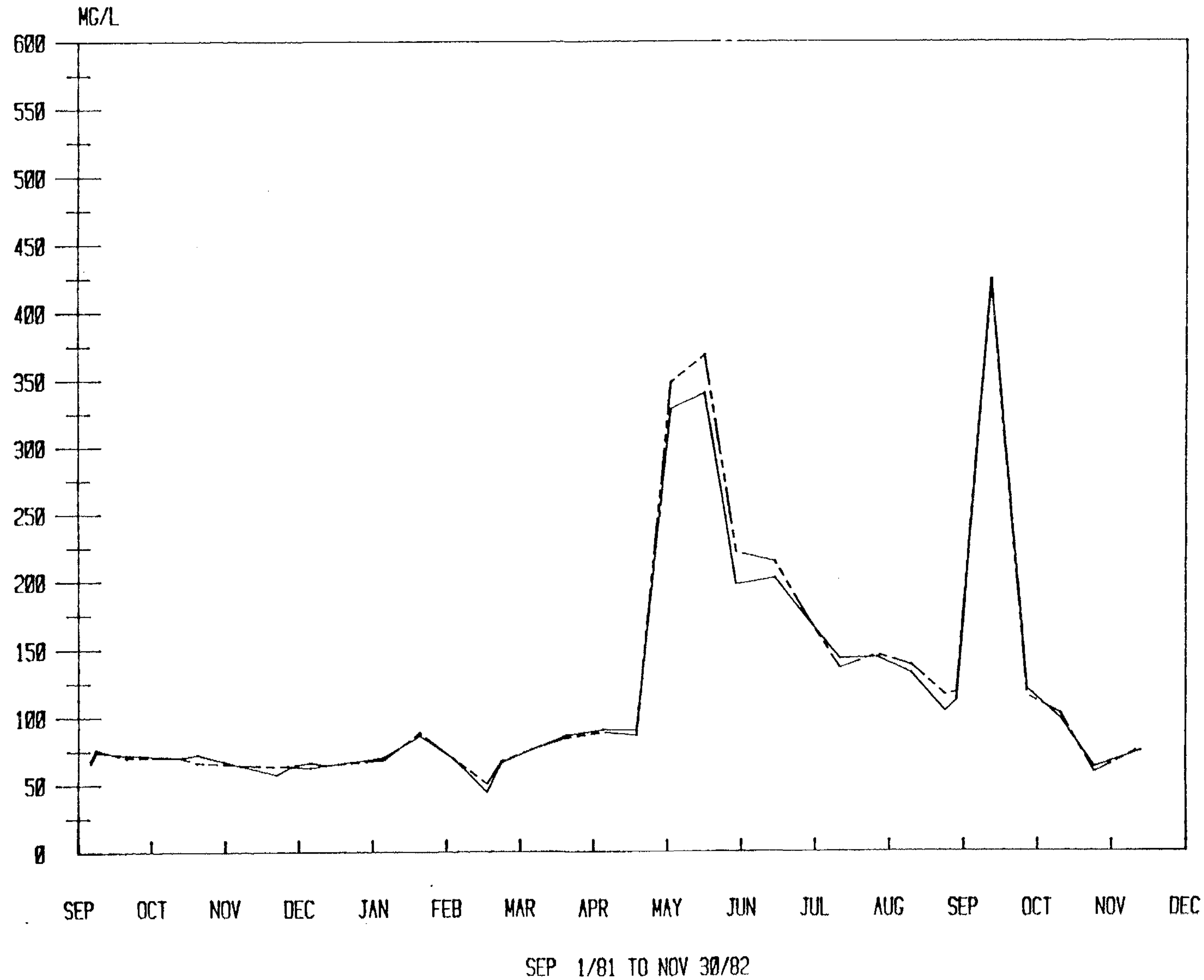


Figure 77 Surface and Depth Comparison of Fraser River Total Residue Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

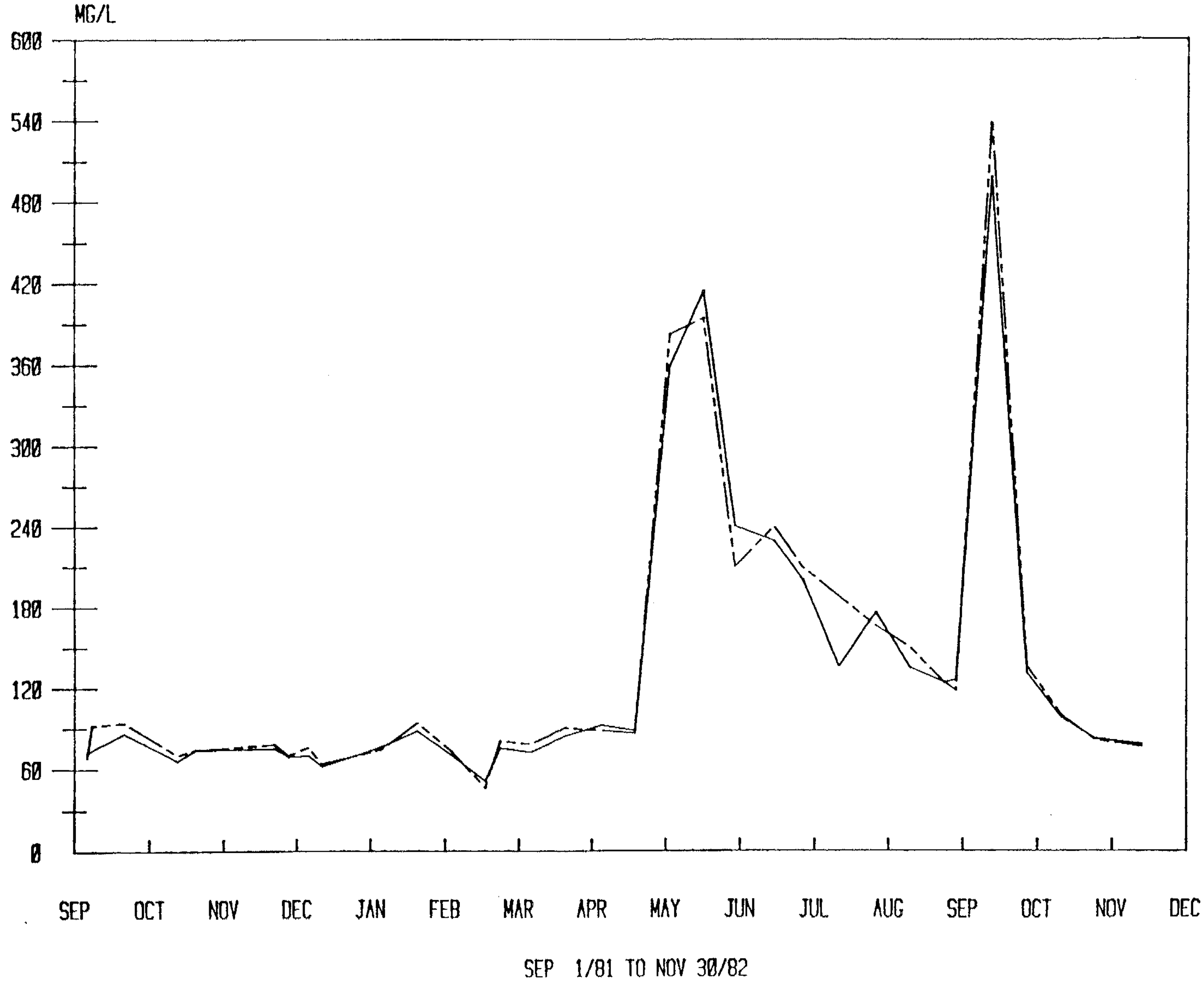


Figure 78 Surface and Depth Comparison of Fraser River Total Residue Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

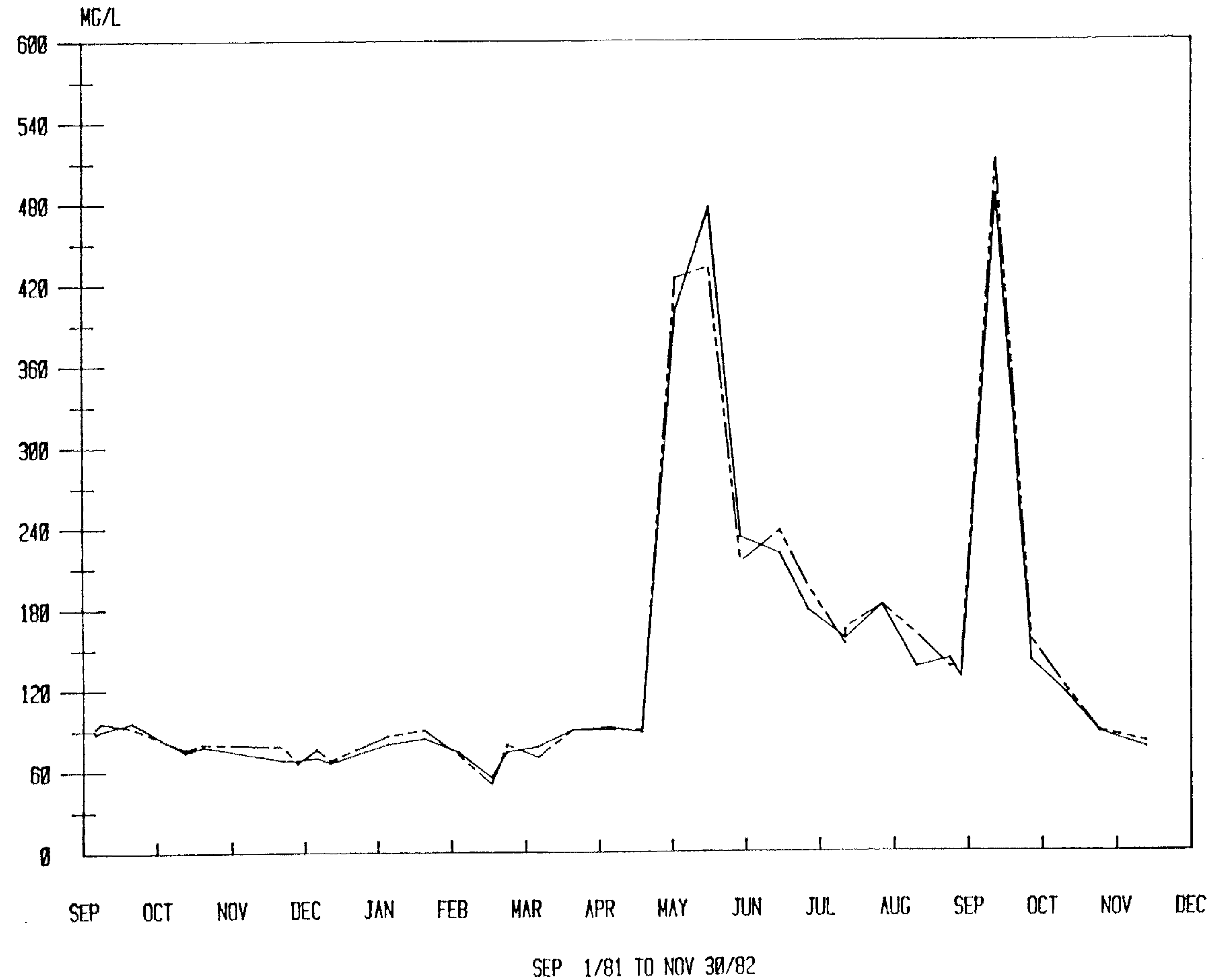


Figure 79 Comparison of Surface Fraser River Total Copper Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

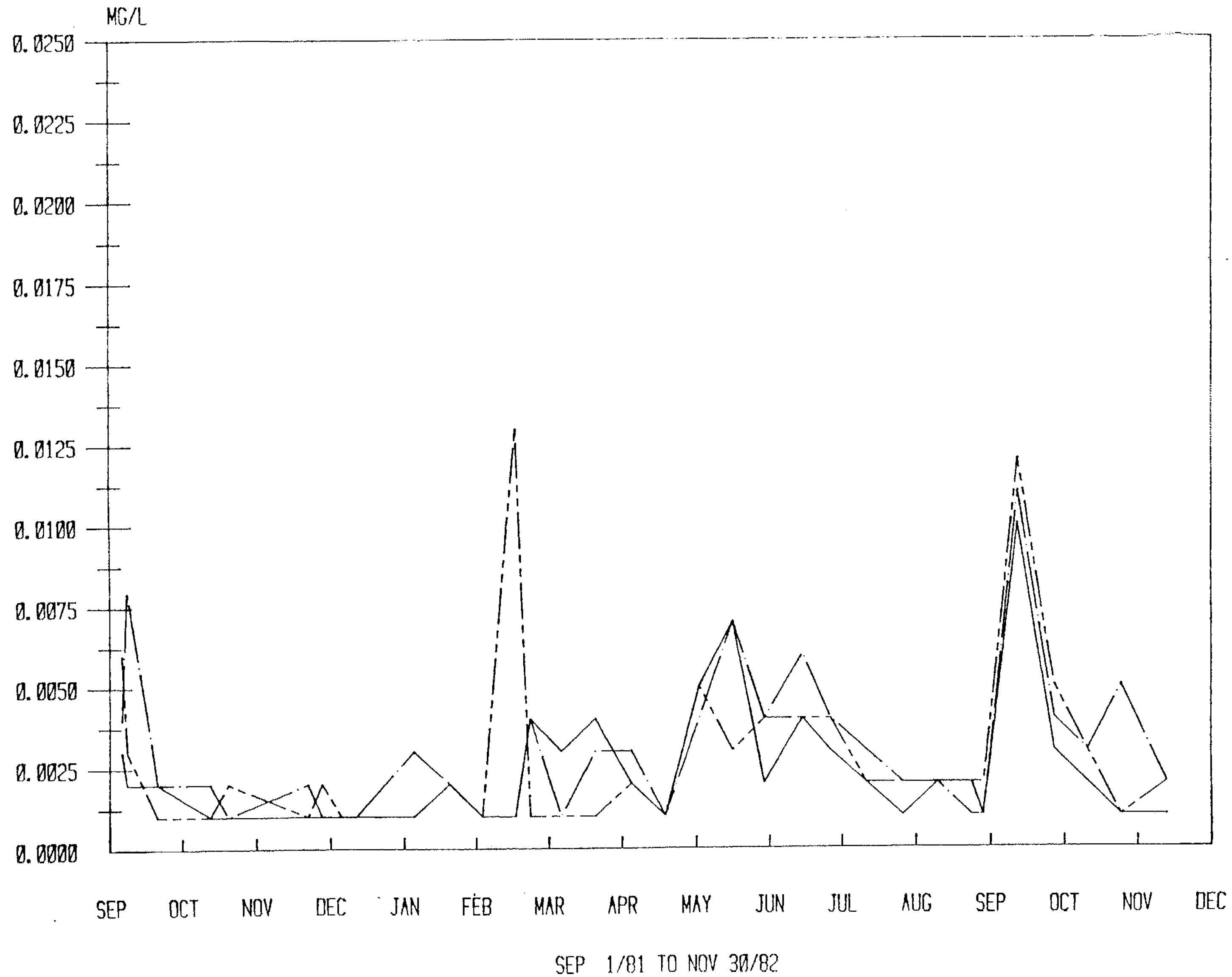


Figure 80 Comparison of Fraser River Total Copper Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

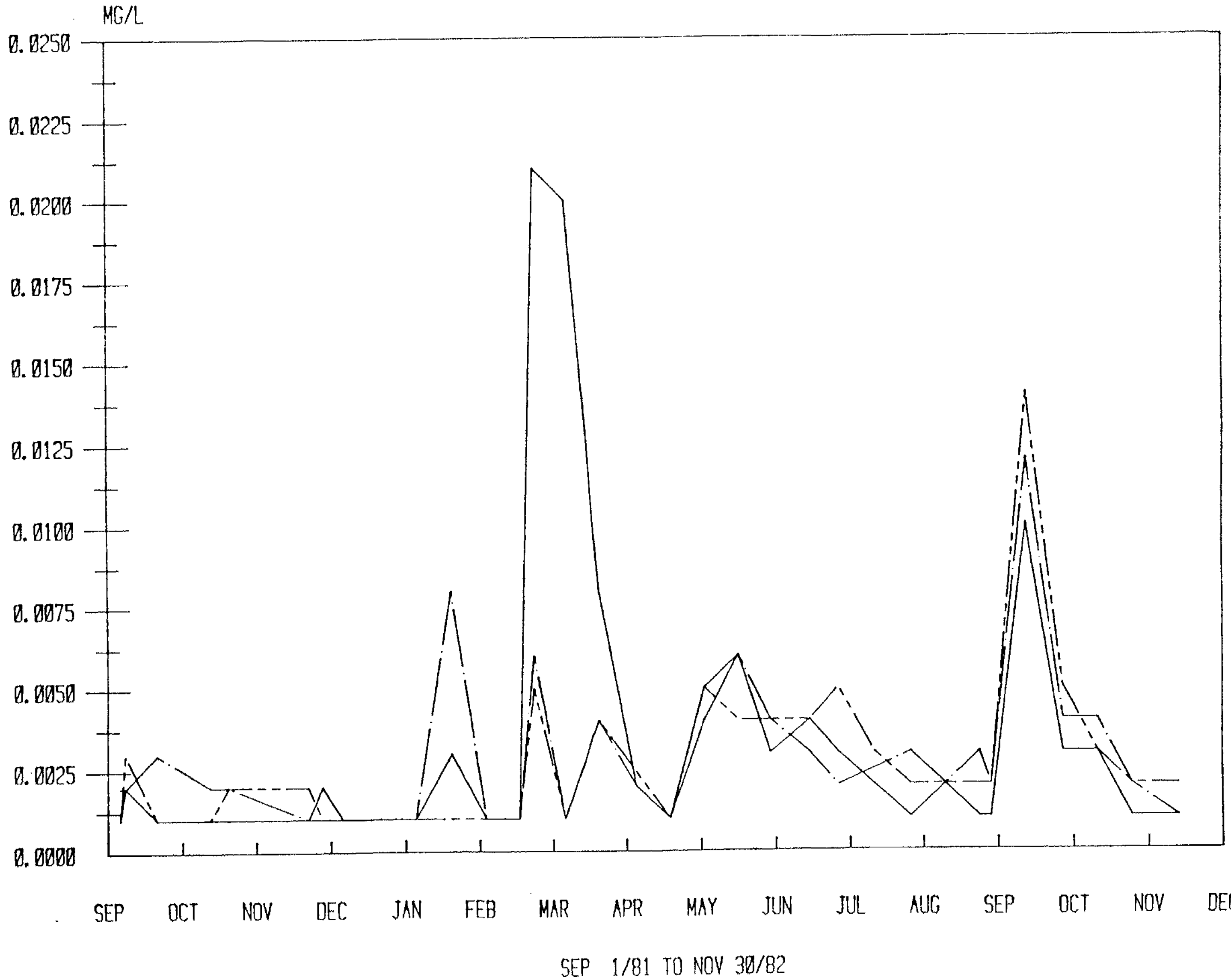


Figure 81 Surface and Depth Comparison of Fraser River Total Copper Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124, 0.m ———, 9.m -- ——— --)

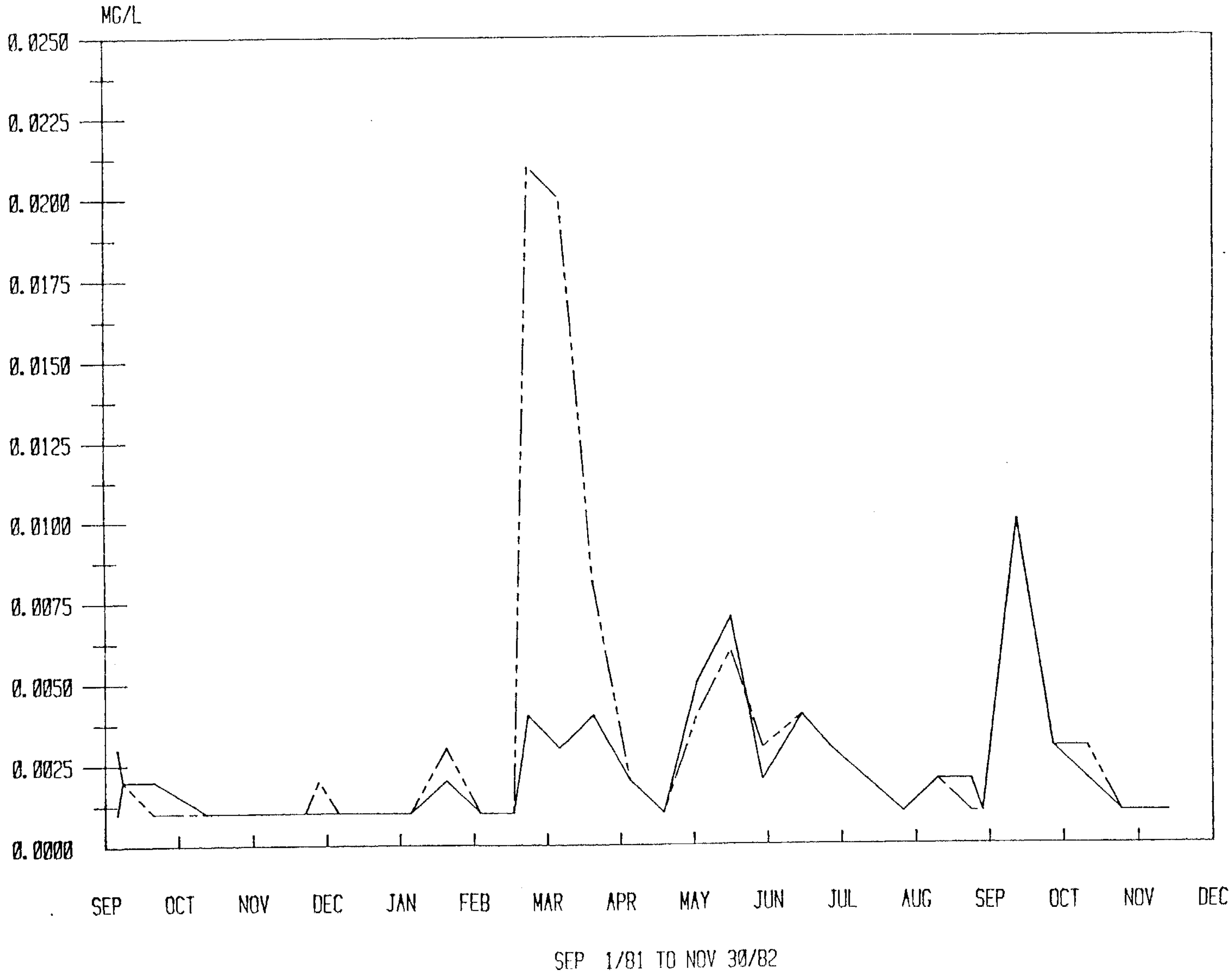


Figure 82 Surface and Depth Comparison of Fraser River Total Copper Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

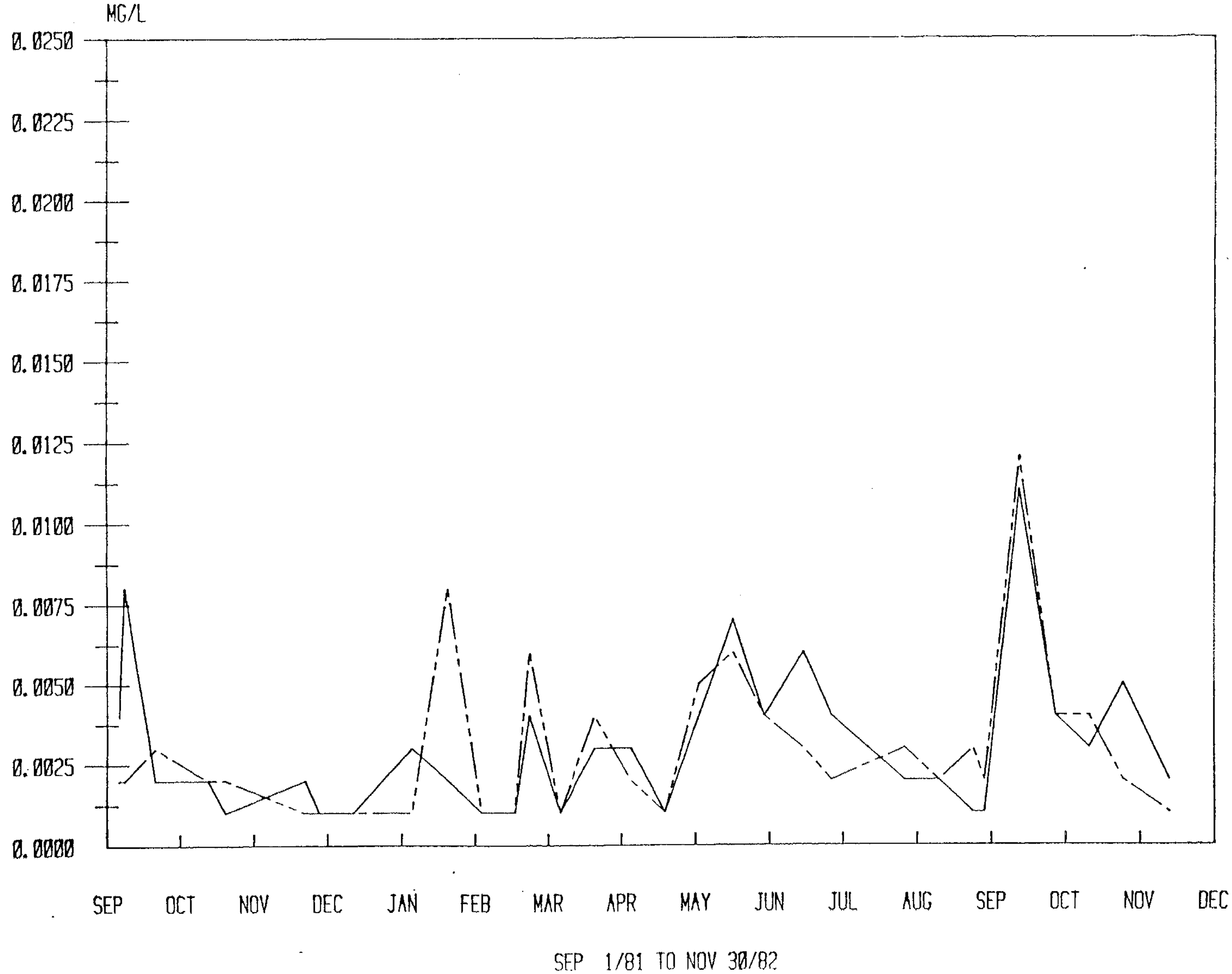


Figure 83 Surface and Depth Comparison of Fraser River Total Copper Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

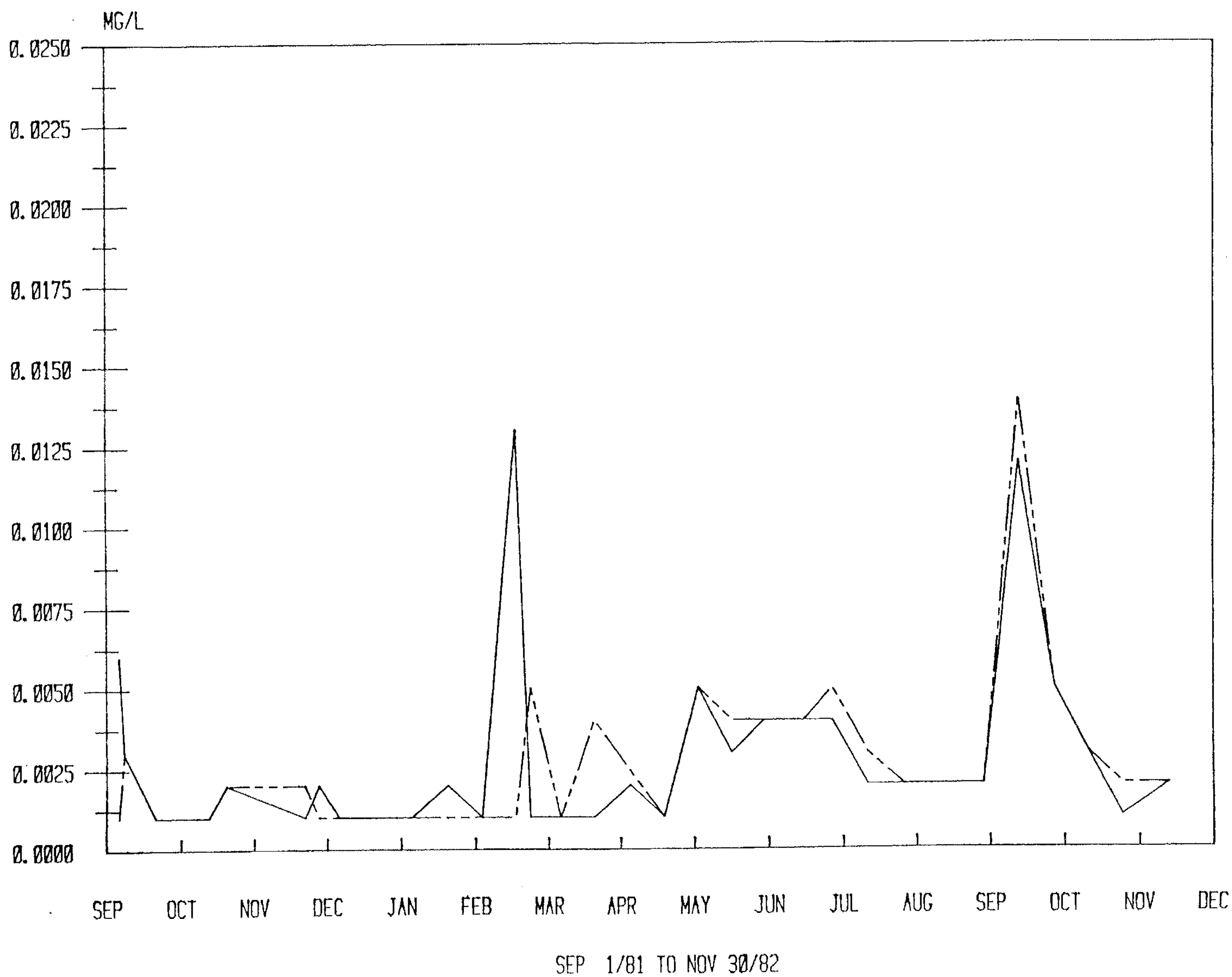


Figure 84 Comparison of Surface Fraser River Total Zinc Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

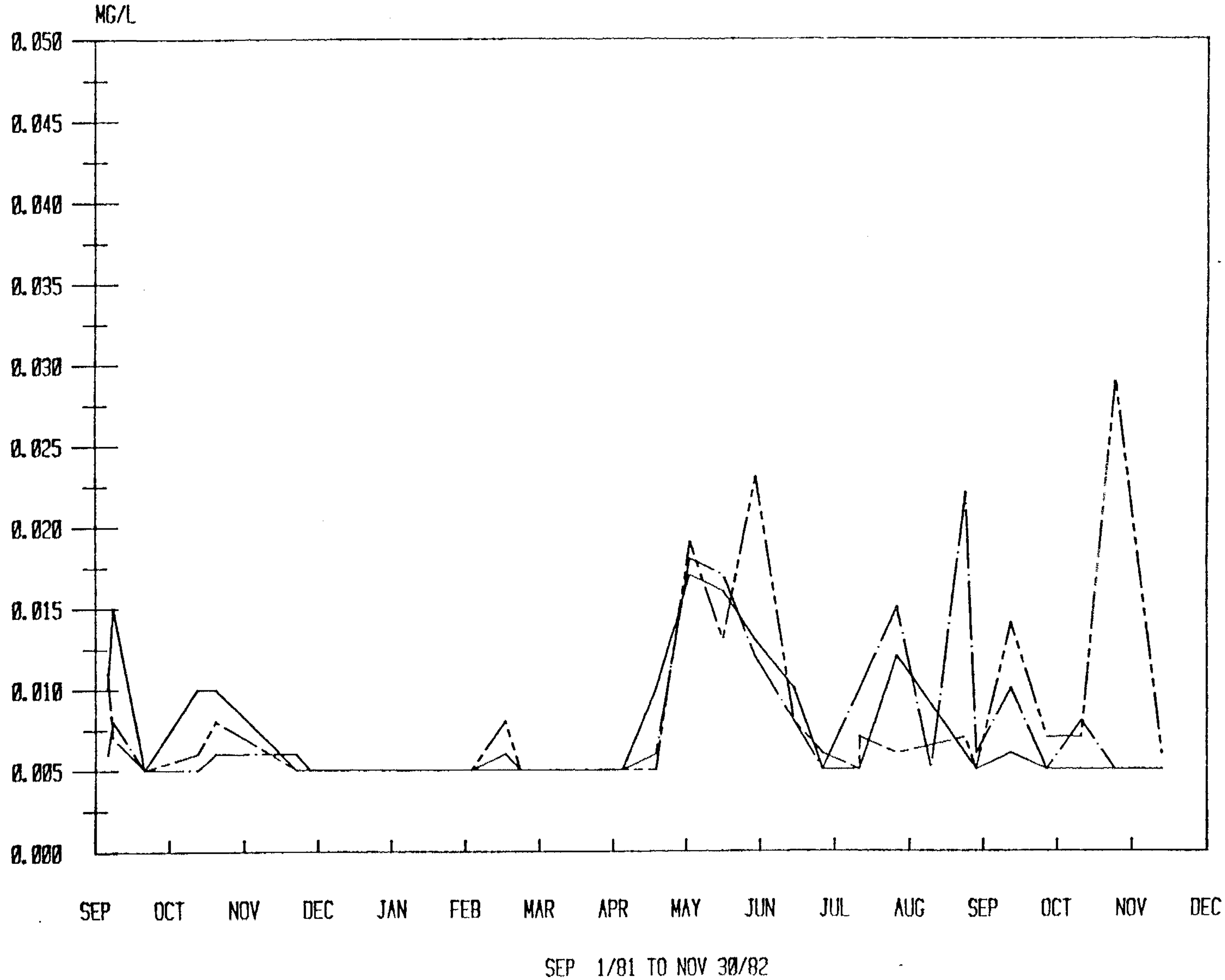


Figure 85 Comparison of Fraser River Total Zinc Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

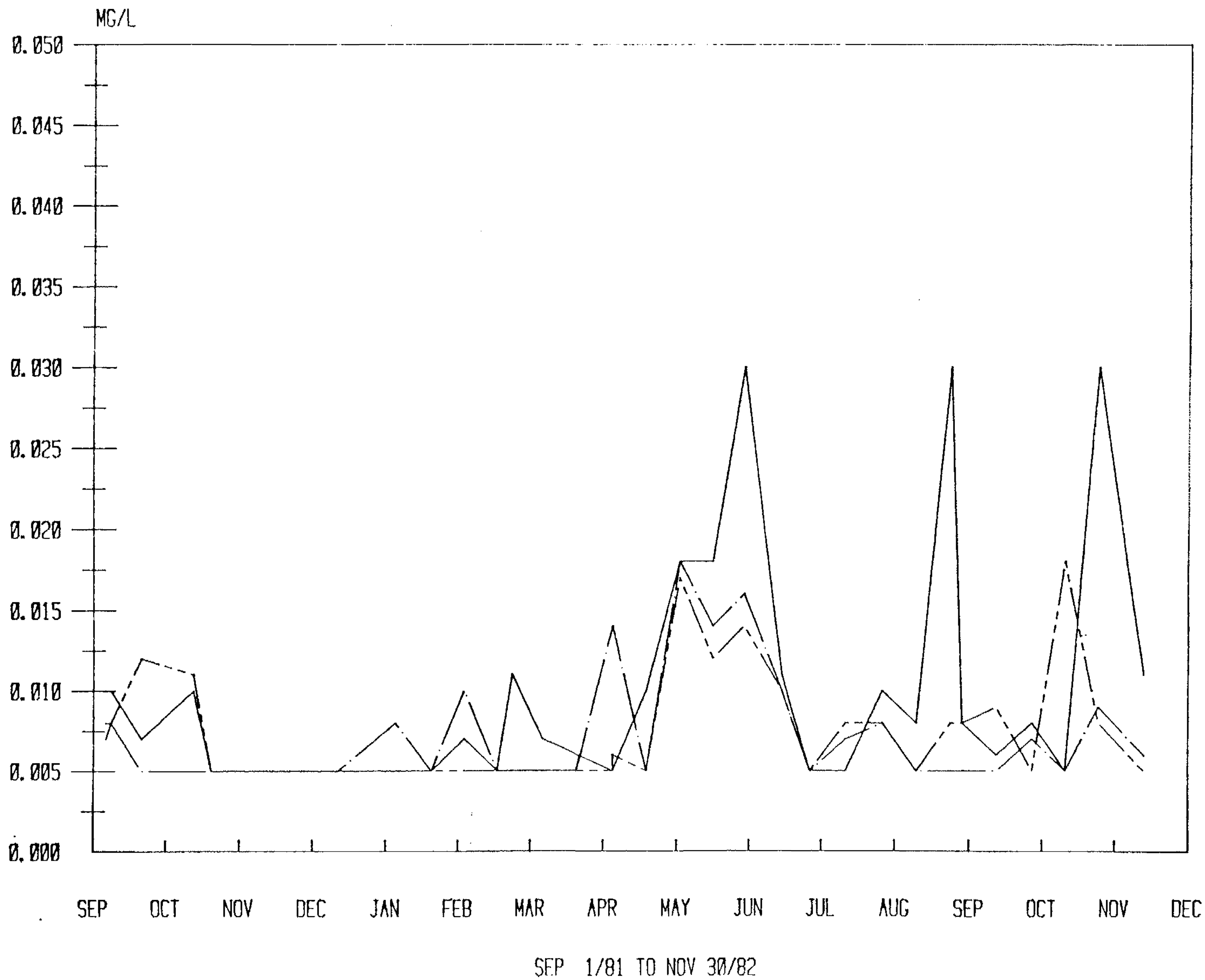


Figure 86 Surface and Depth Comparison of Fraser River Total Zinc Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

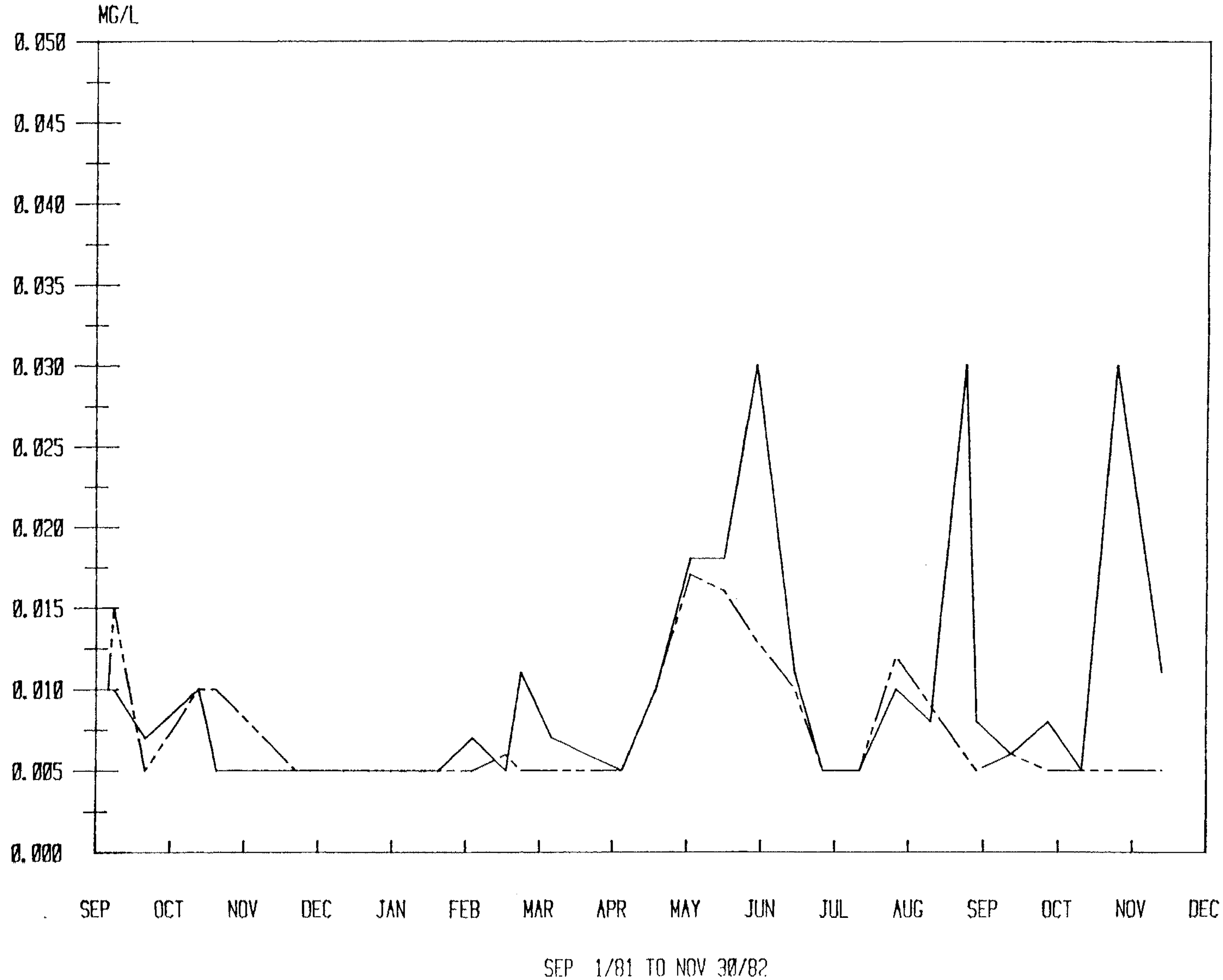


Figure 87 Surface and Depth Comparison of Fraser River Total Zinc Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

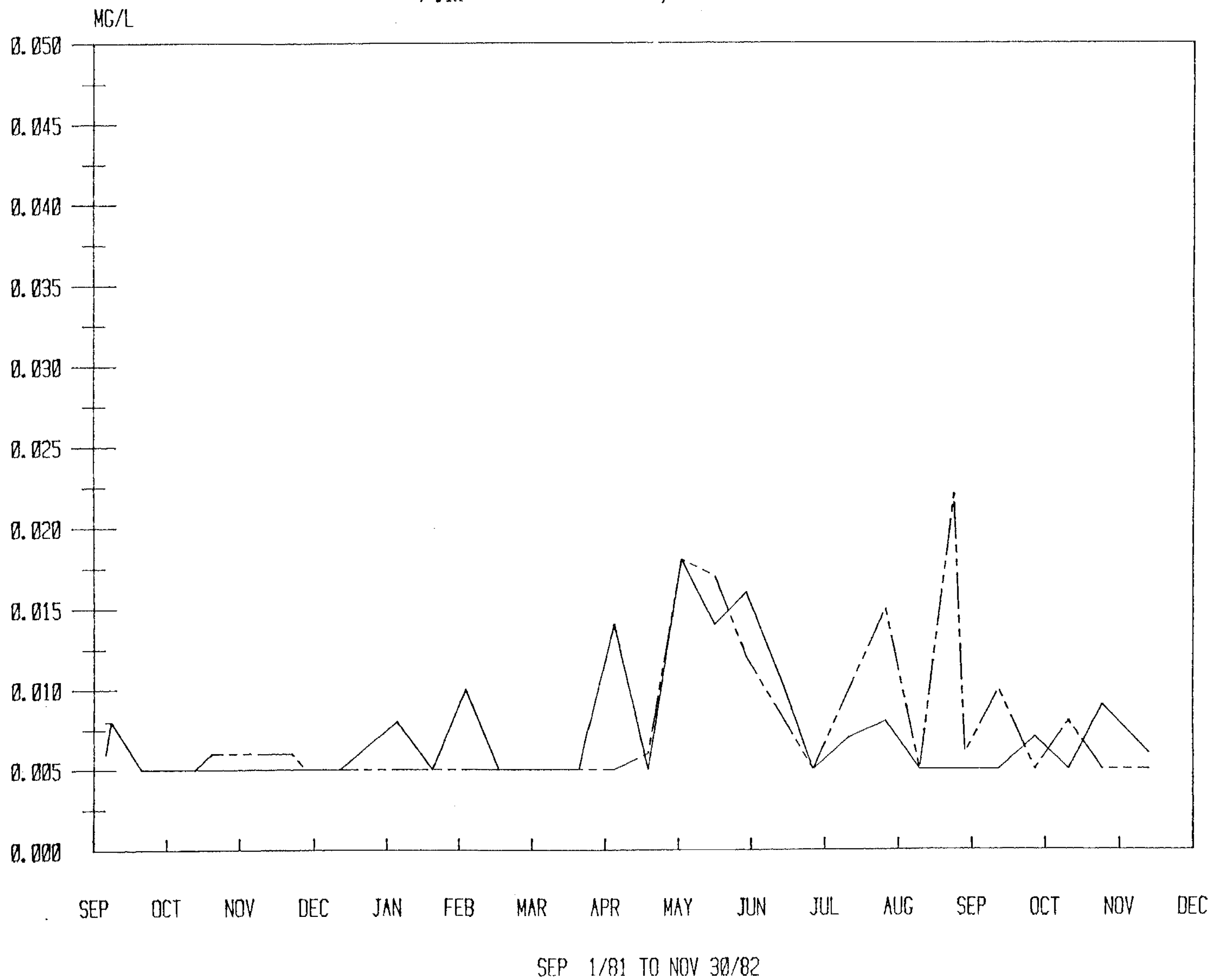


Figure 88 Surface and Depth Comparison of Fraser River Total Zinc Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

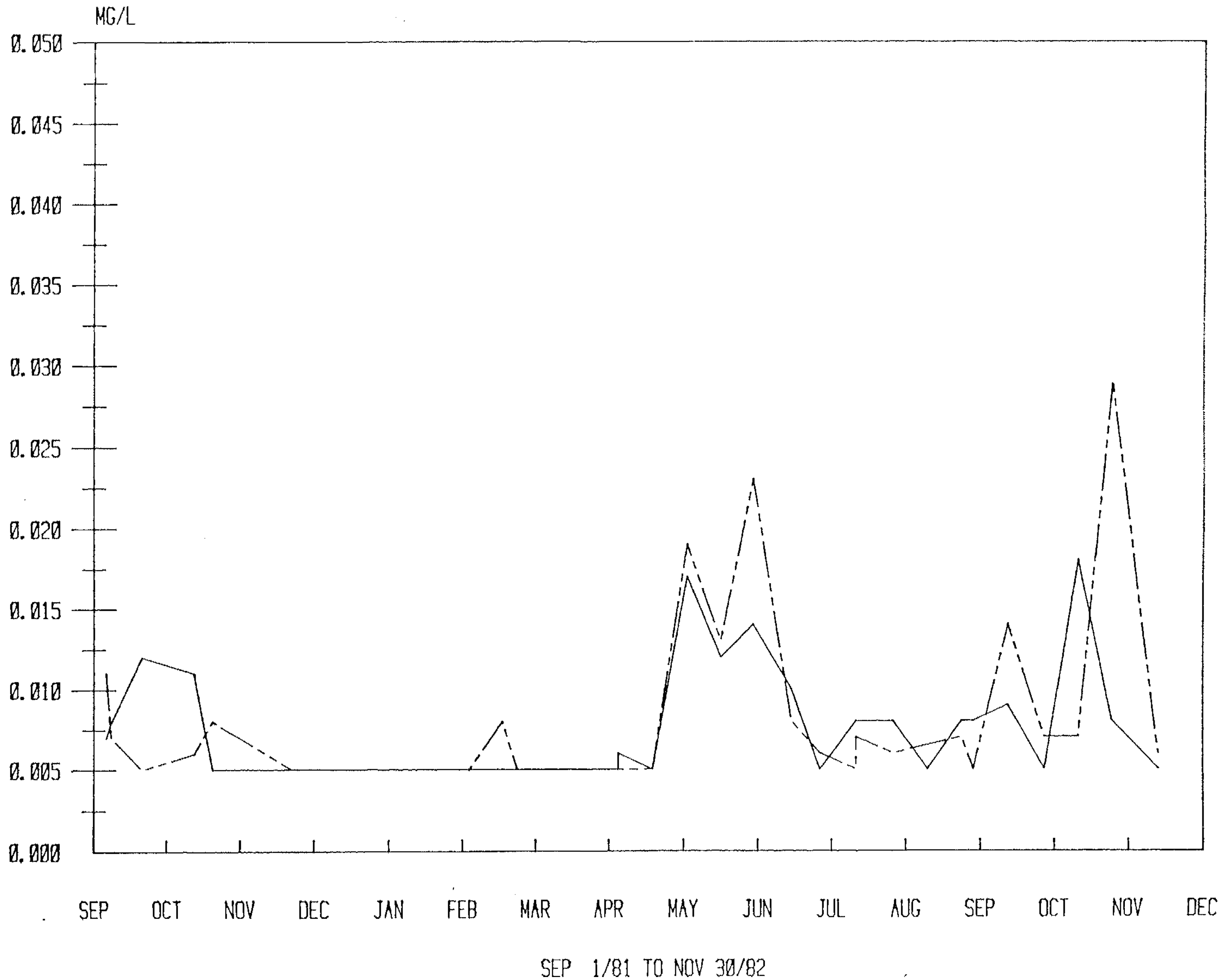


Figure 89 Comparison of Surface Fraser River Total Mercury Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

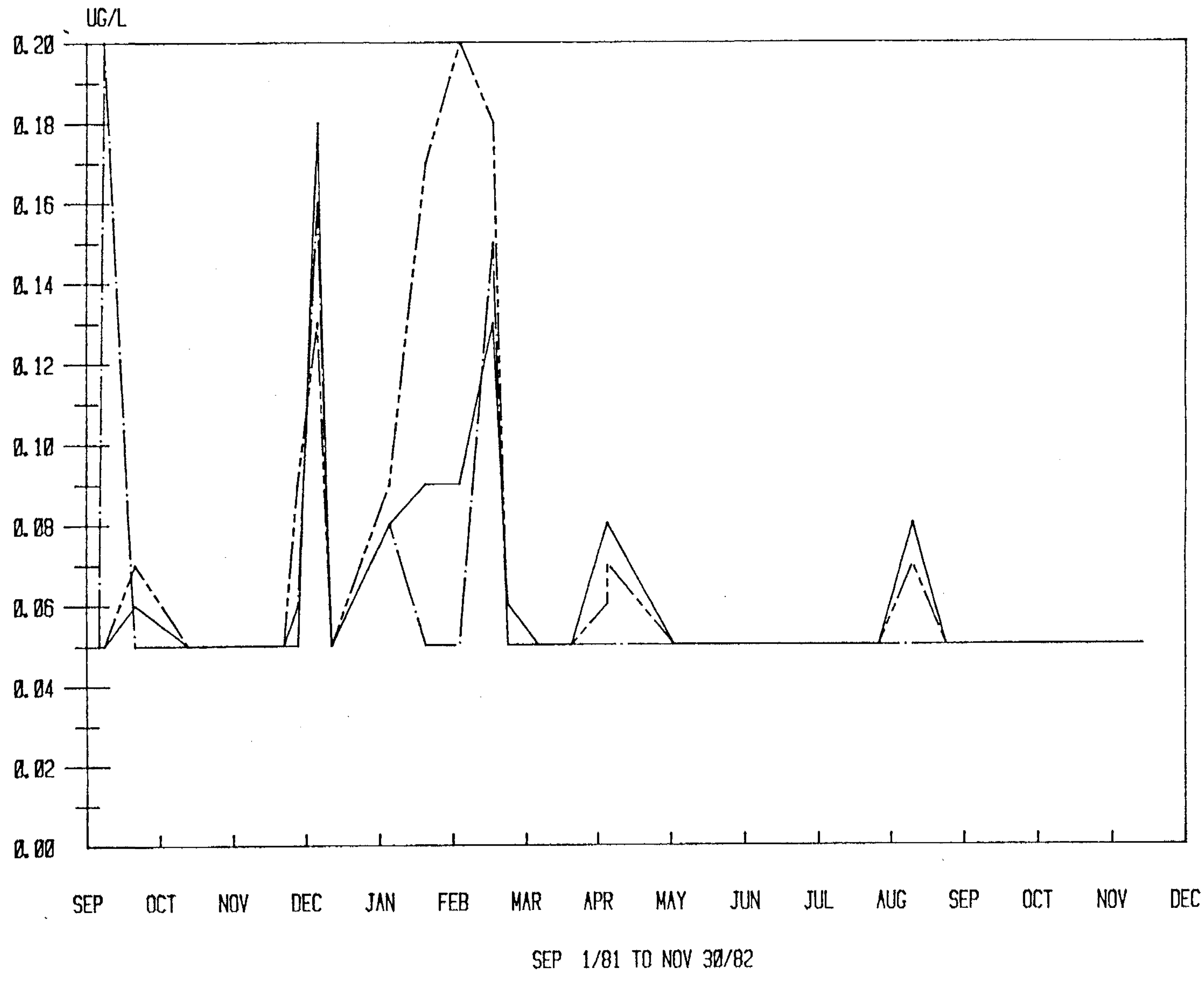


Figure 90 Comparison of Fraser River Total Mercury Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

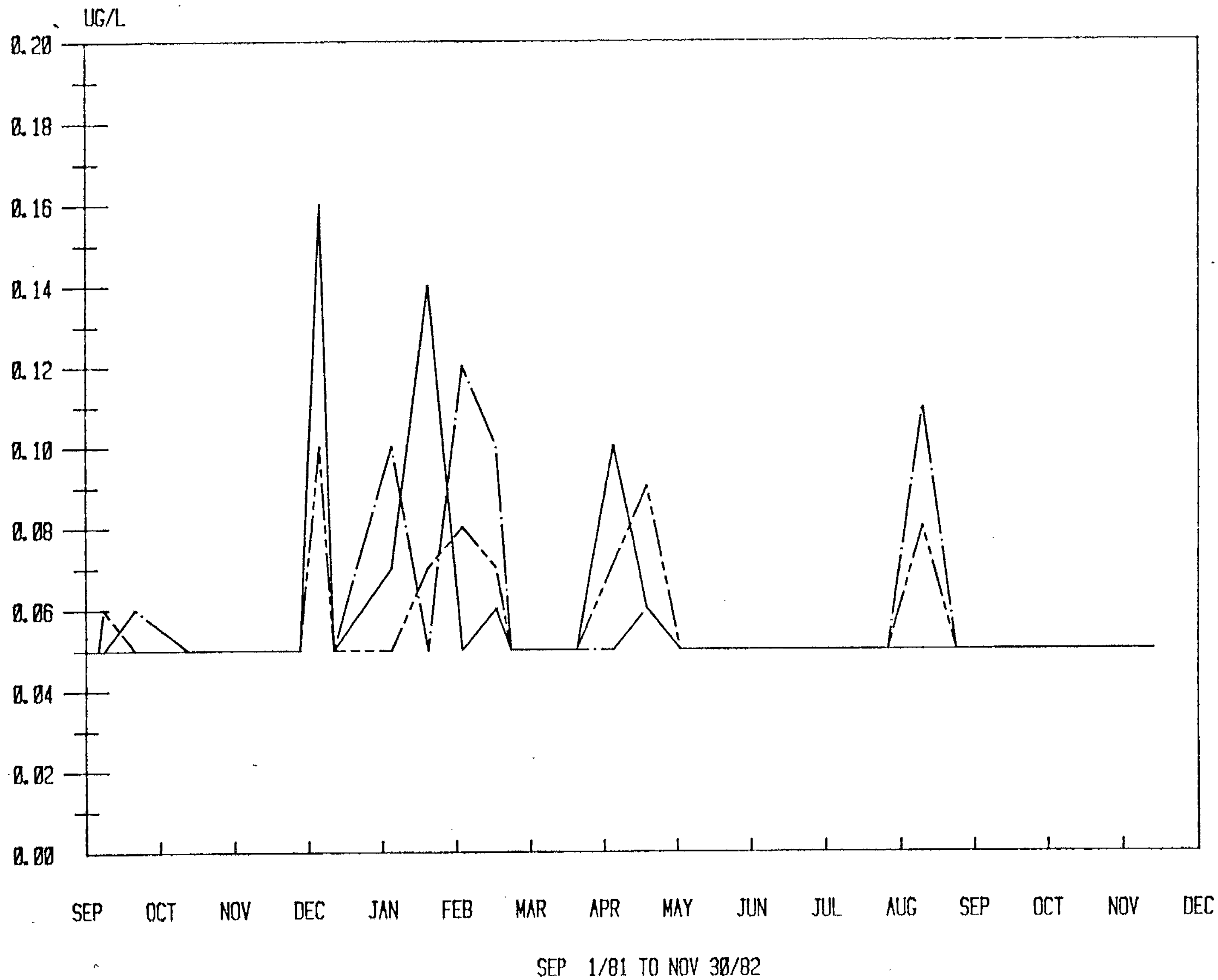


Figure 91 Surface and Depth Comparison of Fraser River Total Mercury Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

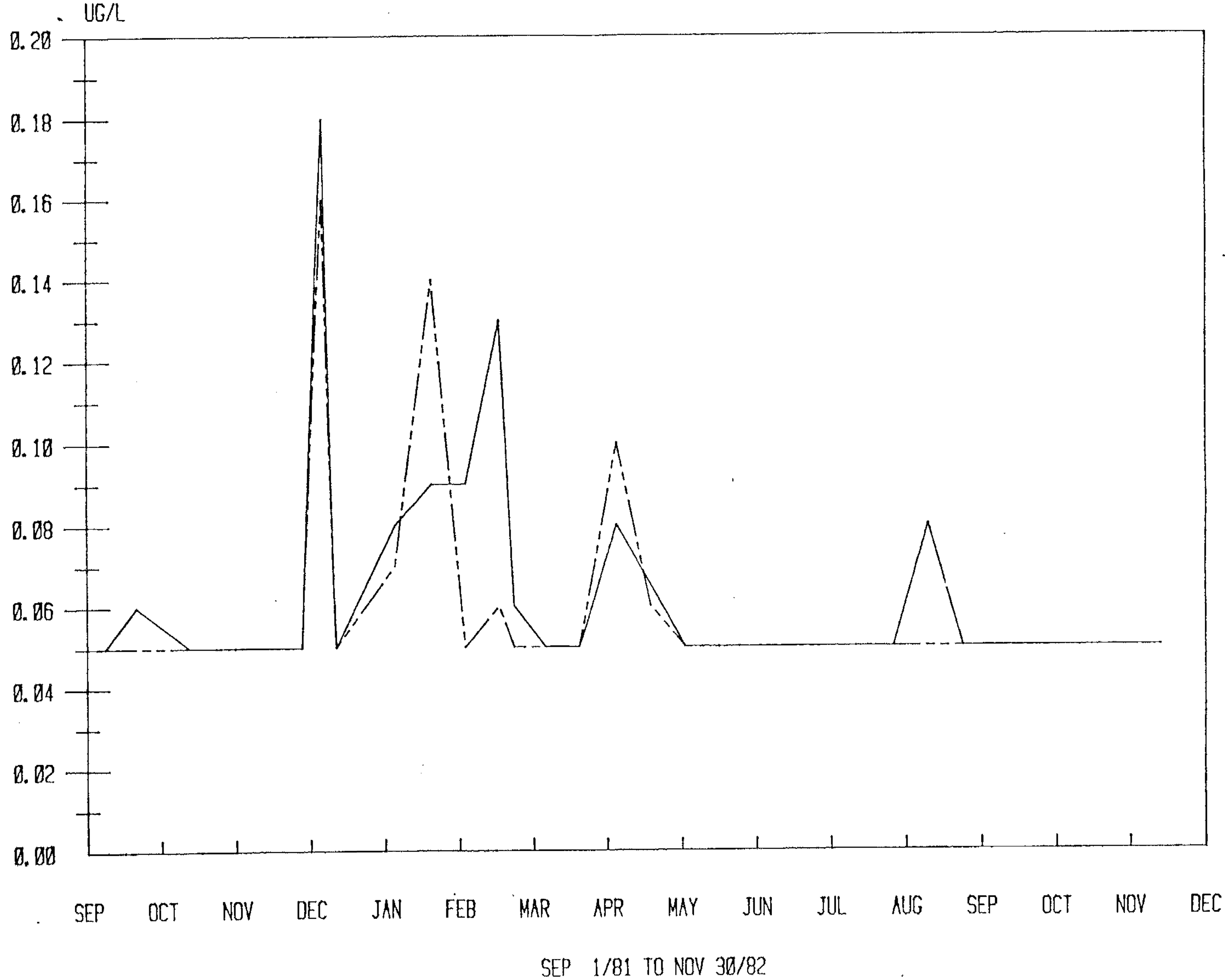


Figure 92 Surface and Depth Comparison of Fraser River Total Mercury Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

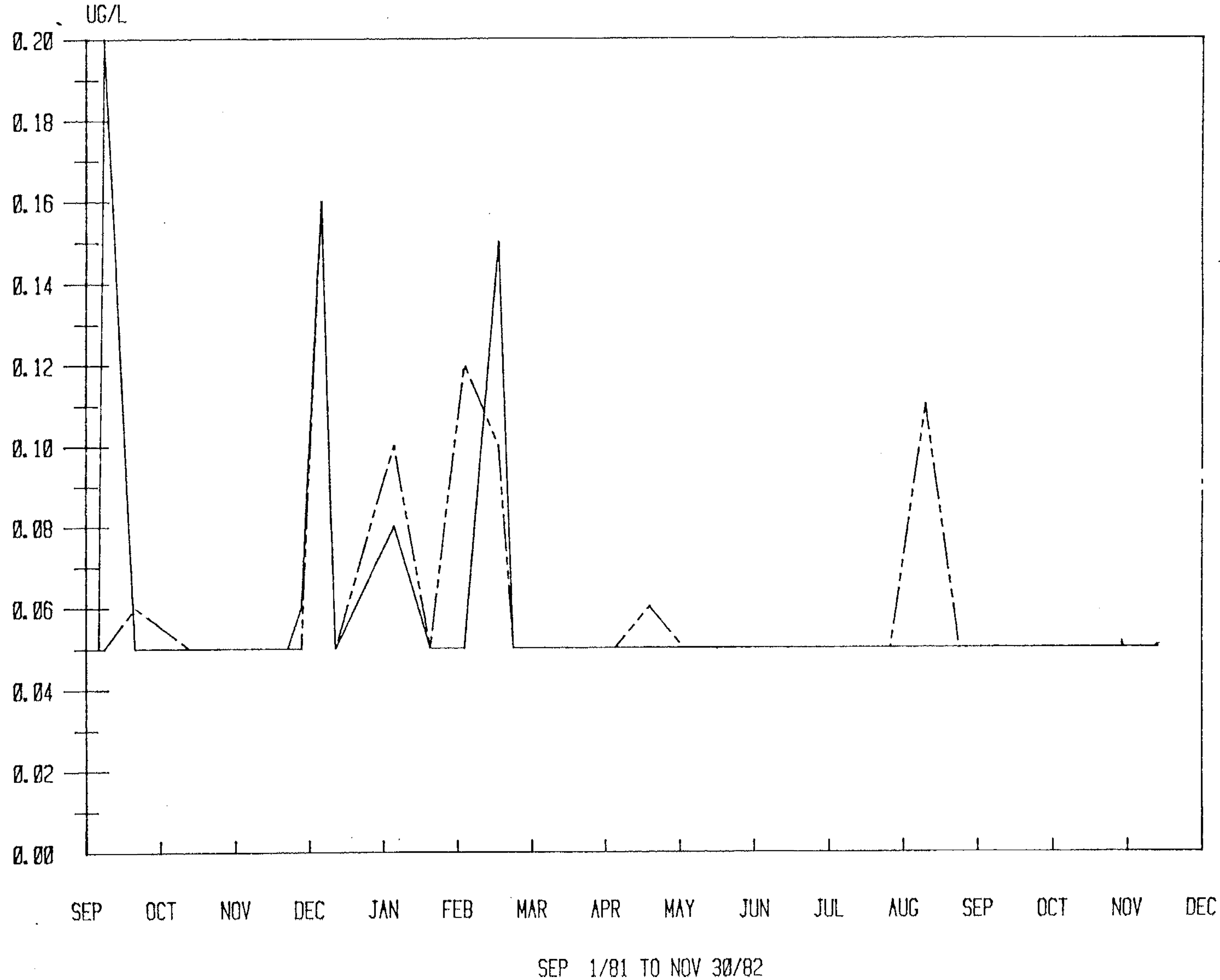


Figure 93 Surface and Depth Comparison of Fraser River Total Mercury Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

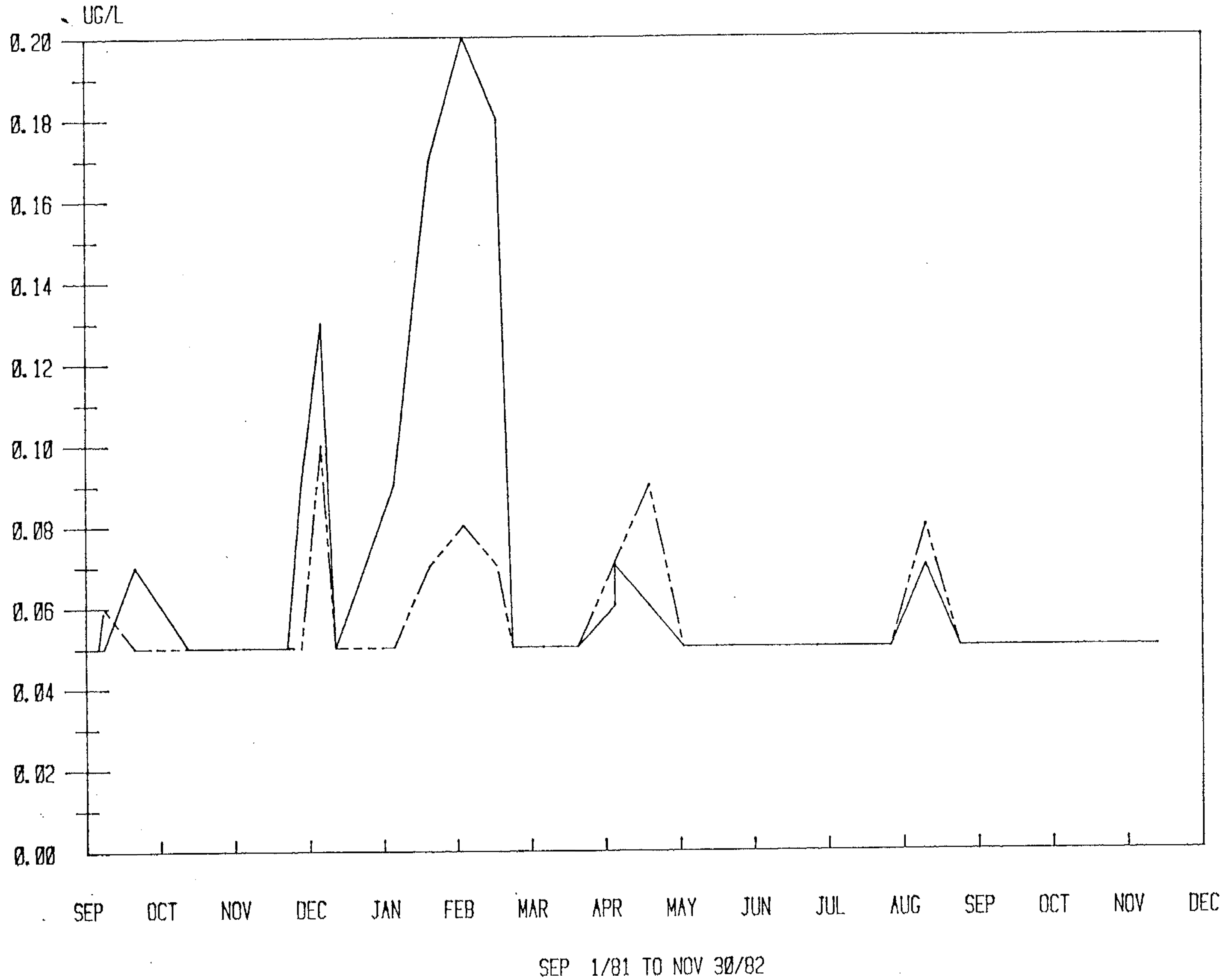


Figure 94 Comparison of Surface Fraser River Chloride Concentrations, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

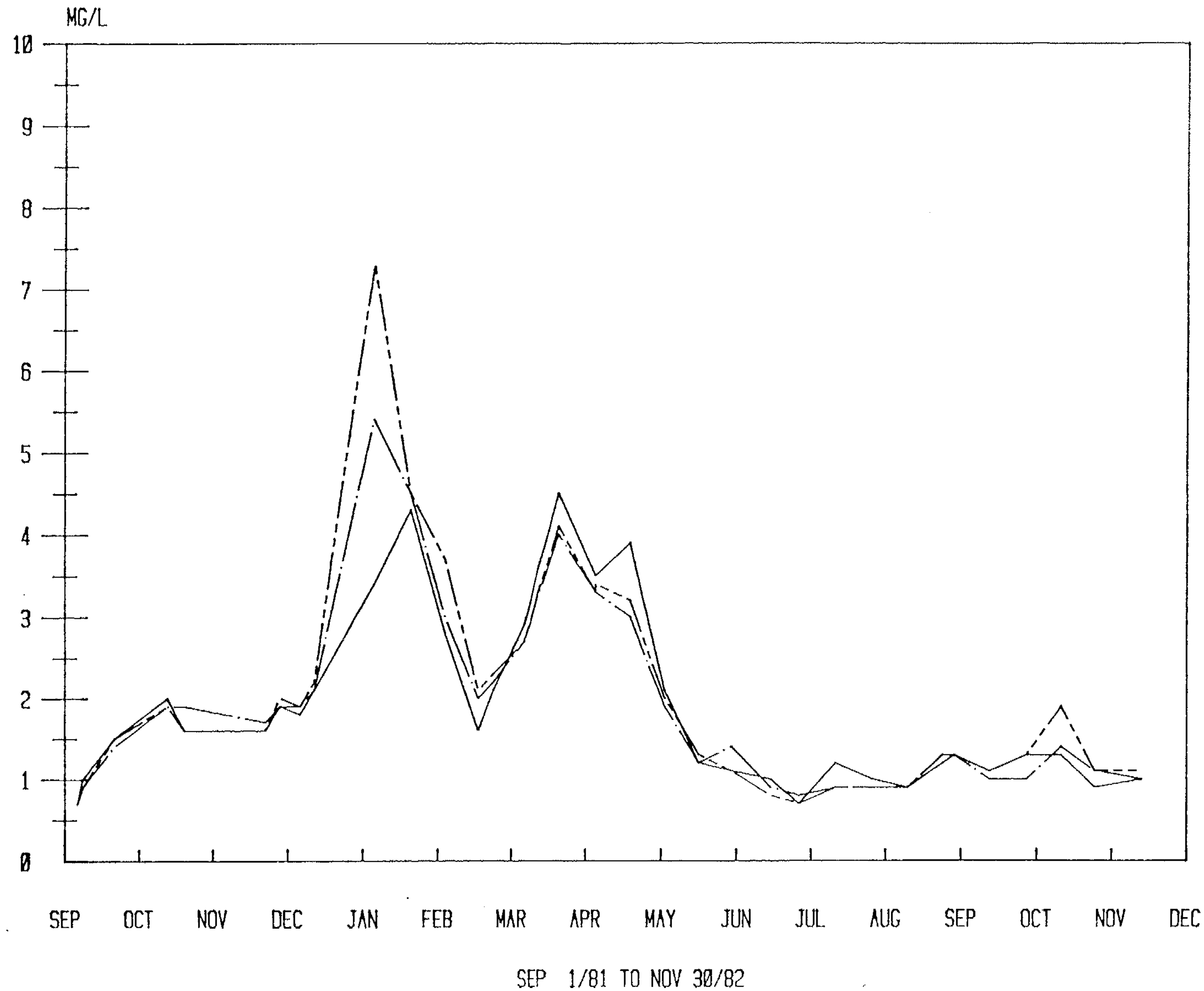


Figure 95 Comparison of Fraser River Chloride Concentrations at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

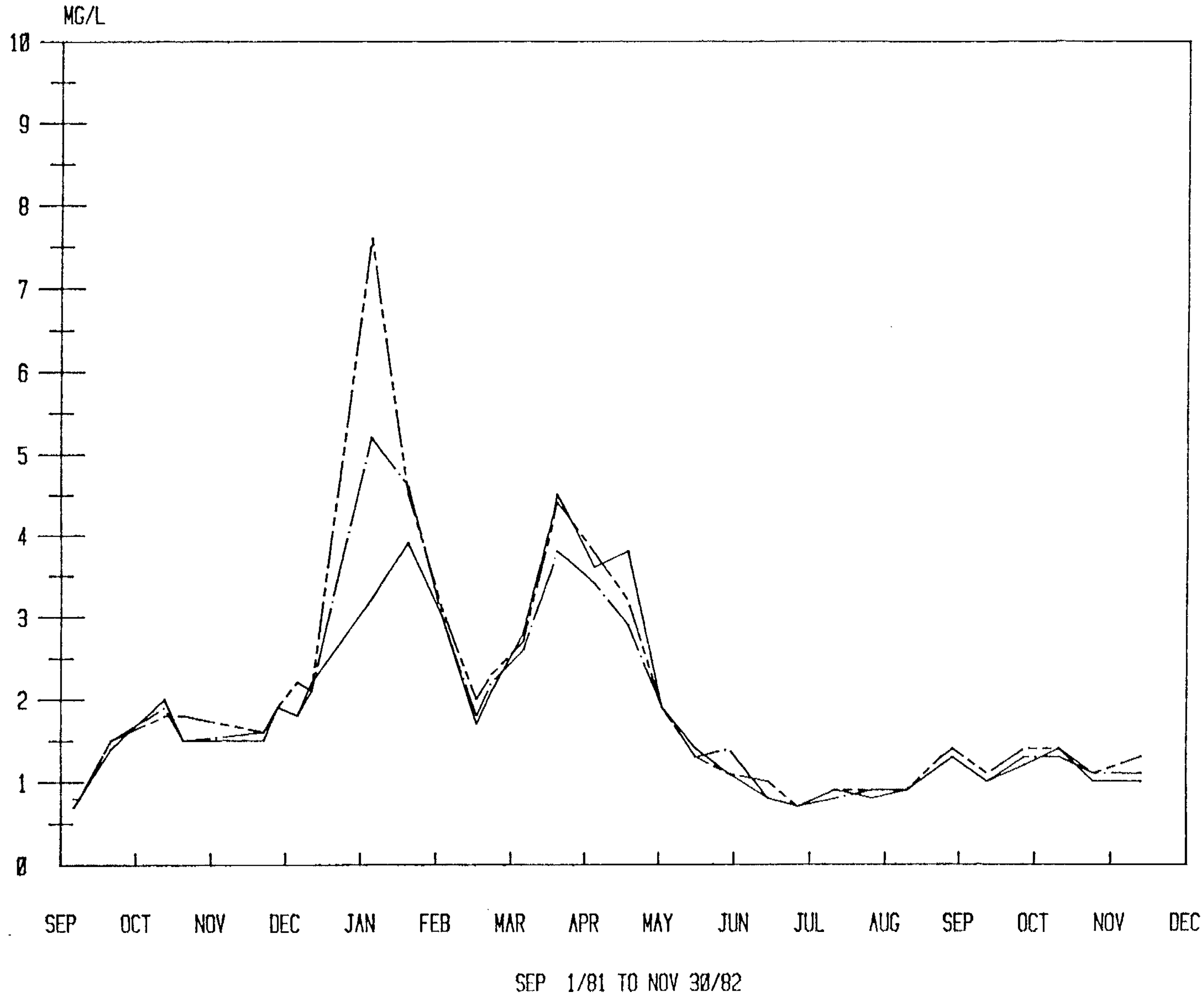


Figure 96 Surface and Depth Comparison of Fraser River Chloride Concentrations at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

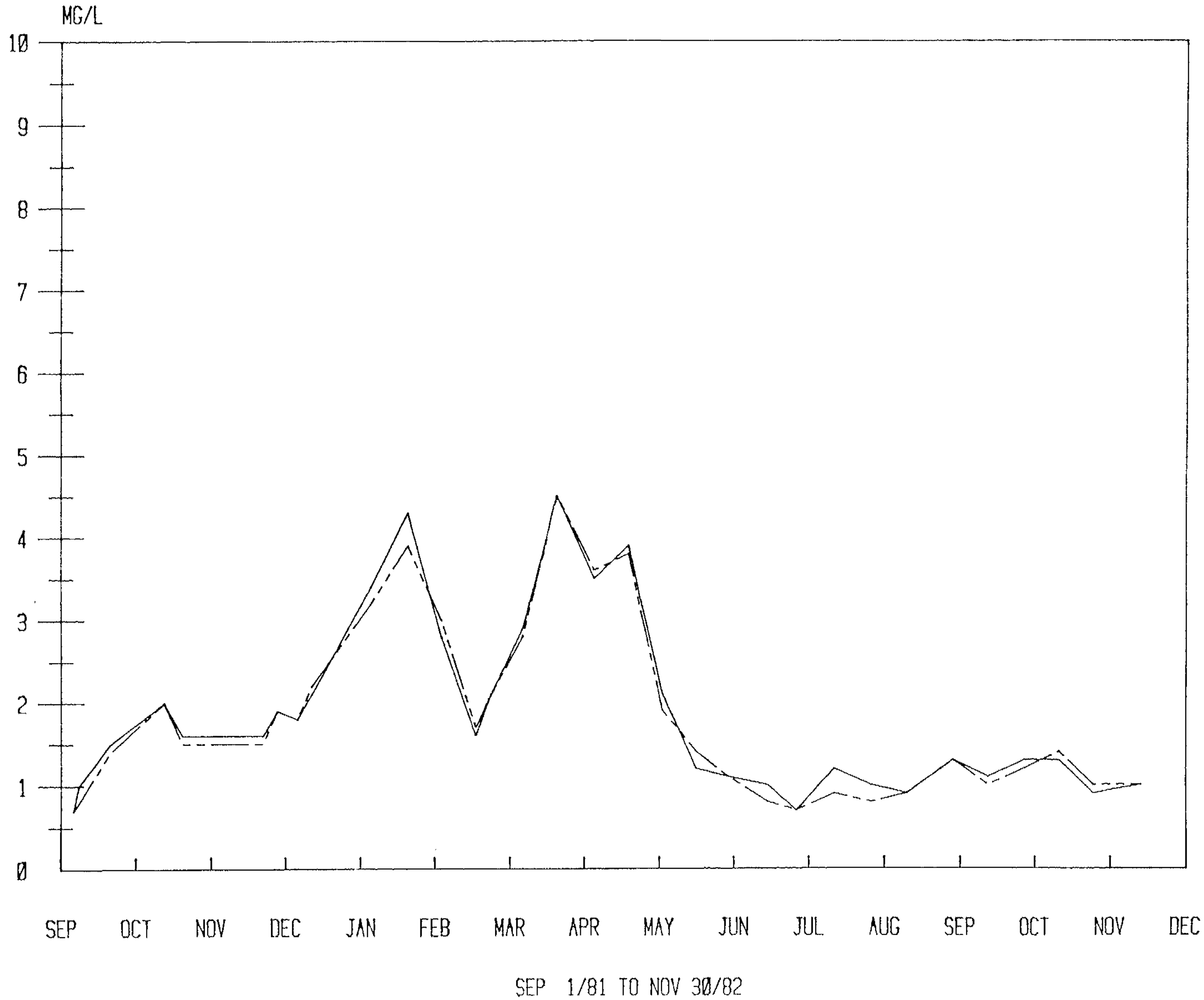


Figure 97 Surface and Depth Comparison of Fraser River Chloride Concentrations at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

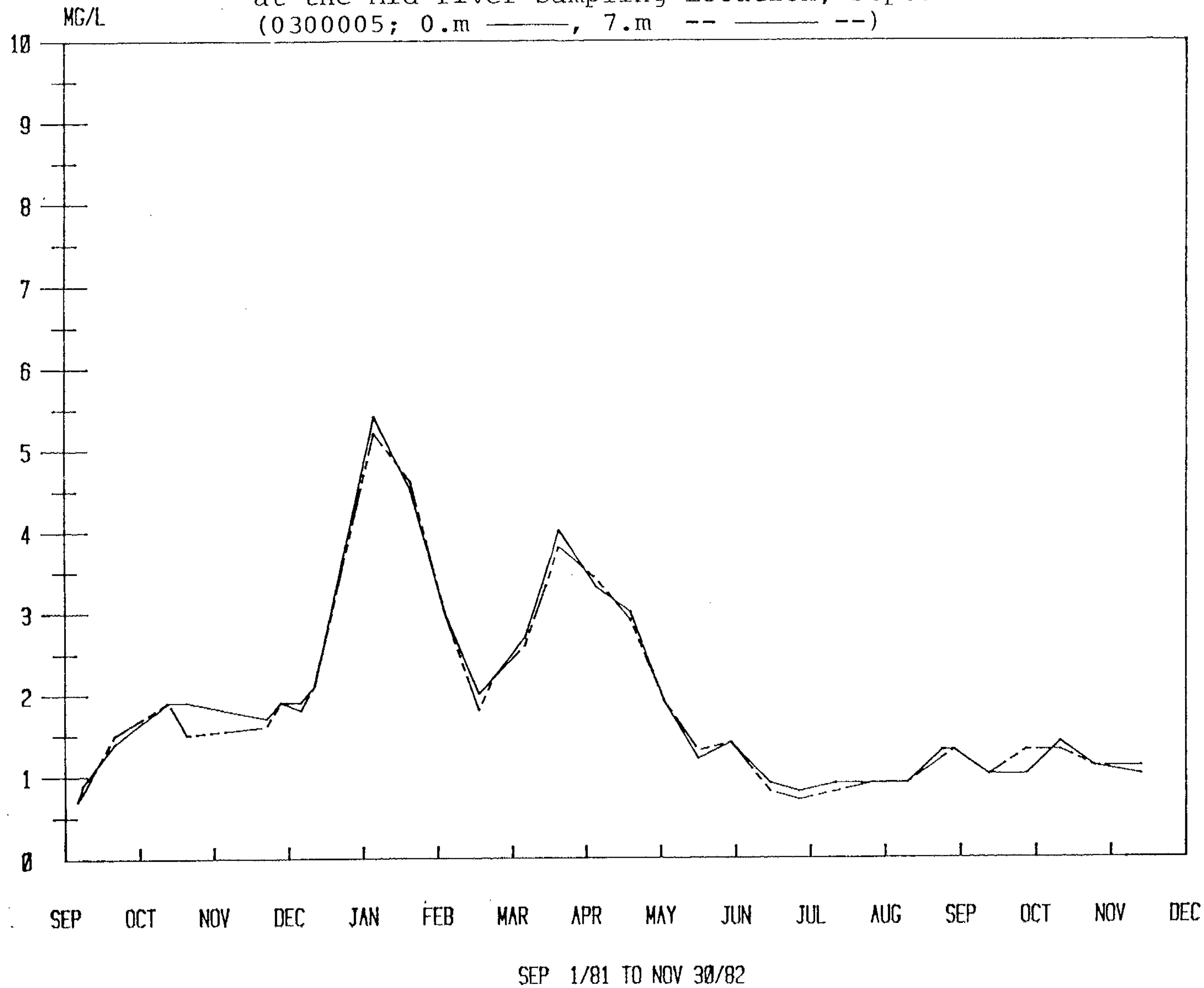


Figure 98 Surface and Depth Comparison of Fraser River Chloride Concentrations at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

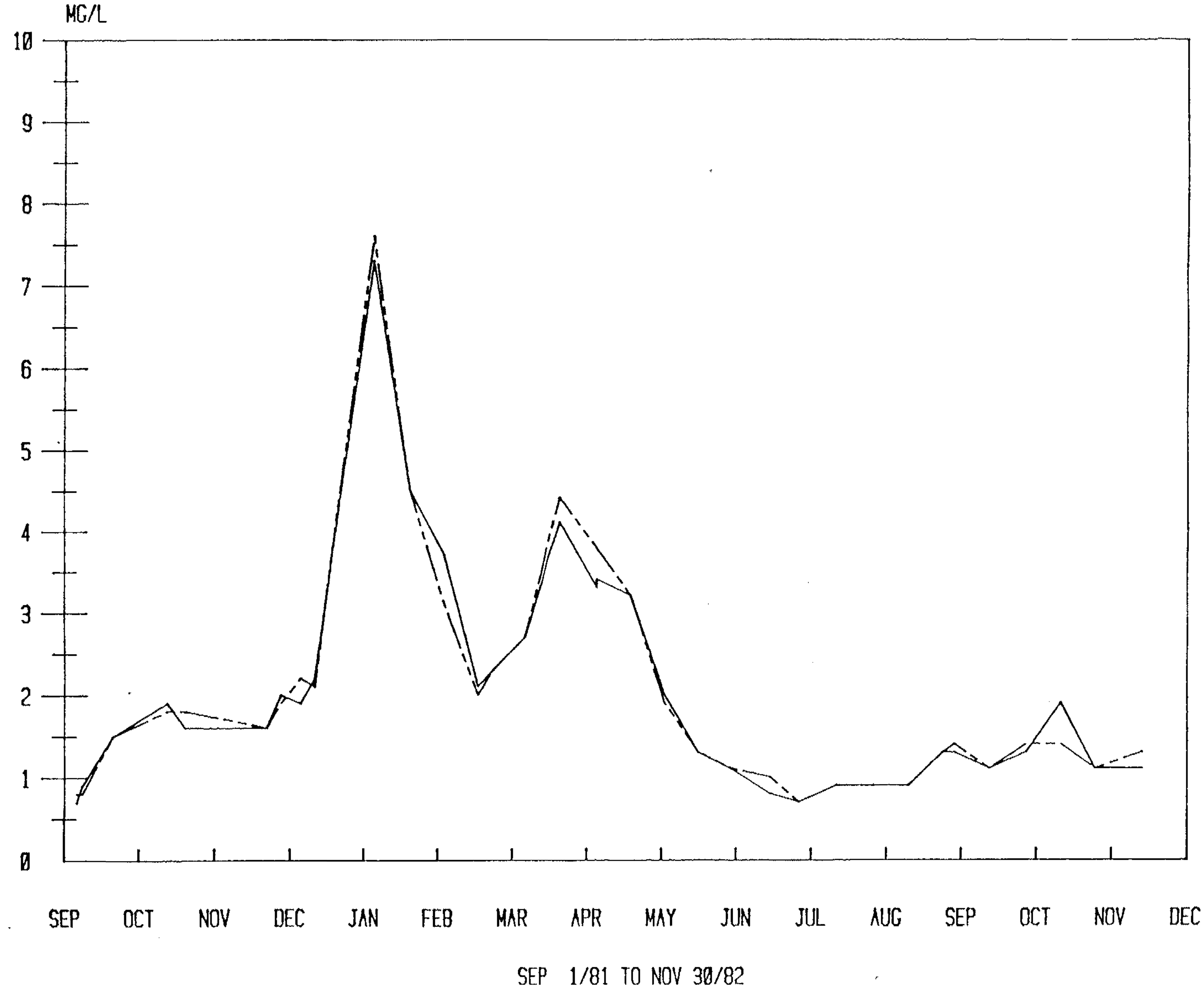


Figure 99 Comparison of Surface Fraser River Total Alkalinity, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

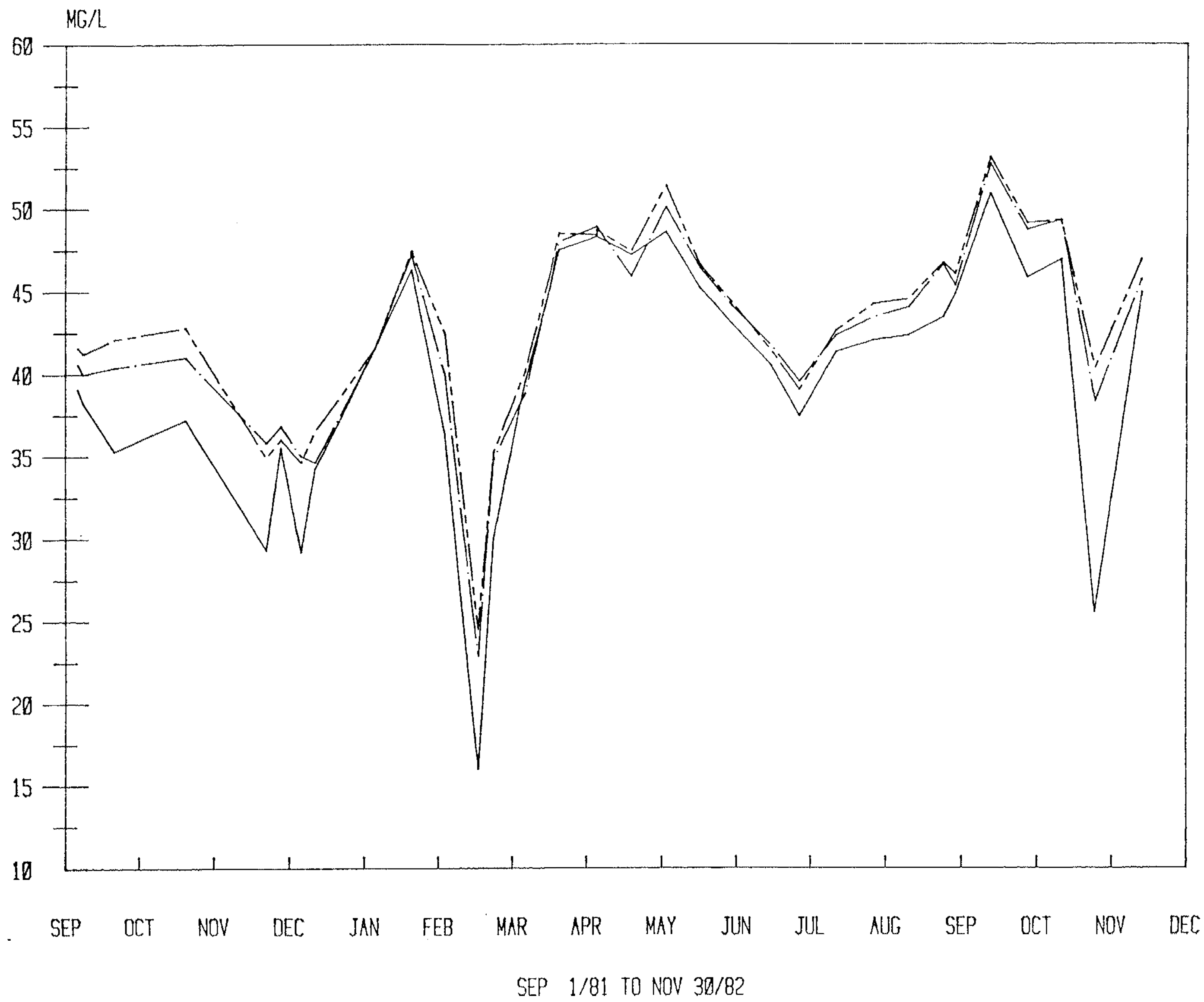


Figure 100 Comparison of Fraser River Total Alkalinity at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

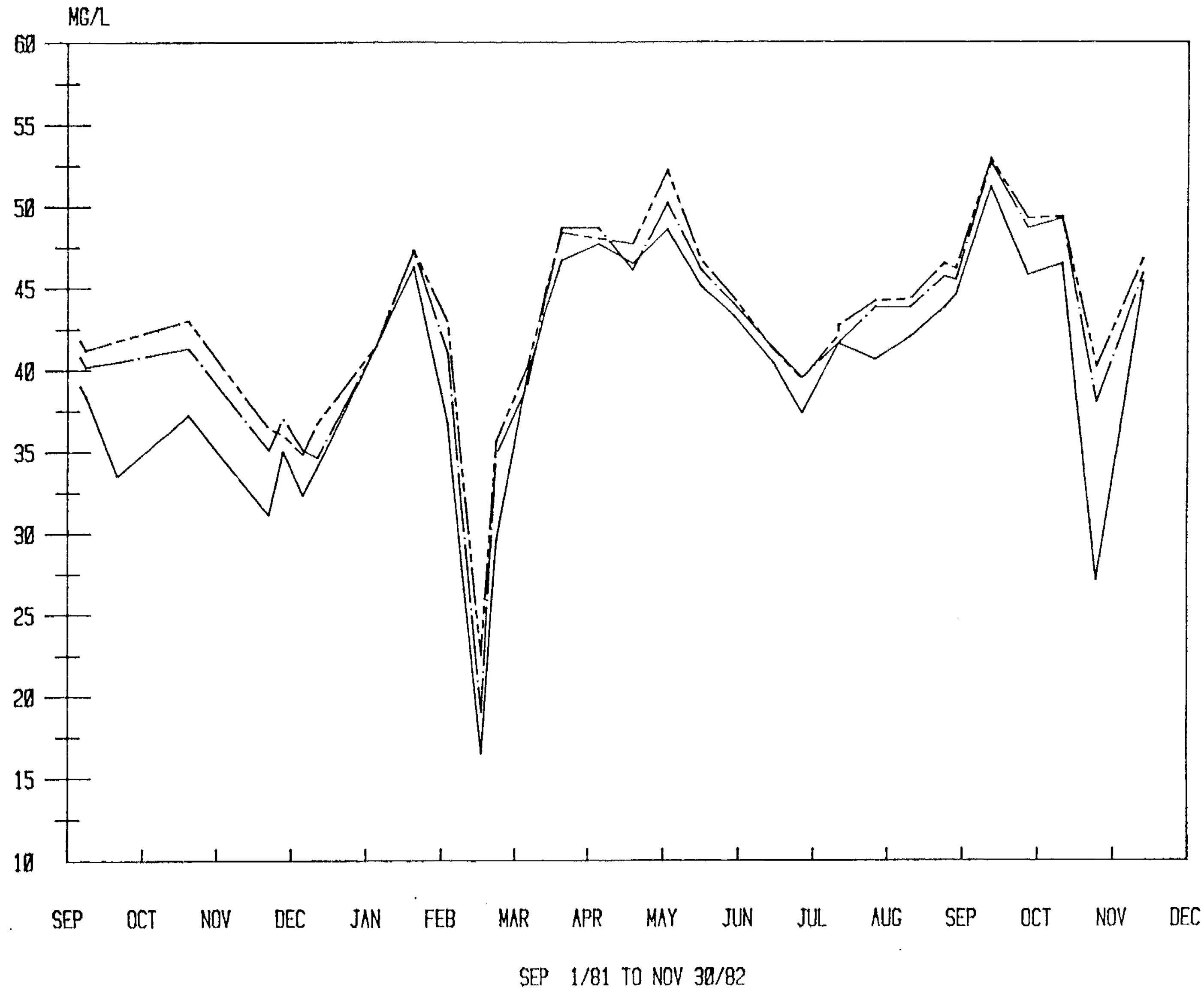


Figure 101 Surface and Depth Comparison of Fraser River Total Alkalinity at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

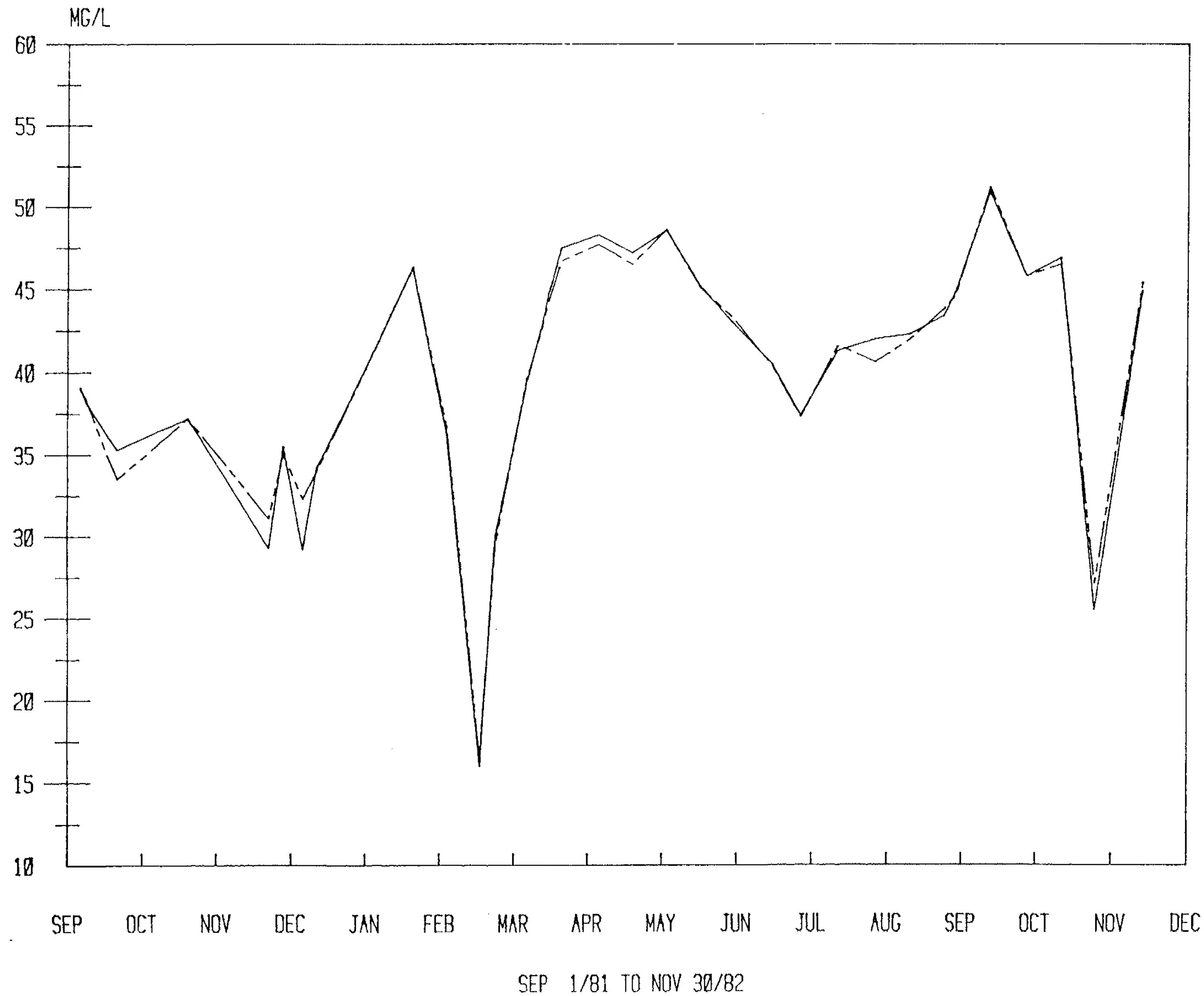


Figure 102 Surface and Depth Comparison of Fraser River Total Alkalinity at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

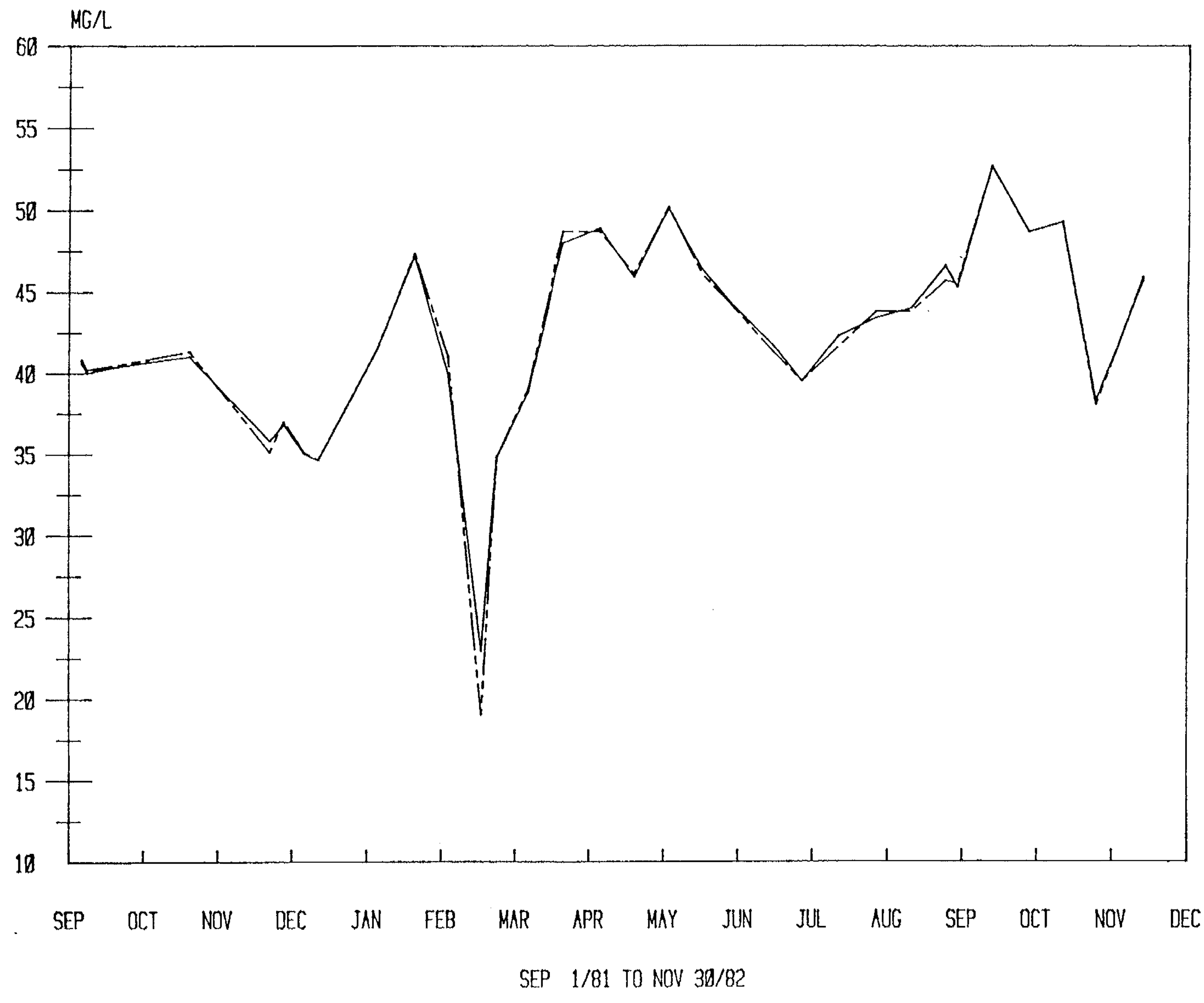


Figure 103 Surface and Depth Comparison of Fraser River Total Alkalinity at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)

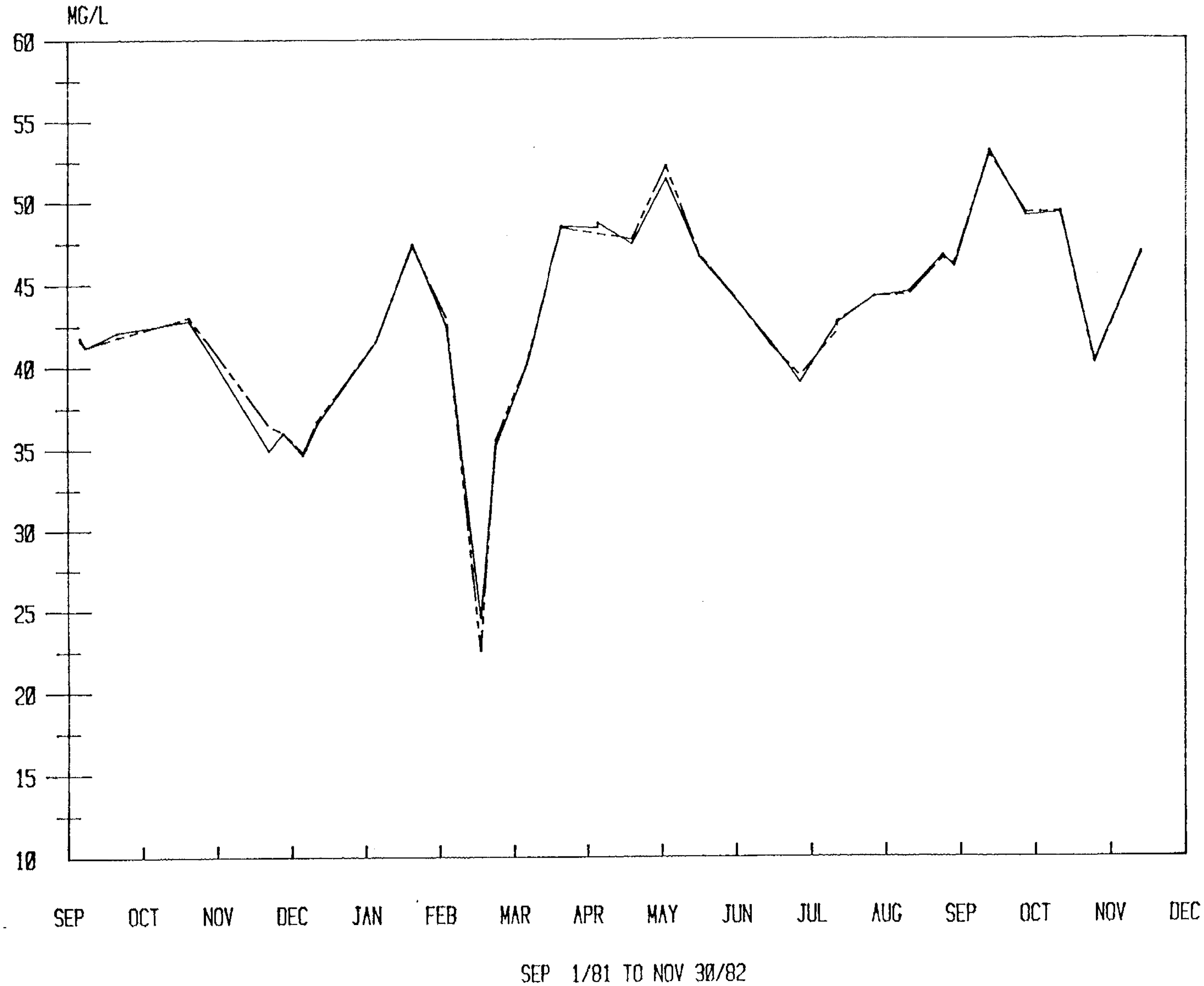


Figure 104 Comparison of Surface Fraser River Fecal Coliform Levels, September 1981 to December 1982 (0300124 ———, 0300005 .———.,
0300125 -- ——— --)

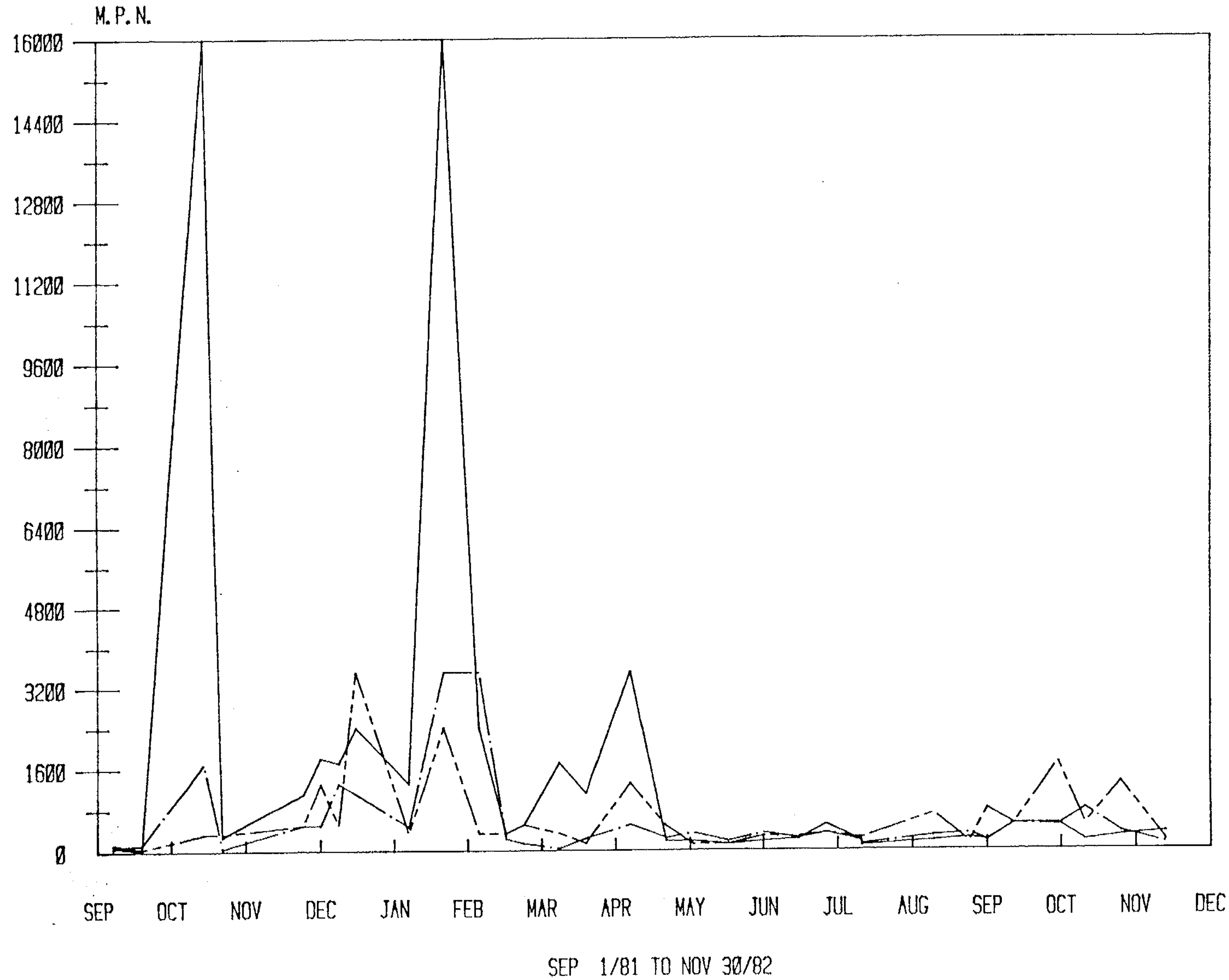


Figure 105 Comparison of Fraser River Fecal Coliform Levels at Depth, September 1981 to December 1982 (0300124 ———, 0300005 .———., 0300125 -- ——— --)

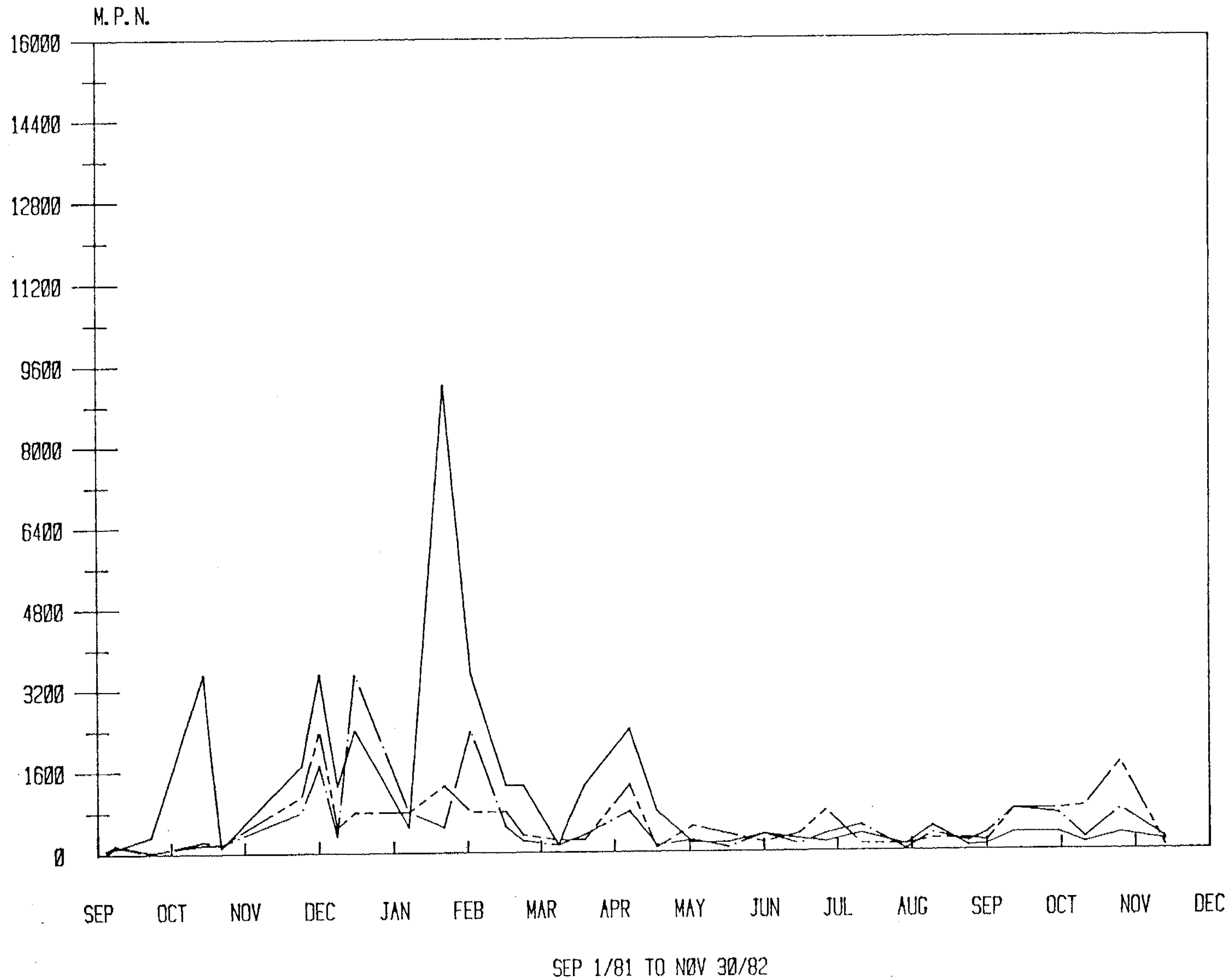


Figure 106 Surface and Depth Comparison of Fraser River Fecal Coliform Levels at the North Sampling Location, September 1981 to December 1982 (0300124; 0.m ———, 9.m -- ——— --)

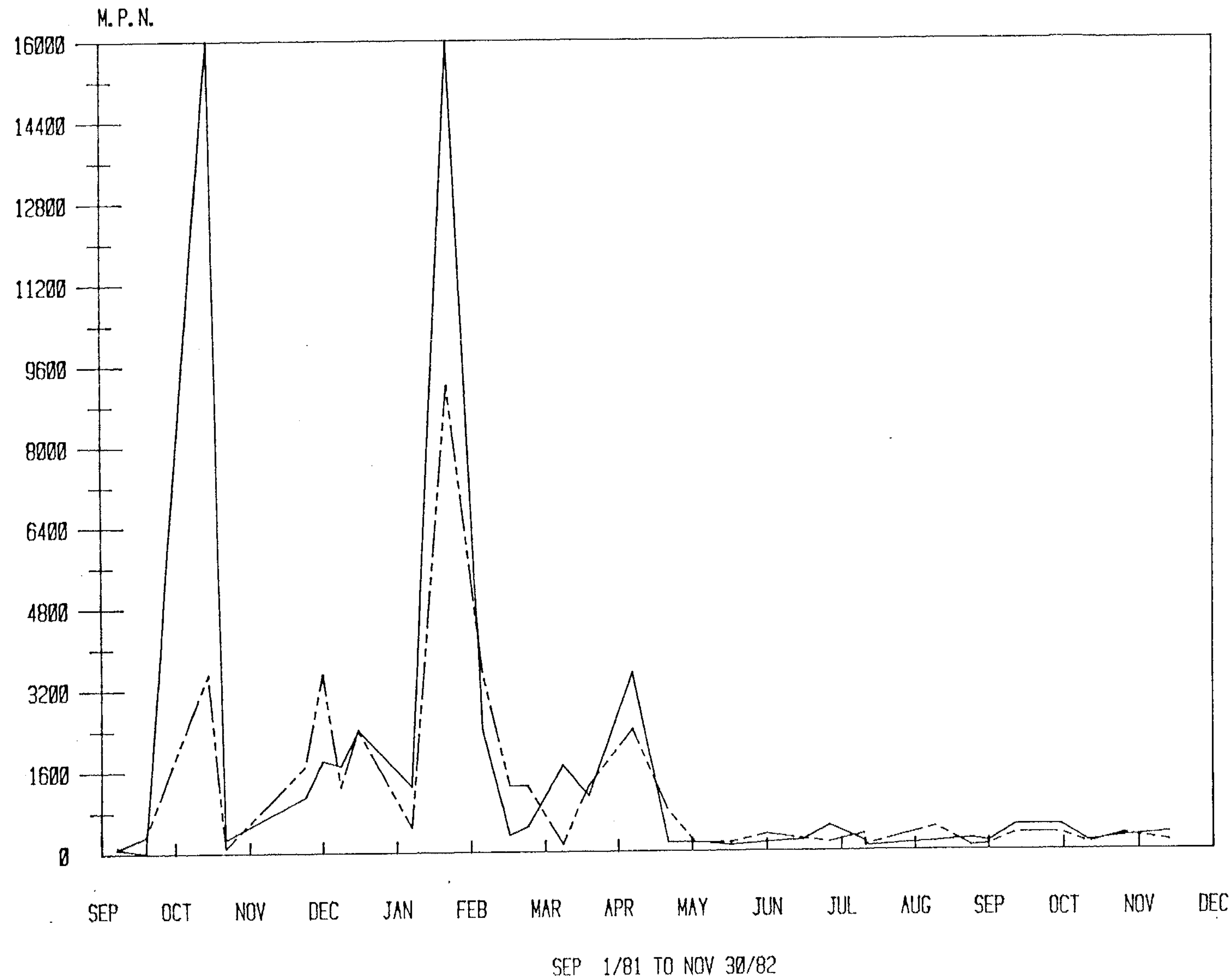


Figure 107 Surface and Depth Comparison of Fraser River Fecal Coliform Levels at the Mid-river Sampling Location, September 1981 to December 1982 (0300005; 0.m ———, 7.m -- ——— --)

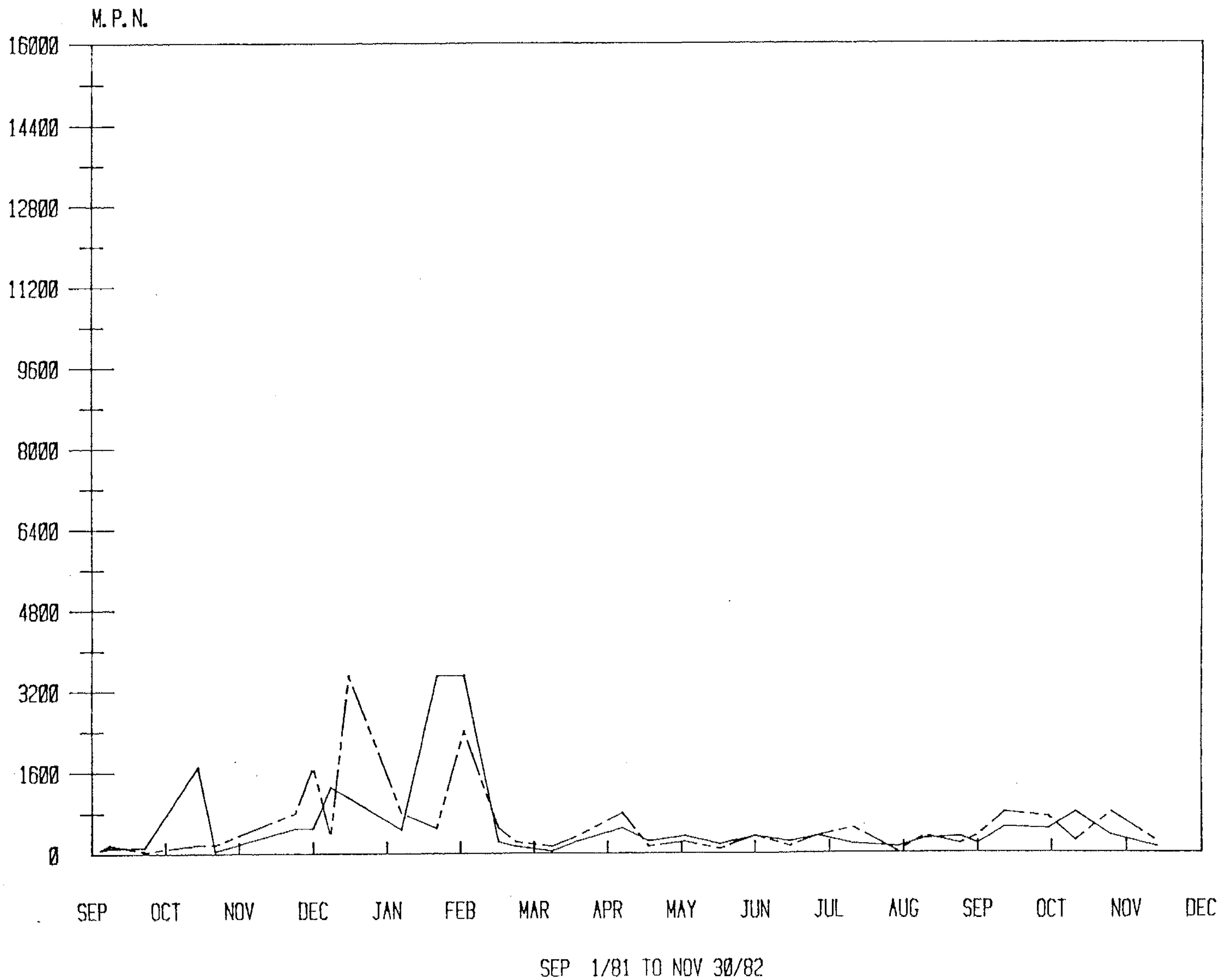
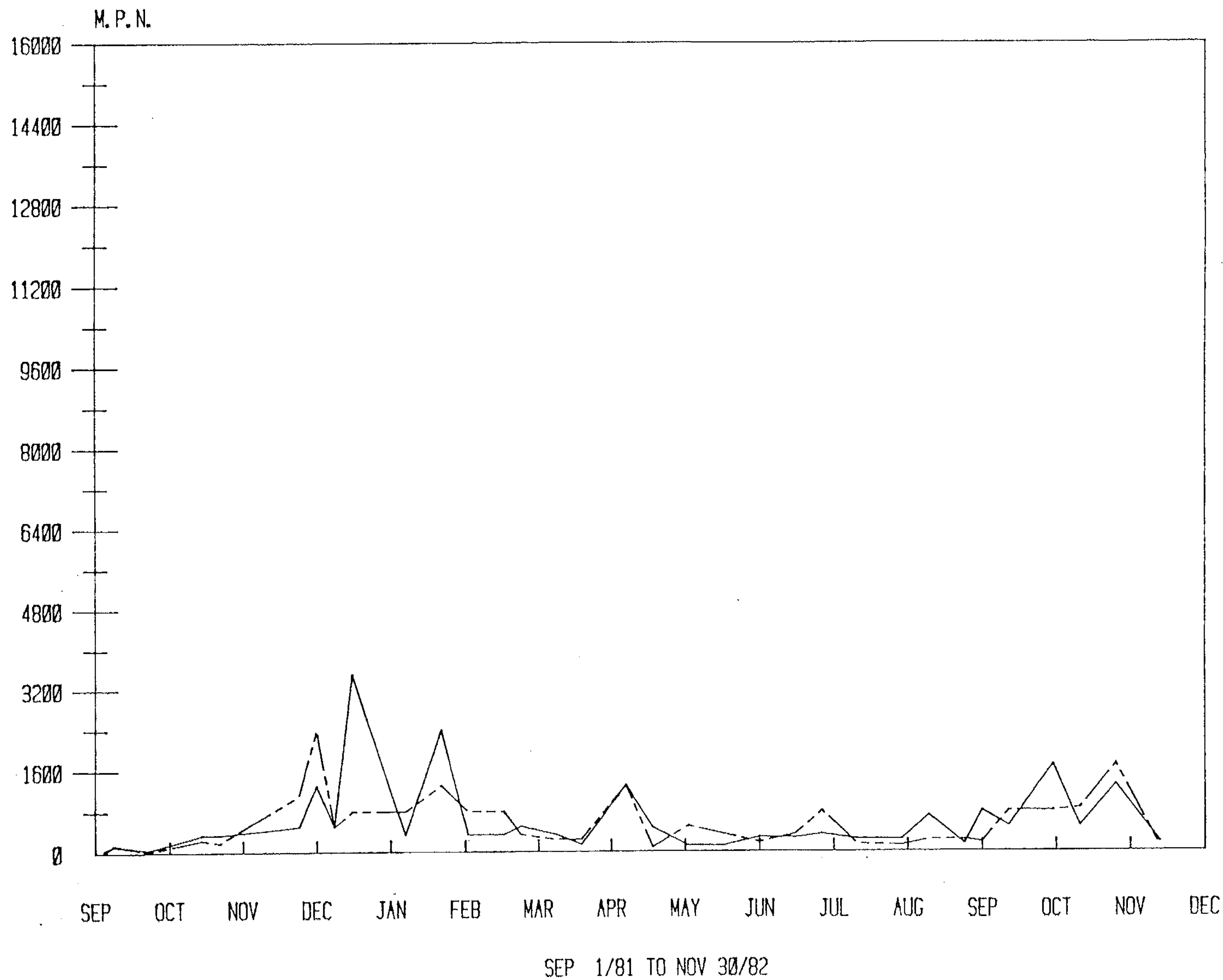


Figure 108 Surface and Depth Comparison of Fraser River Fecal Coliform Levels at the South Sampling Location, September 1981 to December 1982 (0300125; 0.m ———, 7.m -- ——— --)



APPENDIX 4

DATA SUMMARY

Table 6 Fraser River Water Quality Data Summary for the North Surface Sampling Location (0300124), September 1981 to December 1982.

Parameter	Number of Values	Average	Maximum	Minimum	10th Percentile	90th Percentile
Temperature (^{o}C)	33	9.55	18.0	0.0	3.0	17.0
Dissolved Oxygen (mg/L)	32	11.5	14.0	9.3	9.5	12.8
pH	32	7.48	7.9	6.9	7.03	7.87
Field Spec. Cond. (umho/cm)	32	72	112	32	50	88
Lab Spec. Cond. (umho/cm)	33	98	127	5	75	125
Phos. Ort. (mg/L)	32	0.004	0.014	L0.003	0.003	0.007
Phos. Diss. (mg/L)	32	0.007	0.02	0.003	0.004	0.01
Phos. Total (mg/L)	33	0.0594	0.255	0.014	0.019	0.189
Ammonia-N (mg/L)	32	0.018	0.08	L0.005	0.005	0.0392
NO_2/NO_3 (mg/L)	32	0.11	0.27	0.04	0.04	0.2
Nit. Kjel. (mg/L)	32	0.19	0.58	0.05	0.086	0.347
Nit. Total (mg/L)	32	0.30	0.75	0.15	0.153	0.523
Silica Diss. (mg/L)	33	5.18	6.7	3.6	4.14	6.5
Res. NF 105 (mg/L)	32	54	330	5	7	213
Res. Total 105 (mg/L)	33	119	424	44	62	278
Copper Total (mg/L)	34	0.0026	0.01	L0.001	0.001	0.006
Zinc Total (mg/L)	34	0.011	0.04	L0.005	0.005	0.03
Mercury Total (ug/L)	33	0.0000636	0.00018	L0.00005	0.00005	0.000096
Chloride - Diss. (mg/L)	33	1.8	4.5	0.7	0.9	3.7
Alkalinity Total (mg/L)	32	43.4	52	16	29	49
Coliform Fecal (MPN)	33	1642	16000	80	110	2400

Table 7 Fraser River Water Quality Data Summary for the North Depth Sampling Location (0300124), September 1981 to December 1982

Parameter	Number of Values	Average	Maximum	Minimum	10th Percentile	90th Percentile
Temperature (^{o}C)	32	9.23	17.9	0.0	3.0	16.0
Dissolved Oxygen (mg/L)	32	11.5	14.2	4.4	10.1	13.4
pH	32	7.49	8	6.9	7.03	7.87
Field Spec. Cond (umho/cm)	32	71.2	90	35	50	87
Lab Spec. Cond. (umho/cm)	33	97.5	127	48	78.2	122
Phos. Ort. (mg/L)	32	0.0044	0.014	L0.003	0.003	0.0077
Phos. Diss. (mg/L)	32	0.0077	0.02	0.004	0.004	0.0117
Phos. Total (mg/L)	33	0.063	0.269	0.015	0.018	0.200
Ammonia-N (mg/L)	32	0.0182	0.078	L.0.005	0.005	0.045
NO_2/NO_3 (mg/L)	32	0.113	0.27	0.04	0.04	0.19
Nit. Kjel. (mg/L)	32	0.181	0.5	0.03	0.1	0.377
Nit. Total (mg/L)	32	0.294	0.66	0.15	0.17	0.50
Silica Diss. (mg/L)	33	5.19	6.7	3.8	4.14	6.4
Res. NF 105 (mg/L)	32	58	346	6	7.3	227
Res. Total 105 (mg/L)	33	122	422	50	63	297
Copper Total (mg/L)	33	0.003	0.021	L0.001	0.001	0.009
Zinc Total (mg/L)	32	0.0082	0.03	L0.005	0.005	0.0157
Mercury Total (ug/L)	33	0.00006	0.00016	L0.00005	0.00005	0.0001
Chloride - Diss. (mg/L)	33	1.79	4.5	0.7	0.8	3.72
Alkalinity Total (mg/L)	32	39.8	51	16.5	30	47
Coliform Fecal (MPN)	33	1124	9200	80	110	3500

Table 8 Fraser River Water Quality Data Summary for the Mid-river Surface Sampling Location (0300005), September 1981 to December 1982

Parameter	Number of Values	Average	Maximum	Minimum	10th Percentile	90th Percentile
Temperature (^{o}C)	32	9.29	17.5	0.0	3.0	16.0
Dissolved Oxygen (mg/L)	32	11.6	15.0	8.6	9.7	13.0
pH	32	7.54	8	6.9	7.1	7.9
Field Spec. Cond. (umho/cm)	32	74	92	45	60	90
Lab Spec. Cond. (umho/cm)	33	103	127	63	89	123
Phos. Ort. (mg/L)	32	0.0046	0.011	L0.003	0.003	0.0084
Phos. Diss. (mg/L)	32	0.008	0.014	0.004	0.005	0.013
Phos. Total (mg/L)	33	0.066	0.32	0.01	0.02	0.21
Ammonia-N (mg/L)	32	0.017	0.061	L0.115	0.005	0.034
NO_2/NO_3 (mg/L)	32	0.116	0.28	0.04	0.04	0.21
Nit. Kjel. (mg/L)	32	0.164	0.53	0.04	0.083	0.34
Nit. Total (mg/L)	32	0.280	0.7	0.14	0.16	0.44
Silica Diss. (mg/L)	33	5.3	6.8	4.1	4.3	6.6
Res. NF 105 (mg/L)	32	63	406	5	6.3	230
Res. Total 105 (mg/L)	32	134	498	51	67	323
Copper Total (mg/L)	33	0.003	0.01	L0.001	0.001	0.007
Zinc Total (mg/L)	33	0.0097	0.09	L.0.005	0.005	0.015
Mercury Total (ug/L)	32	0.00007	0.0003	L0.00005	0.00005	0.00017
Chloride - Diss. (mg/L)	33	1.86	5.4	0.7	0.9	3.72
Alkalinity Total (mg/L)	32	42	53	23	35	49
Coliform Fecal (MPN)	33	568	3500	20	80	1300

Table 9 Fraser River Water Quality Data Summary for the Mid-river Depth Sampling Location (0300005), September 1981 to December 1982.

Parameter	Number of Values	Average	Maximum	Minimum	10th Percentile	90th Percentile
Temperature (^{o}C)	31	9.32	18.0	0.0	3.0	16.0
Dissolved Oxygen (mg/L)	31	11.5	14.0	5.6	9.6	12.4
pH	33	7.53	8	6.9	7.02	7.88
Field Spec.Cond.(umho/cm)	31	73.5	92	38	60	90
Lab Spec.Cond. (umho/cm)	32	103	128	54	87	123
Phos. Ort. (mg/L)	31	0.0045	0.011	L0.003	0.003	0.007
Phos. Diss. (mg/L)	31	0.008	0.014	0.004	0.005	0.013
Phos. Total (mg/L)	32	0.065	0.33	0.01	0.019	0.232
Ammonia-N (mg/L)	31	0.017	0.06	L0.005	0.005	0.038
NO_2/NO_3 (mg/L)	31	0.118	0.3	0.04	0.042	0.198
Nit. Kjel. (mg/L)	31	0.166	0.47	0.04	0.082	0.354
Nit. Total (mg/L)	31	0.284	0.65	0.14	0.162	0.484
Silica Diss. (mg/L)	32	5.34	6.8	4.1	4.3	6.6
Res. NF 105 (mg/L)	31	65	426	6	9.2	259
Res. Total 105 (mg/L)	32	135	540	46	68.6	339
Copper Total (mg/L)	32	0.0029	0.012	L0.001	0.001	0.006
Zinc Total (mg/L)	32	0.0074	0.022	L0.005	0.005	0.0164
Mercury Total (ug/L)	32	0.00006	0.00016	L0.00005	0.00005	0.00011
Chloride - Diss.(mg/L)	32	1.86	5.2	0.7	0.8	3.68
Alkalinity Total (mg/L)	31	42	53	19	35	49
Coliform Fecal (MPN)	33	545	3500	40	110	790

Table 10 Fraser River Water Quality Data Summary for the South Surface Sampling Location (0300125), September 1981 to December 1982

Parameter	Number of Values	Average	Maximum	Minimum	10th Percentile	90th Percentile
Temperature (^{o}C)	32	9.19	17.8	0.0	3.0	16.0
Dissolved Oxygen (mg/L)	32	11.4	14.3	7.6	9.7	12.9
pH	33	7.53	8	7	7.1	7.9
Field Spec. Cond. (umho/cm)	32	75	93	42	60	88
Lab Spec. Cond. (umho/cm)	34	106	123	66	90	126
Phos. Ort. (mg/L)	33	0.0049	0.01	L0.003	0.003	0.0076
Phos. Diss. (mg/L)	33	0.008	0.021	0.005	0.005	0.012
Phos. Total (mg/L)	34	0.063	0.295	0.015	0.019	0.169
Ammonia-N (mg/L)	33	0.018	0.055	L0.005	0.005	0.026
NO_2/NO_3 (mg/L)	33	0.12	0.28	0.04	0.05	0.21
Nit. Kjel. (mg/L)	33	0.18	0.46	0.07	0.08	0.33
Nit. Total (mg/L)	33	0.29	0.63	0.14	0.17	0.47
Silica Diss. (mg/L)	34	5.42	7	4.2	4.35	6.6
Res. NF 105 (mg/L)	33	65	378	5	8	245
Res. Total 105 (mg/L)	34	137	486	55	68	316
Copper Total (mg/L)	34	0.003	0.013	L0.001	0.001	0.006
Zinc Total (mg/L)	34	0.007	0.018	L0.005	0.005	0.013
Mercury Total (ug/L)	34	0.00007	0.0002	L0.00005	0.00005	0.00015
Chloride - Diss. (mg/L)	34	2.02	7.3	0.7	0.85	3.9
Alkalinity Total (mg/L)	33	43	53	24	35	49
Coliform Fecal (MPN)	33	605	3500	50	110	1300

Table 11 Fraser River Water Quality Data Summary for the South Depth Sampling Location (0300125), September 1981 to December 1982

Parameter	Number of Values	Average	Maximum	Minimum	10th Percentile	90th Percentile
Temperature (^{o}C)	32	9.6	18.0	0.0	3.0	16.5
Dissolved Oxygen (mg/L)	32	11.4	14.0	8.0	9.6	13.8
pH	32	7.52	8	6.9	7.1	7.9
Field Spec.Cond.(umho/cm)	32	75.9	94	42	60	90
Lab Spec.Cond. (umho/cm)	33	104	129	62	90.6	124
Phos. Ort. (mg/L)	32	0.005	0.009	L0.003	0.003	0.008
Phos. Diss. (mg/L)	32	0.008	0.014	0.004	0.005	0.012
Phos. Total (mg/L)	33	0.073	0.319	0.012	0.021	0.216
Ammonia-N (mg/L)	32	0.017	0.058	0.005	0.005	0.041
NO_2/NO_3 (mg/L)	32	0.111	0.28	0.04	0.04	0.21
Nit. Kjel. (mg/L)	32	0.184	0.56	0.06	0.096	0.425
Nit. Total (mg/L)	32	0.30	0.73	0.16	0.17	0.51
Silica Diss. (mg/L)	33	5.32	6.8	4.2	4.34	6.56
Res. NF 105 (mg/L)	32	74	410	6	7.6	284
Res. Total 105 (mg/L)	33	144	512	50	69	349
Copper Total (mg/L)	33	0.003	0.014	L0.001	0.001	0.005
Zinc Total (mg/L)	33	0.010	0.05	L0.005	0.005	0.027
Mercury Total (ug/L)	33	0.00006	0.0001	L0.00005	0.00005	0.00009
Chloride - Diss. (mg/L)	33	1.91	7.6	0.7	0.84	3.92
Alkalinity Total (mg/L)	32	42.7	52.9	22.5	35.7	49.4
Coliform Fecal (MPN)	33	560	2400	20	80	1300

APPENDIX 5

PARAMETER LOADINGS

Table 12 - Parameter Loadings (continued)

PHOSPHORUS-ORTHO. DISS.

	Detec Total Values	Loading (Kg/day)	Detec Total Values	Loading (Kg/day)	Detec Total Values	Loading (Kg/day)
1981						
September	0 - 18	-				
October	4 - 6	-				
November	12 - 12	1430				
December	11 - 12	773				
1982						
January	12 - 12	787				
February	18 - 18	894				
March	12 - 12	646				
April	12 - 12	613				
May	12 - 12	224				
June	11 - 18	2700				
July	7 - 11	2190				
August	4 - 18	-				
September	7 - 12	1180				
October	5 - 12	-				
November	6 - 6	590				