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Province of British Columbia
Ministry of Environment and Parks
ENVIRONMENT DIVISION

MEMORANDUM

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3547 Skaha Lake Road, Penticton, British Columbia V2A 7K2 / Telephone: (604) 493-8261

Environmental Monitoring
Okanagan Sub-Region

January 28, 1988

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Ministry of Environment
Suite 201
3547 Skaha Lake Rd.
Penticton, B.C.
V2A 7K2

Attention: J. Bryan
Section Head

Re: Summary of Phosphorus Loading to Okanagan Lakes from Dustfall and Precipitation

INTRODUCTION

Contribution of phosphorus from dustfall and precipitation to Okanagan lakes was first evaluated during the Okanagan Basin Study (Anon, 1974). Results of this study indicated that phosphorus from the atmosphere could form a significant portion of the nutrient load to shallow lakes such as Wood, south basin of Osoyoos and headwater lakes. A review and update during the Okanagan Basin Implementation Study noted spatial and temporal variability in airborne phosphorus during a short study and contamination of collectors which reduced loading estimate accuracy (Alexander, unpublished). Despite these limitations, the importance of airborne phosphorus as one of the non-controllable nutrient inputs to the Okanagan lakes was recognized.

To better document spatial and temporal variability of phosphorus in precipitation and dustfall the Waste Management Branch began sampling at four urban sites in 1986. Four additional sites were established around Skaha Lake in October 1986 and were sampled for approximately one year. This report will serve to document temporal and spatial variability of phosphorus in dustfall in the Okanagan basin and compare 1986-87 data to previous studies in 1972 and 1982.

Methods

Dustfall and precipitation samples were collected in open topped plastic canisters. Canisters contained deionized water (isopropyl alcohol added in winter months) and were changed at monthly intervals. Samples were analyzed for insoluble and soluble phosphorus at the Environmental Lab using similar methods to those employed in 1972 (T. Tsang personal communication). The four urban sites were located at sites similar to those used for the Okanagan Basin Implementation Study 1981 update. The Skaha Lake sites were chosen to be similar to sites used in the 1972 Okanagan Basin Study. Site numbers, locations and sampling period are provided in Table 1. The discussion of results will focus on soluble phosphorus as this portion of the phosphorus is readily available for algal assimilation and is the fraction of phosphorus reported during the Okanagan Basin Study.

Table 1. Site Number and Location and sampling period for Phosphorus in Dustfall and Precipitation in the Okanagan Basin.

Site Number	Location	Sampling Period
0500827	Vernon RCMP Building - roof top	Jan 1986 - present
E206304	Kelowna OK College - roof top	Feb 1986 - present
0500156	Penticton Air #4 STP - fence	Feb 1986 - present
0500826	OK Falls control (STP) - fence	Feb 1986 - present
E206759	Skaha Air South - Sun & Sand Trailer Park - wharf	Oct 1986 - Oct 1987
E206760	Skaha Air East - DeRenz Place, wharf	Oct 1986 - Oct 1987
E206761	Skaha Air North - float plane wharf	Oct 1986 - Oct 1987
E206762	Skaha Air West - 242 Alder Ave. wharf	Oct 1986 - Oct 1987

Results and Discussion

Table 2 shows the maximum, minimum, mean and geometric mean for soluble phosphorus at all eight sampling locations.

From this summary it is apparent that maximum and mean soluble phosphorus is higher around Skaha Lake than at three of the urban sites. Significant seasonal variation (Figures 1 & 2) is noted with phosphorus higher during the months of June to September. These months would be the period of increased insect activity and presumably a period of lower dust generation compared to spring months. Field observations have noted that the considerable insect capture by the canisters and attached spider webs at Skaha Lake sites occurred to a much lesser degree at urban sites.

Table 2. Soluble Phosphorus portion of Dustfall sample in $mg/dm^2/d$

	n	Max	Min	Mean	Geomean
Vernon RCMP	13	0.0067	L0.00006	0.00116	0.00042
Kelowna OK College	15	0.00220	L0.00006	0.00059	0.00033
Penticton STP	9	0.00232	L0.00006	0.00094	0.00056
Skaha N	11	0.01300	0.00006	0.00343	0.00071
Skaha E	13	0.03500	L0.00006	0.00681	0.00100
Skaha W	12	0.01500	L0.00006	0.00178	0.00035
Skaha S	12	0.02100	L0.00006	0.00370	0.00067
OK Falls	19	0.01600	L0.00006	0.00271	0.00064

Prior to calculating loading rates it is important to recognize the limitations of these sampling results, particularly for the Skaha Lake sites. Sampling at the margins of the lake may not fairly represent phosphorus loading for the entire lake surface particularly for a large lake like Skaha where there may be a significant decrease in insect activity and dustfall with distance from shore. Whether the canisters might attract insects and thereby overestimate airborne phosphorus is also not known.

The problems of spatial variability of airborne phosphorus were identified as limiting data use in 1972. If one can assume that spatial and seasonal variability would be similar for the 1972 and 1986-87 studies then the two data sets might still be compared to see if significant change has occurred to the phosphorus content of precipitation and dustfall.

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Phosphorus loadings from dustfall were calculated in the 1972 study as a nutrient flux using monthly analytical results and the monthly wind direction frequency. Flux calculations will not be repeated for the 1986-87 data since analytical values do not vary greatly from one site to another and annual wind directions are also fairly evenly divided between north, south and other directions. As previously mentioned, there are possibly more serious limitations due to spatial representation of the sites which allows only very approximate loading rates to be developed.

Calculation of airborne P loading rates for Skaha Lake in 1986-87 were made two ways, first by using the grand arithmetic mean of the four sites and a second time using a grand mean of the four geometric means. For comparison purposes the 1972 data was reexamined using arithmetic and geometric means. Results of the loading calculations are shown in Table 3.

Table 3. Soluble Phosphorus loading estimates from dustfall and precipitation to Skaha Lake.
1972 = 760 kg soluble P/yr; flux calculation (Alexander, unpublished)
1972 = 2310 kg soluble P/yr; as a grand arithmetic mean
1972 = 370 kg soluble P/yr; as a grand geometric mean
1986-87 = 2880 kg soluble P/yr; as a grand arithmetic mean
1986-87 = 500 kg soluble P/yr; as a grand geometric mean

Whether an arithmetic or geometric mean is used, the estimate of P in dustfall agrees well between 1972 and 1986. It is unlikely that airborne P loads have changed markedly over this period.

The disparity among the loading estimates reflects the seasonal and spatial variability in sample collectors. To develop an appropriate sampling design to overcome these problems is difficult logistically and will be constrained by untestable assumptions.

Table 4 shows a review of estimates of phosphorus inputs to Skaha Lake (Anon, 1985). It suggests that using the annual arithmetic mean of the four sites yields a loading value biased by high summer values. A realistic phosphorus loading value from dustfall and precipitation sources would probably fall in the range of 300-800 kg P/yr or 0.20 - 0.40 kg/ha/yr.

Table 4. Bioavailable Phosphorus Loadings to Skaha Lake (Anon., 1985)

Source	Tonnes P/yr in 1980
Controllable	
Point Source	
Municipal	2.4
Storm sewers	negligible
Industrial	"
Non Point source	
Agriculture (animals)	0.4
Septic Tanks	1.8
Logging	0.9
Non-Controllable	
Dustfall/Precipitation	0.8
Watershed	3.3
Main Stem Loadings	3.1

Annual phosphorus loads have been calculated using annual arithmetic means for the four sites (Table 5). The 1986-87 total phosphorus values ranged from 0.40 kg/ha/yr at Kelowna to 1.29 kg/ha/yr at Okanagan Falls. Soluble phosphorus values ranged from a low of 0.22 kg/ha/yr at Kelowna to 0.99 kg/ha/yr at Okanagan Falls. These values correspond reasonably well with those from 1981 (Table 5) particularly given the limited number of samples for the 1981 study.

Although 1986-87 data for Kelowna and Vernon during similar months to the 1981 study still show less phosphorus, an overall decrease in airborne P cannot be assumed due to changes in sampling location. Increases in airborne P at Okanagan Falls may be related to relocation of the sampling site in 1986-87 adjacent to the Okanagan River. Lower values at Penticton in 1987 may reflect relocation of this site from adjacent to the Greenwood Forest Products log storage yard to the Penticton STP.

Summary

1. Soluble phosphorus in dustfall demonstrates significant spatial (higher at lake margins) and temporal (higher in summer months) variability.

2. This variability limits the ability to develop accurate loading rates, particularly from samples collected at lake margins. Soluble phosphorus loading to Skaha Lake from dustfall and precipitation is estimated to range from 500 - 2880 kg P/yr.

3. The various loading estimates for Skaha Lake suggest that little change in airborne P load has occurred between 1972 and 1986. Since the range is the same.

4. Loadings calculated from urban site data would indicate little change from 1981 with a range of 0.22 to 0.99 kg soluble P/ha/yr.

5. The variability among the samples collected at different times and places could mask any shifts in the mean or median result which might exist within the observed range of results.

Table 5. Annual Phosphorus Loadings from Dustfall and Precipitation for four urban sites in the Okanagan Basin for 1981+ and 1987.

Centre	Sampling Period	Location	Number of Months Sampled	Loading in Kg P/ha/yr	
				Total Phos.	Soluble Phos.
OK Falls	1986-87	OK Falls STP	19	1.29	0.99
	1981	SE of Sawmill	1	0.34	0.26
Penticton	1986-87	Penticton STP	9	0.99	0.34
	1981	N Penticton Airport	2-3	1.41	0.72
Kelowna	1986-87	OK College roof top	15	0.40	0.22(.08 Jan-May)
	1981	(Jan-May)	5	0.92	0.82
Vernon	1986-87	RCMP Building	13	0.76	0.42(.43 Jan-June)
	1981	Near downtown (Jan-June)	5	1.39	0.68

+1981 data taken from Alexander, D.G. Review of nutrient loadings from dustfall and precipitation. Okanagan Basin Implementation Agreement. Office of study Director, Box 458, Penticton, B.C. 9p.

REFERENCES

Anonymous, 1974. Canada - B.C. Okanagan Basin Agreement, Tech. Sup. IV. Water Quality and waste loadings in the Okanagan Basin B.C. Water Resources Service 565p.

Alexander, G.D., Unpublished Working Report. Review of nutrient loadings from dustfall and precipitation. Okanagan Basin Implementation Agreement. Office of the Study Director, Box 458, Penticton, B.C. 9p.

Anonymous, 1985. Phosphorus in the Okanagan Valley Lakes - sources, water quality objectives and control possibilities, B.C. Ministry of Environment, 163p.

E.V. Jensen
Environmental Impact
Assessment Biologist
Waste Management Program

EVJ/pa/ms

FIGURE 1

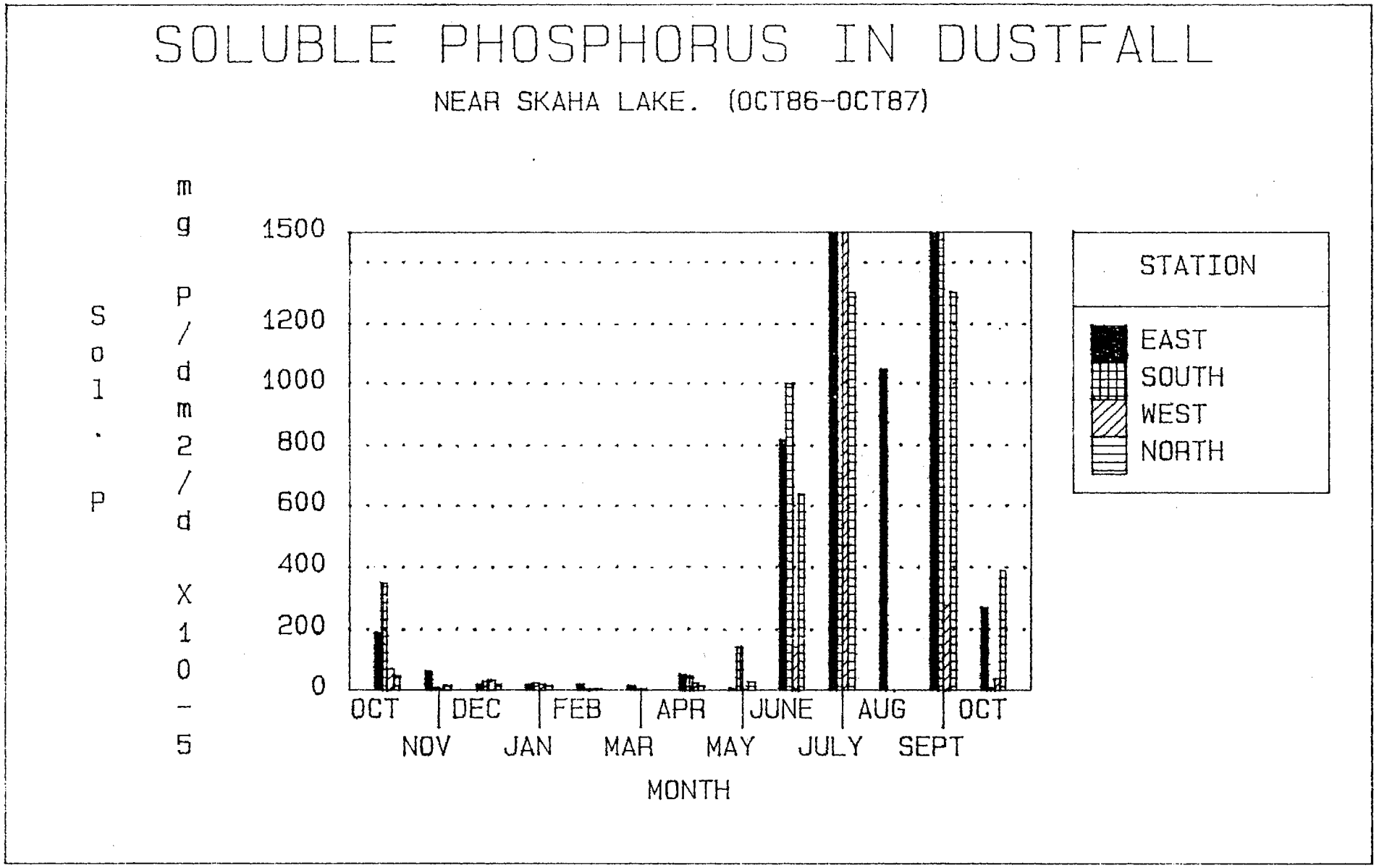
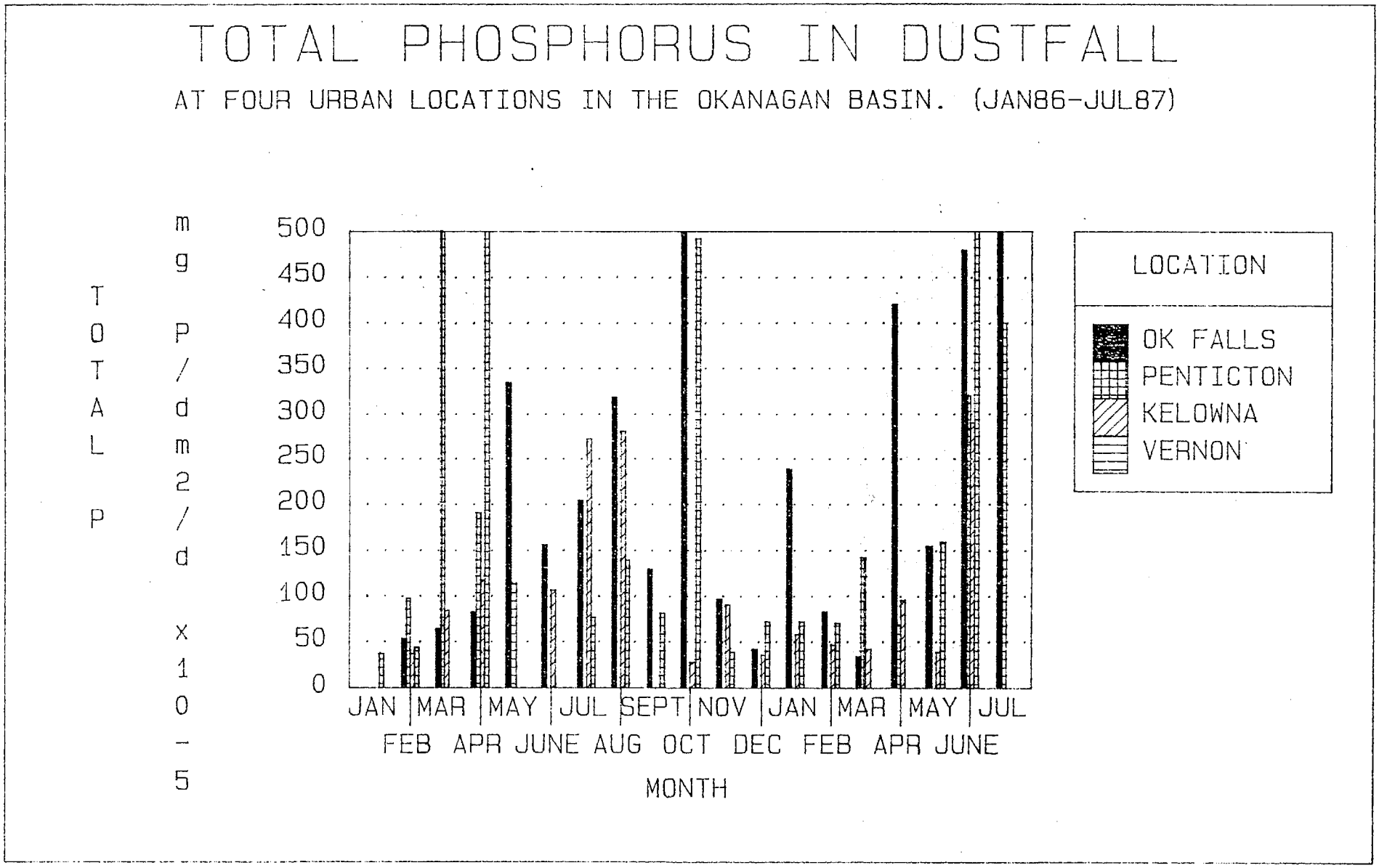

SOLUBLE PHOSPHORUS IN DUSTFALL
NEAR SKAHA LAKE. (OCT86-OCT87)
Sol. P
mg P/dm2/d X10-5
1500
1200
1000
800
600
400
200
0
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
MONTH
STATION
EAST
SOUTH
WEST
NORTH

FIGURE 2


TOTAL PHOSPHORUS IN DUSTFALL
AT FOUR URBAN LOCATIONS IN THE OKANAGAN BASIN. (JAN86-JUL87)
TOTAL P
mg P/dm2/d x 10-5
500
450
400
350
300
250
200
150
100
50
0
JAN
FEB
MAR
APR
MAY
JUNE
JUL
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUNE
JUL
MONTH
LOCATION
OK FALLS
PENTICTON
KELOWNA
VERNON