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PRELIMINARY CALIBRATION TRIALS OF FPMI HELICOPTER EXPERIMENTAL SPRAY SYSTEM INSTALLED IN HUGHES MODEL 500 HELICOPTER, 1977

by

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INTRODUCTION

A recent study (Edwards 1976) pointed out the lack of both a helicopter-specific aerial spray system for forestry applications, and of reliable data on the utilization of helicopters in this role. In accordance with the recommendations of this study, a prototype spray system was developed for installation on the Hughes Model 500 helicopter.

Field testing and preliminary calibration trials were planned for May, 1977. However, delays in both helicopter availability and the completion of certain custom-built components caused the work to be postponed until early autumn at which time it was hampered by extremely inclement weather conditions.

The objectives of these preliminary trials were:

1. Field test the prototype spray system.
2. Determine effect of airspeed on droplet spectrum, droplet distribution and effective swath width, using both water- and oil-based formulations.
3. Determine the effect of rotor wake on droplet deposition at various airspeeds.

MATERIALS AND METHODS

Experimental Design

The field tests and preliminary calibration trials were conducted at the Ottawa District Headquarters of the Ontario Ministry of Natural Resources, Leitrim, Ontario during the period September 22 to October 6, 1977.

Deposit samples were obtained by placing sample units at permanent stations along three parallel lines in, or adjacent to, a cleared gas pipeline right-of-way (Figure 1) which traversed an area of coniferous plantations and mixed-wood stands 20 to 25 feet in height.

The first line, Line 'X' was in the open and extended for 500 yards down the approximate centre of the right-of-way with sample stations located at five yard intervals for the first 100 yards from the planned flight line, and at 10-yard intervals thereafter. The line was also extended by 35 yards in the opposite direction with stations spaced five yards apart.

A second sample line, Line 'P', was established in the first row of the plantation immediately adjacent to the southwestern border of the cleared right-of-way. Sample stations, consisting of vertical 12 foot poles, were erected at 20-yard intervals over a distance of 140 yards.

The third line, Line 'Y', was located in the plantation, 25 yards from the southwestern border of the right-of-way, with sample stations placed in openings approximately five yards apart over a length of 100 yards.

The sample stations of Lines 'X' and 'Y' consisted of aluminum platforms fixed horizontally atop 12" aluminum stakes.

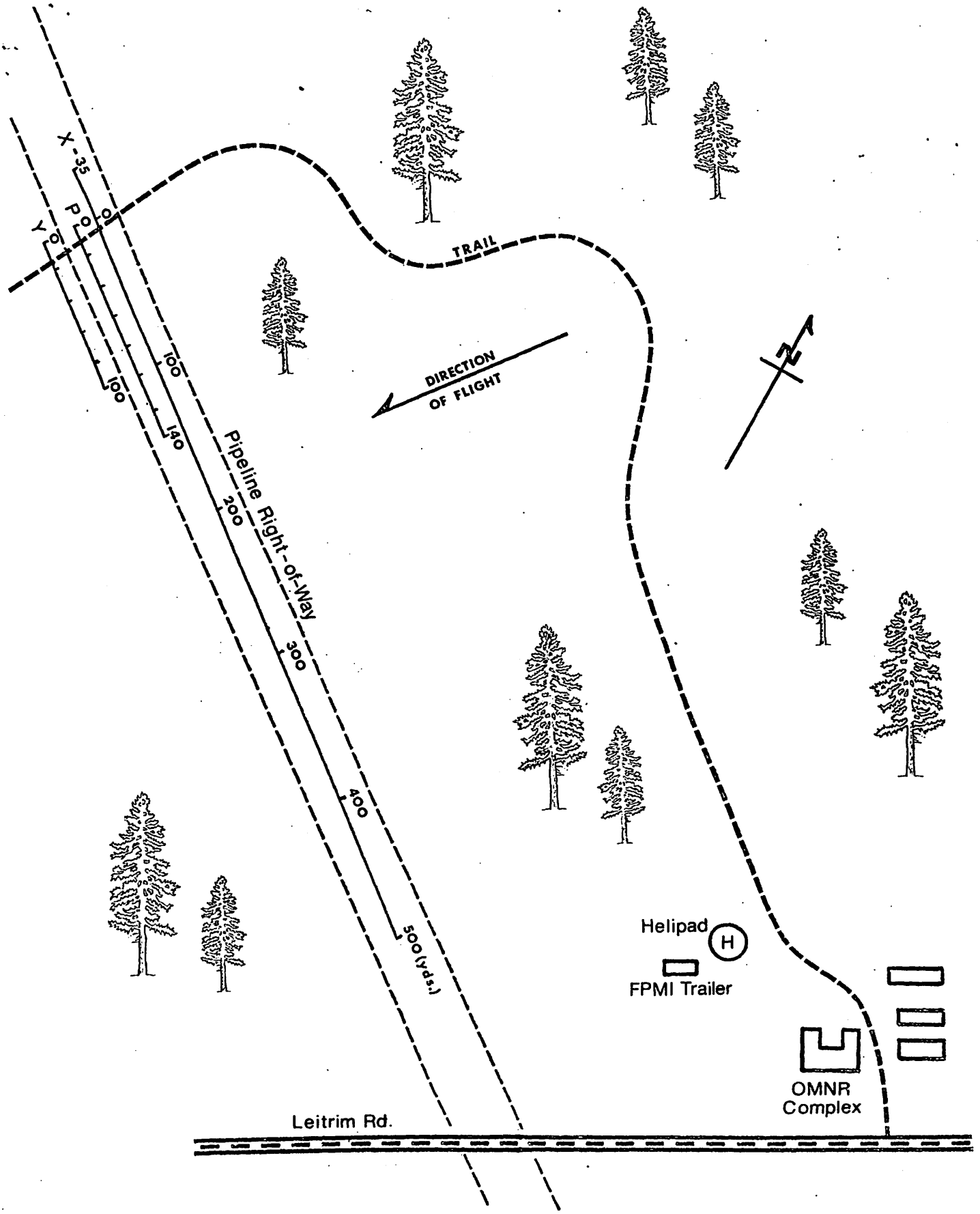


Fig. 1. F.P.M.I. Experimental Site Layout

At the uppermost end of the 12 foot poles in Line 'P' was attached a steel clip which could hold two sample units horizontally, back-to-back, with one facing up and the other down. This was to provide preliminary data concerning the ability of the turbulence created by the rotor wake to effect droplet impingement on the lower surface of objects in the mid-crown area of the canopy.

Sample Units

Each of the units used to collect droplet deposit samples at each station consisted of two square aluminum plates measuring 10 cm. to a side, joined together by cloth tape which created a hinge effect and allowed the unit to be opened and closed like a book (Figure 2). With the unit lying flat in the open position, a 10 x 10 cm. Kromekote® card was attached to one of the aluminum plates with two rubber bands, and two, hinged, 50 x 75 mm. glass slides were attached to the other by double-backed tape which is used to make one of the slides adhere to the aluminium.

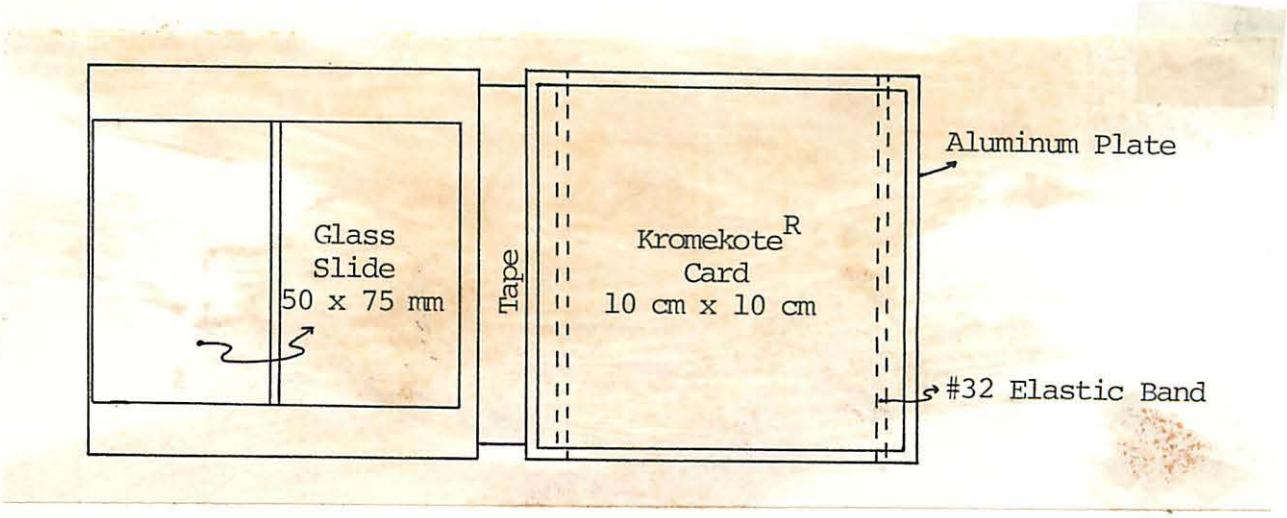


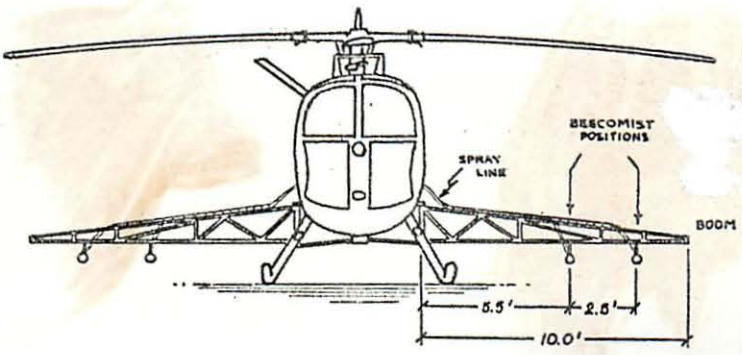
Fig. 2. Diagram of Opened Sample Unit.

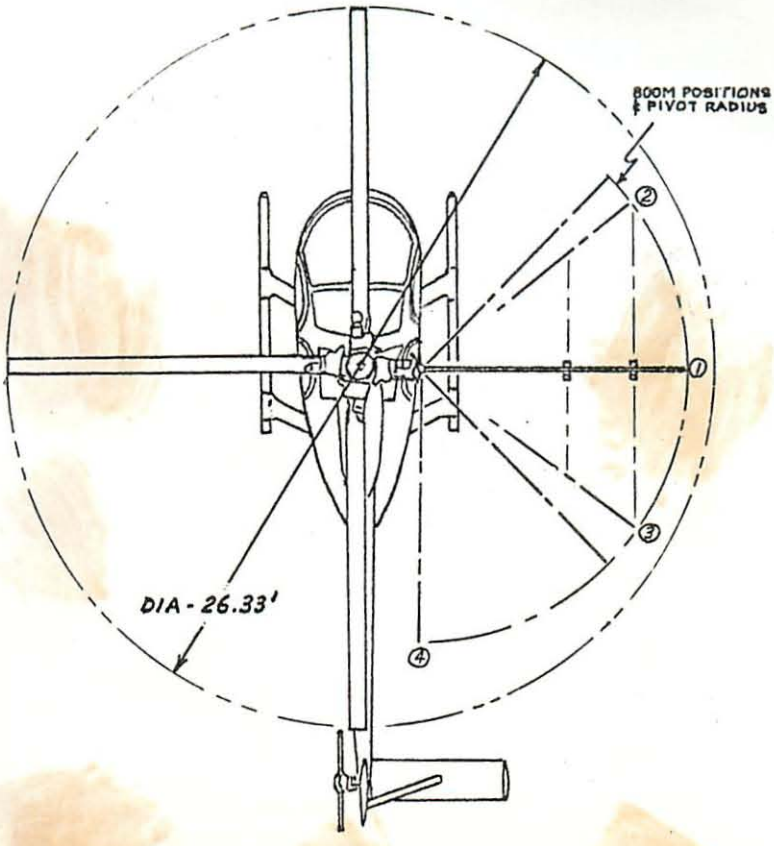
Helicopter Employed

For a number of reasons (Edwards 1976), the Hughes Model 500 Helicopter was selected as the test aircraft and one was contracted from Viking Helicopters Ltd. of Ottawa. The Hughes 500 is equipped with a four-bladed, 26.33-feet diameter main rotor (Figure 3) and a Detroit Diesel Allison 250-C18 gas turbine engine developing 317 shaft horsepower at sea level. Maximum certified gross weight is 2,550 pounds with an internal load, and maximum useful load is 1,350 pounds.

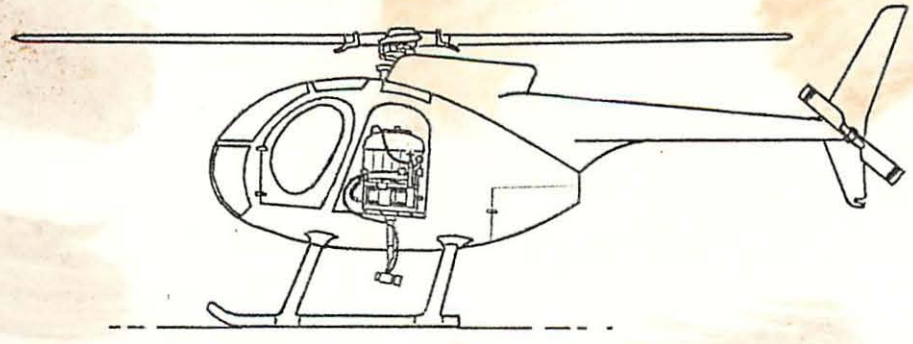
Spray System

In designing the spray system, a number of basic criteria were adhered to. The helicopter's wide airspeed capability range demanded an atomization device whose operation is completely independent of airspeed. For spray economy and efficacy compatible with helicopter payloads, this device must produce droplet spectra superior to those obtainable with standard hydraulic nozzles. In addition, the system must be light-weight, simple, reliable, easily-maintained and economical. For ease of installation and removal it should consist of three modules: two booms complete, and a palletized tank/pump module for cabin installation, all with standard anchor points and quick-disconnect attachments to the ship electrical and hydraulic systems. The prototype spray system thus included off-the-shelf items representing the better features of existing systems plus custom-fabricated components specific to the program. The palletized, internal, cabin module (Figures 3b and 3c) consisted of a 200-liter, fiberglass tank with loading strainer and tank shut-off valve close-plumbed to an electrically-driven, 24-volt, Simplex, centrifugal spray pump. The system

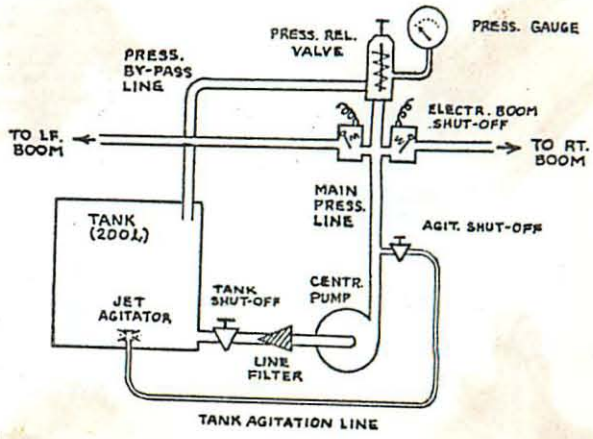




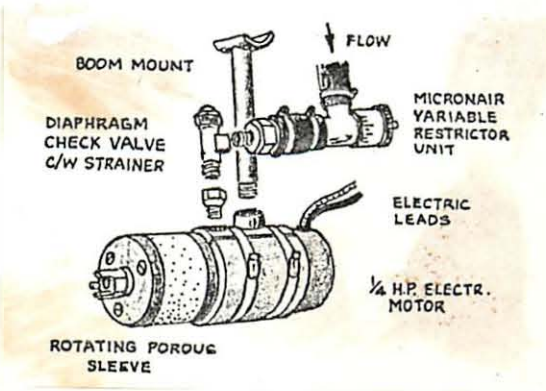
a) Front and plan views of spray boom installation and configuration.



b) Side view showing internal system installation.



c) Schematic diagram of spray delivery system.



d) Detail of Beecomist boom installation.

Figure 3

Prototype FPMI Helicopter

Experimental Spray System

Mounted on

Hughes 500 Helicopter

included a line strainer, agitation line, pressure gauge and pressure-regulated bypass line to the tank. Flow to the booms was controlled by a pair of 12-volt, electric, solenoid valves wired in series for compatibility with the 24-volt electrical system of the helicopter. This total module was mounted on a plywood pallet which could be spring-pinned to standard hard-points in the floor of the aft cabin, thus permitting speed and ease of installation and removal. To the same end, all plumbing and electrical leads incorporated quick-disconnect capability as well.

Hoses conducted the liquid spray from the solenoid valves to the left and right booms respectively, and to the two Beecomist Model 350 spray heads installed on each boom. The plumbing of each spray head employed a diaphragm check valve and Micronair VRU (variable restrictor unit) to facilitate calibration, together with a mounting bracket which permitted the unit to be rotated and locked in the horizontal plane for proper longitudinal alignment (Figures 3a and 3d). The upper end of the mounting bracket was attached to the boom with a stainless steel hose clamp, and a strip of rubber was used to maximize the friction between the bracket, hose clamp and boom.

Each Beecomist spray head was comprised of an interchangeable, porous sleeve through which the spray is emitted as the sleeve is rotated at a minimum r.p.m. of 10,000 by an integral 12-volt, electric motor rated at 0.25 horsepower (Figure 3d). As with the solenoid valves, the two Beecomists on each boom were wired in series to utilize power from

the aircraft's 24-volt system.

The booms were constructed by Viking Helicopters Limited. They were 10 feet in length and could be swung and locked in various positions from 45° forward to full aft. This feature permitted the experimental location of the Beecomists in various positions relative to the rotor wake and the centre-line of the aircraft, as well as a "trail" position (Figure 3a) of the booms for ferry purposes.

The electric motors of the spray heads and insecticide pump were connected to the aircraft electrical system via a small control box in the cockpit. This box was equipped with two switches for activating the spray heads, one for the two units on the left boom and one for the two on the right. A third switch controlled the insecticide pump. Separate circuit breakers were installed in conjuction with each switch.

The solenoid valves controlling pesticide flow to the boom were wired to the cargo hook switch on the pilot's cyclic stick.

Spray Formulations

Two formulations were employed during the trials, one water-based and the other oil-based, as follows:

a)	#2 Fuel oil	40.00 U. S. Gallons
	Arotex	8.00 " "
	Automate Red B dye	0.25
	Total:	48.25 U. S. Gallons
b)	water	40.00 U. S. Gallons
	ethylene glycol	8.00 " "
	Rhodamine 'B' dye	0.25 " "
		48.25 U. S. Gallons

A complete set of spray trials was carried out with each of these formulations.

Rate of Flow Calibration

Since the Simplex centrifugal insecticide pump operated at constant r.p.m., the flow of liquid to the spray heads was controllable by three means:

1) Varying the setting of the tank shut-off valve between the insecticide tank and the pump;
2) Varying the pressure setting of the pressure relief valve;
3) Selecting orifices of various diameters with the VRU's installed immediately upstream of each spray head.

Rate of flow calibrations of the system were carried out before each of the two sets of spray trials to adjust the emission rates to that required for an application rate of 0.5 gallons (U.S.) per acre at each of 30, 45, and 60 miles per hour over an assumed swath width of 100 feet. Respectively, the total required flow rates from the four heads were 3.03, 4.54 and 6.0 gallons (U.S.) per minute.

The calibration procedure involved running the helicopter on the ground with the spray system operating in the bypass mode, the porous sleeves removed from the spray heads, and the spray head electric motors switched off. A plastic bag was secured over each spray head and the flow of liquid switched on for exactly 60 seconds. The bags were then removed, carefully drained into graduated containers and the volumes recorded. This procedure was repeated, with adjustments to the VRU's and check valves until the flow rate was the same for each spray head. Total flow rate was then adjusted by varying the line pressure at the pressure relief valve, and all settings recorded. The tank shut-off valve was used

initially for coarse adjustment.

Spray Application

All spray trials were flown in the early morning and late evening hours during periods of optimum meteorological conditions. Temperature and relative humidity were measured with a battery-operated psychrometer. (Table I). Measurement of wind speed and direction involved the use of a 25-foot tower located in a large open area immediately adjacent to the work site (Table I, Figures 6-12).

Spray runs were flown at 90 degrees to the sample line layout and the point of intersection of the flight path and layout was marked with a balloon. (Figure 1).

During the trials, all spray runs were flown at a height of 45 feet above ground, 25 feet above the plantation canopy.

A total of seven trials were carried out, three with the water-based formulation and four with the oil-based formulation. Each trial was duplicated, giving a total of 14 separate spray runs.

During trials T1 to T6 (water-based), plastic sleeves of 40 µm porosity were installed on the Beecomist spray heads. Trials T7 to T12 (oil-based) employed perforated metal sleeves of supposed 80 to 100 µm porosity but, since these resulted in a rather coarse droplet breakup, the 60 mph replicates were reflown with the 40 µm plastic sleeves. These were designated T13 and T14. Inclement weather prevented further work.

Deposit Assessment

Physical analysis of the deposit collected on Kromekote cards was accomplished using NCR Micro-card Readers. In random sample areas

Table I

Summary Data - Hughes 500 Calibration Trials - Lietrim, Ont. 1977

Trial No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
VRU Setting	7	13	13	7	13	13	7	7	9	9	11	11	11	11
Flow Rate	2.75 GPM	4.65 GPM	4.65 GPM	2.75 GPM	4.65 GPM	4.65 GPM	3.125 GPM	3.125 GPM	4.475 GPM	4.475 GPM	6.0 GPM	6.0 GPM	6.0 GPM	6.0 GPM
Pressure (PSI)	20	20	20	20	20	20	25	25	21	21	18	18	20	20
A/C Speed mph	30	45	60	30	45	60	30	30	45	45	60	60	60	60
A/C Ht/ft	45	45	45	45	45	45	45	45	45	45	45	45	45	45
Wind Speed	2 - 4 Gust 6	2 - 4 Gust 6	2 Gust 6	2 - 3 Gust 5	0 - 2	0 - 1	2 - 4	0 - 2	0 - 2 Gust 4	0 - 2 Gust 4	1 - 3 Gust 6	2 - 4 Gust 6	3 - 4 Gust 8	2 - 3 Gust 6
Temp o F	42	44.5	54	55	48.5	43	49	43.5	37	45.5	52	55.5	45.5	45.5
R.H. %	94	90	49	49	89	94	86	91	100	94	88	75	71	71
Swath 1. Width (ft)	135	60	0	90	165	135	150	105	135	180	60	30	0	105
Swath 2. Width (ft)	120	30	0	30	120	135	135	90	120	120	60	30	0	90
MMD µm	150	136	145	130	150	150	107	124	144	130	155	157	117	110
NMD µm	112	100	111	95	115	123	64	65	72	65	78	81	75	70
D max µm	383	312	418	383	348	348	277	277	291	291	291	306	215	200
Sleeve Type	plast. 40 µm	plast. 40 µm	plast. 40 µm	plast. 40 µm	plast. 40 µm	plast. 40 µm	metal perf.	metal perf.	metal perf.	metal perf.	metal perf.	metal perf.	nylon 40 µm	nylon 40 µm
Date	29/9	29/9	29/9	29/9	29/9	29/9	4/10	4/10	5/10	5/10	5/10	5/10	6/10	6/10
Time	0745	0840	1655	1745	1818	1850	1805	1846	0715	0827	0935	0951	1750	1849

Swath Width...1. based on drop counts of 15^{+}drops/cm^2

Swath Width...2. based on drop counts of 20^{+}drops/cm^2

on each card, stains were measured and placed in 100 μm diameter classes as they were counted. For each sample station and for each trial, deposit density was calculated in terms of the number of droplets/cm ^{2} (Figures 6-12), and deposit volume in number of ounces per acre (Tables IV - VII).

The mass median diameter (MMD) and number median diameter (NMD) was calculated for each trial (Figures 4 - 5).

RESULTS AND DISCUSSION

The Leitrim, Ontario site of the preliminary calibration trials was almost ideal for the purpose. The pipeline right-of-way was sufficiently wide that the sample line located therein, in the open, was unaffected by wind blowing across the top of the canopy and down into the right-of-way from either side.

The coniferous plantation and other wooded area through which the cleared right-of-way passed made it possible to place sample units both within and below a forest canopy, as well as in the open, and to locate the sample lines within convenient proximity to one another. All three lines could thus be covered by the same spray run and within only a few seconds, providing excellent comparison of droplet deposition under the three sets of conditions described.

The deposit densities obtained indicated little or no correlation between the helicopter's airspeed and deposit differential. Averaging the deposit over the first 100 yards of both the open ground and in-canopy sample lines yielded deposit density ranges of 4.98 to 23.22 droplets/cm ^{2} and 1.20 to 7.21 droplets/cm ^{2} respectively. When these values are grouped according to the helicopter airspeed, the differential has no trend. (Table II).

Table II

Average Deposit (Density Droplets/cm^2) and Deposit Differential

A/C Speed m.p.h.		Water Formulation			Oil Formulation		
		Open	Canopy	% diff.	Open	Canopy	% diff.
30	a	19.83	3.69	81.4	22.11	4.57	79.3
	b	7.13	1.72	75.9	12.8	9.11	28.8
45	a	7.18	2.02	71.9	14.88	10.45	29.8
	b	22.12	12.06	45.5	23.22	7.21	68.9
60	a	4.98	1.20	75.9	7.93	4.10	48.3
	b	8.96	7.21	19.5	7.06	2.40	66.0

The deposit density did, however, vary inversely with wind velocity. In other words, the higher the wind velocity, the lower the deposit density.

Analysis of material from the sample units suspended at mid-canopy on 12-foot poles showed very little deposit on the samples which had faced vertically downward. (Tables III - VII). This implies insufficient in-canopy turbulence from the rotor wake to effect impingement on the glass slides and Kromekote cards. This, in turn, may have been because the altitude of 25 feet above canopy was too great, all three airspeeds were too high, or a combination thereof. A third possibility, is that the turbulence existed, at least in some cases, but imparted insufficient velocity to the droplets to cause impingement on flat targets as large as those presented by the sample units used (Edwards 1976).

In principle at least, electrically-driven, rotary atomizers like the Beecomist spray head should produce droplet spectra which are largely unaffected by the airspeed at emission. Data collected during the trials indicated that increasing airspeed caused an increase in MMD and NMD on the deposited spray. This, however, is probably because the downward vector of the rotor wake tends to accelerate the descent of the spray cloud, causing more of the fines to deposit closer to the aircraft's track over the ground. At higher speeds, the wake effect may be expected to diminish, allowing the smaller droplets to be borne downwind before depositing (Figures 6-9).

If effective swath widths for each trial are based on a minimum deposit density of 20 droplets/cm^2 (Table III), swaths of 75 feet are indicated for the water-based formulation sprayed at 30 and 45 m.p.h. dropping to 68 feet at 60 m.p.h. When perforated metal sleeves were used to disperse the oil formulation, the effective swath width varied from

Table III

Comparison of Droplet Spectra and Effective Swath at Various Airspeeds

Speed mph	Formu-lation	Sleeve size	MMD µm	NMD µm	Avg. Swath @ 20 drop/cm^2	VRU Setting	Pressure PSI
30	H^2O T1 + 4	plastic 70 µm	120	103.5	75 ft	7	20
45	H^2O T2 + 5	plastic 70 µm	143	107.5	75 ft	13	20
60	H^2O T3 + 6	plastic 70 µm	148	117.0	68 ft	13	20
30	Oil T7 & 8	metal perf.	115.5	64.5	127 ft	7	25
45	Oil T9 & 10	metal perf.	137	68.5	120 ft	9	21
60	Oil T11 & 12	metal perf.	156	79	45 ft	11	18
60	Oil T13 & 14	plastic 70 µm	113.5	72.5	90 ft *	11	20

* Only data from T14 used here.

127 feet at 30 m.p.h. to 45 feet at 60 m.p.h. This suggests that the effective swath width is greater at lower airspeeds.

When oil is sprayed at 60 m.p.h. using 40 μm plastic sleeves, the droplet spectrum is superior in terms of Dmax, MMD and NMD to that when the perforated metal sleeves are used.

The four Beecomists required a total of 36 amperes from the helicopter electrical system and the Simplex centrifugal pump/electrical motor assembly required in excess of 80 amperes. The total amperage draw of 116 amperes on the aircraft system is considered excessive in view of the fact that the helicopter's starter-generator has a maximum, non-derated capacity of only 150 amperes.

Following completion of the calibration trials, the rotational speeds of the four Beecomist spray heads were measured under no load, using a Strobex® blade tracker. These speeds were 10,000, 10,860, 11,000, and 11,400 r. p. m. respectively. The manufacturer specifies that all units are factory adjusted for minimum speeds of more than 10,000 r.p.m. under load. Clearly, not only did these units vary widely in terms of rotational speed but, under load, at least one, and probably two of them would have turned at speeds substantially less than the 10,000 r.p.m. specified by the manufacturer.

CONCLUSIONS

1. The mechanical performance of the prototype spray system was excellent.

2. The Beecomist spray heads delivered coarser droplet spectra in terms of D max, MMD and NMD than expected, especially when utilizing the perforated metal sleeves.

3. At the airspeeds and altitude used for the trials, the rotor wake effect varied from slight under open ground conditions to negligible at mid-crown, according to data obtained from the type of sample units involved.

4. The 40 µm plastic sleeves appear to produce a superior droplet spectrum to that of the perforated metal sleeves with the oil-based formulation.

5. The effective swath width increases as the emission airspeed decreases.

6. The amperage requirements of the prototype spray system are excessive in relation to the capacity of the Hughes model 500.

7. The preset, minimum r.p.m. of the Beecomist spray head appears to vary significantly from one unit to the next, and some units may not maintain design r. p. m. under load.

RECOMMENDATIONS

1. Further development of the spray system is required to:
   a) lighten the overall weight;
   b) decrease the amperage draw on the aircraft electrical system;
   c) streamline the total system both mechanically and aerodynamically;
   d) guarantee the required Beecomist sleeve r.p.m. under load.
2. Further trials should be conducted to improve deposit and define operating parameters by:
   a) employing higher rotational speeds of the porous sleeves;
   b) concentrating on the use of an oil-based formulation to be sprayed with 40 µm plastic sleeves;
   c) investigating optimum positions of spray heads on both the longitudinal and lateral axes of the helicopter;
   d) decreasing emission altitude;
   e) conducting one complete series of upwind trials to determine droplet spectrum;
   f) conducting a series of crosswind trials to determine effective swath width.
3. Improve methods of sampling deposit by:
   a) redesigning sampling units for use at ground level;
   b) using sampling units in the tree crowns which present smaller, narrower targets for small droplets at near-critical velocities;
   c) conduct foliage analysis for deposit.

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REFERENCE CITED

1. EDWARDS, J. C., 1976. The use and potential of helicopters in forest pest management. Report prepared under contract for Chemical Control Research Institute, Environment Canada, Forestry Service, pp. 334.

APPENDIX I. DEPOSIT SUMMARY

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 1

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	0.08	0.0109	Y 0	1.92	2.1812	PT 0	14.63	26.7551
-X 30	0.04	0.0233	Y 5	11.50	24.5246	PB 0	0.98	1.5709
-X 25	0.08	0.0972	Y 10	24.20	46.3630	PT 20	5.17	8.8413
-X 20	0.07	0.1163	Y 15	11.27	23.6529	PB 20	0.02	0.0055
-X 15	0.34	0.3353	Y 20	6.35	20.8778	PT 40	6.05	8.7181
-X 10	2.04	2.4289	Y 25	0.94	1.8145	PB 40	0.01	0.0027
-X 5	4.07	7.9286	Y 30	5.36	5.0330	PT 60	4.36	7.3374
X 0	26.40	40.4200	Y 35	1.21	1.6051	PB 60	0.23	0.1437
X 5	30.50	37.3438	Y 40	1.43	2.3646	PT 80	5.47	5.8020
X 10	40.75	70.5852	Y 45	2.62	3.2158	PB 80	0.12	0.0575
X 15	37.50	75.5908	Y 50	2.02	2.1936	PT 100	0.00	0.0000
X 20	45.00	92.3511	Y 55	1.92	3.5319	PB 100	0.00	0.0000
X 25	32.50	68.8952	Y 60	0.15	0.2162	PT 120	3.85	3.8562
X 30	27.00	49.5459	Y 65	1.08	0.8292	PB 120	0.02	0.0055
X 35	32.00	47.9586	Y 70	0.44	0.4776	PT 140	0.95	1.2015
X 40	28.75	60.3892	Y 75	0.05	0.0506	PB 140	0.28	0.0547
X 45	16.43	24.9242	Y 80	0.33	0.1861			
X 50	12.33	17.3528	Y 85	0.21	0.4420			
X 55	5.83	6.4233	Y 90	0.18	0.1861			
X 60	13.25	15.5136	Y 95	0.26	0.3312			
X 65	11.20	15.9036	Y 100	0.42	0.9469			
X 70	8.15	12.1925						
X 75	11.55	12.7809						
X 80	9.17	12.1159						
X 85	8.58	12.9876						
X 90	9.08	12.3923						
X 95	7.28	9.5186						
X 100	3.08	3.6235						
X 110	1.82	2.0088						
X 120	2.26	1.9992						
X 130	2.45	2.7163						
X 140	2.61	1.9910						
X 150	2.27	2.2934						
X 160	1.65	1.5299						
X 170	0.59	0.6541						
X 180	0.70	0.8539						
X 190	0.41	0.4495						
X 200	0.35	0.4201						
X 210	0.11	0.1382						
X 220	0.08	0.1218						
X 230	0.02	0.0178						
X 240	0.01	0.0082						
X 250	0.00	0.0000						
X 260	0.01	0.0082						
X 270	0.00	0.0000						
X 280	0.02	0.0178						
X 290	0.01	0.0137						
X 300	0.00	0.0000						

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 2

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	0.02	0.0041	Y 0	0.01	0.0766	PT 0	0.36	0.3572
-X 30	0.10	0.0205	Y 5	7.93	11.4152	PB 0	0.02	0.0041
-X 25	0.20	0.0192	Y 10	6.00	7.6932	PT 20	1.54	1.6421
-X 20	0.00	0.0000	Y 15	0.86	0.6732	PB 20	0.01	0.0082
-X 15	0.01	0.0027	Y 20	5.05	4.2913	PT 40	0.47	0.7061
-X 10	0.01	0.0027	Y 25	1.41	1.4026	PB 40	0.00	0.0000
-X 5	0.00	0.0000	Y 30	0.00	0.0000	PT 60	12.63	14.3532
X 0	0.02	0.0014	Y 35	2.63	2.1197	PB 60	0.15	0.1724
X 5	0.07	0.0123	Y 40	2.14	1.8665	PT 80	8.46	9.7704
X 10	0.01	0.0014	Y 45	5.62	12.0516	PB 80	0.51	0.2422
X 15	0.08	0.1026	Y 50	2.87	6.4000	PT 100	2.42	2.0211
X 20	0.38	1.7488	Y 55	2.29	4.6580	PB 100	0.00	0.0000
X 25	1.70	4.2434	Y 60	0.56	1.5983	PT 120	2.69	3.1815
X 30	14.00	17.4732	Y 65	0.29	0.5405	PB 120	0.05	0.0342
X 35	22.80	29.4043	Y 70	0.15	0.2272	PT 140	1.38	1.5737
X 40	21.80	28.9842	Y 75	0.10	0.2627	PB 140	0.02	0.0055
X 45	14.29	20.8217	Y 80	0.12	0.2176			
X 50	11.67	13.2585	Y 85	0.10	0.1724			
X 55	12.00	11.4084	Y 90	0.03	0.0123			
X 60	7.13	6.7093	Y 95	0.07	0.1190			
X 65	7.07	11.7012	Y 100	0.09	0.1533			
X 70	6.38	8.0257						
X 75	5.09	7.1294						
X 80	4.95	6.0319						
X 85	4.27	4.3556						
X 90	5.94	6.5656						
X 95	5.94	7.4359						
X 100	5.16	6.1715						
X 110	6.06	7.0281						
X 120	5.94	6.0401						
X 130	5.58	6.0114						
X 140	6.63	7.9026						
X 150	4.35	5.2218						
X 160	3.59	4.3857						
X 170	3.35	3.4976						
X 180	2.67	2.4440						
X 190	2.23	2.2716						
X 200	2.02	1.9938						
X 210	1.07	1.0140						
X 220	0.63	0.7184						
X 230	0.60	0.6596						
X 240	0.36	0.6719						
X 250	0.12	0.1136						
X 260	0.60	0.5036						
X 270	0.23	0.1779						
X 280	0.26	0.2012						
X 290	0.40	0.3790						
X 300	0.26	0.2449						

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 3

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	0.00	0.0000	Y 0	0.09	0.0725	PT 0	0.09	0.0794
-X 30	0.00	0.0000	Y 5	0.42	0.2983	PB 0	0.00	0.0000
-X 25	0.05	0.1190	Y10	0.41	1.6434	PT 20	0.40	0.5994
-X 20	0.46	0.3599	Y15	0.25	0.2956	PB 20	0.03	0.0041
-X 15	0.13	0.1149	Y20	0.18	0.5802	PT 40	2.58	4.4651
-X 10	0.13	0.1505	Y25	1.30	1.4505	PB 40	0.00	0.0000
-X 5	0.30	0.2997	Y30	3.00	4.6143	PT 60	9.08	13.2927
X 0	0.22	0.2381	Y35	3.05	4.1038	PB 60	0.02	0.0055
X 5	0.29	0.2969	Y40	3.12	6.6970	PT 80	6.31	8.0886
X 10	0.20	0.4885	Y45	4.36	7.6713	PB 80	0.02	0.0014
X 15	0.12	0.1081	Y50	2.78	5.8020	PT 100	0.63	0.7472
X 20	0.37	1.1070	Y55	3.00	9.0260	PB 100	0.00	0.0000
X 25	1.17	2.5096	Y60	0.14	0.0616	PT 120	0.01	0.0219
X 30	1.54	3.4949	Y65	0.21	0.5337	PB 120	0.00	0.0000
X 35	3.45	5.8705	Y70	0.37	0.4406	PT 140	0.03	0.0137
X 40	2.86	4.2448	Y75	0.02	0.0246	PB 140	0.00	0.0000
X 45	3.29	4.0532	Y80	0.02	0.0246			
X 50	8.15	8.8768	Y85	0.02	0.0520			
X 55	7.77	8.8755	Y90	0.02	0.0014			
X 60	8.13	7.9108	Y95	0.01	0.0027			
X 65	8.62	15.1633	Y100	0.00	0.0000			
X 70	9.54	15.1729						
X 75	8.38	11.5986						
X 80	9.00	13.3392						
X 85	10.18	11.9257						
X 90	9.64	14.5831						
X 95	8.17	11.3605						
X 100	3.47	4.9536						
X 110	0.91	0.9346						
X 120	0.66	0.6322						
X 130	0.15	0.1108						
X 140	0.02	0.0096						
x 150								
X 160								
X 170								
X 180								
X 190								
X 200								
X 210								
X 220								
X 230								
X 240								
X 250								
X 260								
X 270								
X 280								
X 290								
X 300								

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 4

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	1.30	1.0372	Y 0	9.27	7.3648	PT 0	36.75	41.6187
-X 30	1.94	2.0020	Y 5	12.44	9.2997	PB 0	0.78	0.4981
-X 25	4.14	4.0135	Y10	4.81	3.0967	PT 20	0.32	0.5542
-X 20	5.29	4.7620	Y15	0.93	1.4902	PB 20	0.00	0.0000
-X 15	10.73	7.8040	Y20	0.44	0.5816	PT 40	0.17	0.2162
-X 10	19.50	12.5196	Y25	0.38	0.2901	PB 40	0.00	0.0000
-X 5	16.86	15.3864	Y30	0.32	0.2121	PT 60	0.00	0.0000
X 0	34.50	35.1954	Y35	0.11	0.0438	PB 60	0.13	0.0958
X 5	36.50	44.6265	Y40	0.11	0.0739	PT 80	0.03	0.0274
X 10	24.00	30.9725	Y45	0.13	0.0478	PB 80	0.00	0.0000
X 15	12.22	17.7824	Y50	0.09	0.1054	PT 100	0.00	0.0000
X 20	15.29	21.4252	Y55	0.05	0.0452	PB 100	0.00	0.0000
X 25	6.38	7.4564	Y60	0.00	0.0000	PT 120	0.00	0.0000
X 30	6.12	5.7911	Y65	0.01	0.0014	PB 120	0.00	0.0000
X 35	3.55	2.7300	Y70	0.01	0.0219	PT 140	0.00	0.0000
X 40	1.58	1.1508	Y75	0.06	0.0055	PB 140	0.00	0.0000
X 45	1.06	0.7800	Y80	0.03	0.0096			
X 50	0.37	0.4105	Y85	0.00	0.0000			
X 55	0.26	0.4132	Y90	0.00	0.0000			
X 60	0.40	0.5337	Y95	0.00	0.0000			
X 65	0.08	0.2080	Y100	0.01	0.0027			
X 70	0.06	0.1204						
X 75	0.07	0.0493						
X 80	0.06	0.0534						
X 85	0.04	0.0643						
X 90	0.02	0.0233						
X 95	0.00	0.0000						
X 100	0.02	0.0178						
X 110	0.01	0.0014						
X 120	0.00	0.0000						
X 130	0.00	0.0000						
X 140	0.00	0.0000						

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 5

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	0.00	0.0000	Y 0	13.88	23.7870	PT 0	15.50	23.7145
-X 30	0.00	0.0000	Y 5	40.00	56.9449	PB 0	1.12	1.3232
-X 25	0.00	0.0000	Y10	40.75	57.2774	PT 20	18.50	36.7062
-X 20	0.00	0.0000	Y15	9.00	11.1566	PB 20	0.01	0.0082
-X 15	0.00	0.0000	Y20	21.80	23.5489	PT 40	18.00	26.3076
-X 10	0.00	0.0000	Y25	15.57	14.5010	PB 40	0.00	0.0000
-X 5	2.95	11.2661	Y30	13.13	17.9426	PT 60	18.00	23.4942
X 0	18.67	49.7211	Y35	18.67	23.1644	PB 60	0.00	0.0000
X 5	35.25	55.5970	Y40	20.00	31.5308	PT 80	8.83	7.8095
X 10	43.25	96.7286	Y45	9.00	9.4803	PB 80	0.00	0.0000
X 15	39.50	100.8530	Y50	12.50	13.3365	PT 100	4.95	4.9878
X 20	51.00	127.4644	Y55	0.00	0.0000	PB 100	0.00	0.0000
X 25	41.50	107.6348	Y60	0.00	0.0000	PT 120	2.68	2.2976
X 30	32.50	60.0580	Y65	0.00	0.0000	PB 120	0.00	0.0000
X 35	17.00	30.6250	Y70	0.30	0.3394	PT 140	2.00	1.5928
X 40	24.40	39.6934	Y75	0.28	0.2983	PB 140	0.00	0.0000
X 45	24.40	57.5429	Y80	0.55	0.4447			
X 50	19.00	32.5571	Y85	0.05	0.0315			
X 55	18.00	26.2105	Y90	0.02	0.0246			
X 60	13.38	17.1804	Y95	0.30	0.3476			
X 65	13.00	15.2167	Y100	1.26	0.9059			
X 70	8.46	14.4490						
X 75	lost	---						
X 80	9.08	13.8483						
X 85	12.33	15.8434						
X 90	7.31	8.6962						
X 95	7.73	9.2094						
X 100	6.65	5.5147						
X 110	6.38	7.9299						
X 120	6.38	6.1866						
X 130	4.90	4.9399						
X 140	4.55	3.9218						
X 150	3.88	3.4087						
X 160	3.74	2.0417						
X 170	2.51	1.6216						
X 180	1.83	1.1653						
X 190	1.34	0.7499						
X 200	1.37	0.8156						
X 210	1.23	0.6432						
X 220	0.91	0.4297						
X 230	0.90	0.6746						

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 6

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	28.50	51.6355	Y 0	25.00	34.5126	PT 0	58.25	105.6670
-X 30	38.75	65.7711	Y 5	41.50	63.1274	PB 0	0.03	0.0520
-X 25	21.50	47.6808	Y10	22.20	38.9777	PT 20	14.13	23.0098
-X 20	50.50	94.2203	Y15	0.81	1.4067	PB 20	0.00	0.0000
-X 15	59.75	76.5350	Y20	14.25	19.8474	PT 40	5.94	10.6106
-X 10	56.50	92.3907	Y25	7.00	7.5235	PB 40	0.00	0.0000
-X 5	65.50	109.7709	Y30	2.84	3.1911	PT 60	0.18	0.2217
X 0	74.50	173.2226	Y35	0.83	0.7444	PB 60	0.00	0.0000
X 5	46.25	118.2810	Y40	0.00	0.0000	PT 80	0.02	0.0301
X 10	24.75	101.1102	Y45	0.26	0.2012	PB 80	0.00	0.0000
X 15	12.11	20.0841	Y50	0.03	0.1875	PT 100	0.00	0.0000
X 20	10.50	19.4670	Y55	6.39	5.9142	PB 100	0.00	0.0000
X 25	4.88	10.9185	Y60	2.68	2.6684	PT 120	0.00	0.0000
X 30	3.44	8.8413	Y65	0.80	0.8854	PB 120	0.00	0.0000
X 35	1.70	4.0245	Y70	0.95	0.8470	PT 140	0.00	0.0000
X 40	0.71	1.8254	Y75	0.82	0.7786	PB 140	0.04	0.0000
X 45	0.08	0.1834	Y80	1.28	1.1837			
X 50	0.09	0.1355	Y85	1.04	0.9880			
X 55	0.03	0.0520	Y90	0.68	0.6692			
X 60	0.03	0.0657	Y95	0.48	0.1806			
X 65	0.05	0.1081	Y100	0.00	0.0000			
X 70	0.01	0.0219						
X 75	0.02	0.0246						
X 80	0.05	0.0082						
X 85	0.05	0.0301						
X 90	0.01	0.0014						
X 95	0.03	0.0137						

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 7

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	0.00	0.0000	Y 0	0.00	0.0000	PT 0	0.04	0.0027
-X 30	0.00	0.0000	Y 5	0.15	0.0192	PB 0	0.04	0.0096
-X 25	0.00	0.0000	Y10	0.49	0.0999	PT 20	2.82	1.4560
-X 20	0.00	0.0000	Y15	4.87	2.3249	PB 20	0.00	0.0000
-X 15	0.00	0.0000	Y20	10.42	4.3803	PT 40	16.57	8.3281
-X 10	0.10	0.0109	Y25	12.18	3.9643	PB 40	6.56	3.9916
-X 5	0.21	0.0178	Y30	21.17	9.9593	PT 60	24.00	10.0988
X 0	0.96	0.1847	Y35	9.33	4.7853	PB 60	0.00	0.0000
X 5	8.00	2.2209	Y40	15.00	8.9768	PT 80	12.11	3.9834
X 10	10.18	3.8534	Y45	10.00	11.8107	PB 80	0.00	0.0000
X 15	23.20	14.0221	Y50	3.92	5.2930	PT 100	2.61	0.9784
X 20	28.25	11.5470	Y55	0.80	0.4885	PB 100	0.00	0.0000
X 25	46.50	18.8854	Y60	0.14	0.2244	PT 120	0.57	0.1587
X 30	52.00	23.5900	Y65	0.14	0.0807	PB 120	0.04	0.0014
X 35	52.25	21.2158	Y70	0.56	0.2573	PT 140	0.14	0.0274
X 40	54.25	28.1632	Y75	0.26	0.0287	PB 140	0.00	0.0000
X 45	44.50	23.6392	Y80	0.49	0.6048			
X 50	33.00	17.6566	Y85	0.61	0.3380			
X 55	28.75	18.6008	Y90	0.18	0.0479			
X 60	20.60	6.3344	Y95	0.44	0.1327			
X 65	17.71	9.3024	Y100	0.21	0.0725			
X 70	14.43	5.1124						
X 75	9.64	3.0885						
X 80	9.30	4.2858						
X 85	4.16	1.8597						
X 90	2.64	1.3274						
X 95	2.69	1.4218						
X 100	1.26	0.3872						
X 110	0.79	0.2381						
X 120	0.36	0.1163						
X 130	0.26	0.1054						
X 140	0.09	0.0410						
X 150	0.01	0.0014						
X 160	0.09	0.0096						
X 170	0.00	0.0000						
X 180	0.02	0.0055						
X 190	0.02	0.0055						
X 200	0.00	0.0000						

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 8

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	0.00	0.0000	Y 0	4.28	2.8819	PT 0	8.50	2.2915
-X 30	0.00	0.0000	Y 5	19.00	8.5443	PB 0	0.06	0.0260
-X 25	0.15	0.0205	Y10	20.83	9.3435	PT 20	15.57	11.7683
-X 20	0.84	0.0985	Y15	4.31	1.6065	PB 20	0.03	0.0055
-X 15	2.38	0.3065	Y20	26.67	9.2545	PT 40	24.40	16.0802
-X 10	7.47	1.4574	Y25	27.50	15.1428	PB 40	0.00	0.0000
-X 5	10.40	3.1378	Y30	7.50	8.1037	PT 60	2.75	2.0198
X 0	15.28	5.8417	Y35	13.22	16.4017	PB 60	0.00	0.0000
X 5	21.60	7.3018	Y40	8.21	7.7657	PT 80	0.00	0.0000
X 10	27.00	16.5290	Y45	3.58	2.7902	PB 80	0.00	0.0000
X 15	43.25	19.4820	Y50	1.40	1.1344	PT 100	0.02	0.0014
X 20	42.25	39.3266	Y55	0.09	0.0575	PB 100	0.00	0.0000
X 25	36.25	27.7171	Y60	0.02	0.0014	PT 120	0.00	0.0000
X 30	28.40	29.3523	Y65	0.01	0.0000	PB 120	0.01	0.0005
X 35	16.71	12.4634	Y70	0.02	0.0014	PT 140	0.02	0.0041
X 40	11.10	8.2022	Y75	0.00	0.0000	PB 140	0.00	0.0000
X 45	7.38	6.1154	Y80	0.00	0.0000			
X 50	4.17	3.2335	Y85	0.00	0.0000			
X 55	1.72	1.6394	Y90	0.00	0.0000			
X 60	0.64	0.6336	Y95	0.00	0.0000			
X 65	0.15	0.1437	Y100	0.00	0.0000			
X 70	0.04	0.0150						
X 75	0.04	0.0082						
X 80	0.00	0.0000						
X 85	0.03	0.0014						
X 90	0.01	0.0005						
X 95	0.01	0.0003						
X 100	0.03	0.0068						
X 110	0.05	0.0014						
X 120	0.01	0.0041						
X 130	0.02	0.0014						
X 140	0.01	0.0041						
X 150	0.01	0.0082						
X 160	0.05	0.0014						
X 170	0.03	0.0260						
X 180	0.00	0.0000						
X 190	0.00	0.0000						
X 200	0.00	0.0000						
X 210	0.00	0.0000						
X 220	0.01	0.0041						
X 230	0.01	0.0014						
X 240	0.01	0.0082						
X 250	0.00	0.0000						
X 260	0.00	0.0000						
X 270	0.01	0.0041						

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 9

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	0.00	0.1368	Y 0	0.00	0.2737	PT 0	0.01	0.5475
-X 30	0.00	0.1368	Y 5	0.00	0.1368	PB 0	0.00	0.2737
-X 25	0.01	0.0000	Y10	0.01	0.1368	PT 20	0.00	0.2737
-X 20	0.28	0.0000	Y15	0.00	0.1368	PB 20	0.00	0.1368
-X 15	0.27	0.1368	Y20	0.48	2.1894	PT 40	40.25	18.3366
-X 10	0.10	0.4105	Y25	1.10	2.1894	PB 40	0.20	0.2737
-X 5	0.09	0.0000	Y30	0.65	2.0526	PT 60	4.00	3.1473
X 0	0.31	0.0000	Y35	16.28	10.5367	PB 60	0.02	0.0000
X 5	0.08	0.1368	Y40	21.20	9.0305	PT 80	3.05	0.2737
X 10	0.47	0.0000	Y45	25.00	7.6631	PB 80	0.00	0.1368
X 15	0.00	10.8104	Y50	18.33	5.6105	PT 100	0.00	0.2737
X 20	0.01	13.5472	Y55	18.28	8.2104	PB 100	0.00	0.0000
X 25	0.03	16.1472	Y60	20.86	7.9368	PT 120	0.50	0.0000
X 30	22.80	15.5998	Y65	13.12	6.4315	PB 120	0.00	0.0000
X 35	21.00	21.6208	Y70	12.55	6.5684	PT 140	0.00	0.0000
X 40	30.25	16.2840	Y75	7.50	3.0105	PB 140	0.00	0.0000
X 45	33.25	10.9472	Y80	10.40	3.6947			
X 50	33.75	0.1368	Y85	12.40	2.4631			
X 55	27.50	0.1368	Y90	5.05	1.3684			
X 60	23.40	0.0000	Y95	3.03	1.0947			
X 65	26.80	11.2209	Y100	1.93	0.6842			
X 70	22.80	8.8946						
X 75	14.14	8.4841						
X 80	13.67	5.8842						
X 85	13.50	7.1157						
X 90	13.75	4.7894						
X 95	9.08	3.4210						
X 100	5.92	2.3263						
X 110	8.53	2.3263						
X 120	7.29	1.9158						
X 130	5.48	1.6421						
X 140	4.95	1.3684						
X 150	4.72	.9579						
X 160	4.30	.5475						
X 170	3.86	.5475						
X 180	3.53	.4105						
X 190	2.33	.4105						
X 200	2.21	.2737						
X 210	0.99	.1368						
X 220	1.25	.2737						
X 230	1.06	.2737						
X 240	0.97	0.4105						
X 250	0.70	0.2737						
X 260	0.73	0.9579						
X 270	0.44	0.1368						
X 280	0.38	0.0000						
X 290	0.14	0.0000						
X 300	0.13	0.0000						
X 310	0.05	0.0000						
X 320	0.03	0.0000						

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 10

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	0.00	0.0000	Y 0	31.50	5.0631	PT 0	25.00	13.8209
-X 30	0.00	0.0000	Y 5	18.67	2.4631	PB 0	0.20	0.0000
-X 25	0.08	0.0000	Y 10	30.00	5.6105	PT 20	17.00	4.5157
-X 20	0.23	0.0000	Y 15	28.00	7.6631	PB 20	0.05	0.0000
-X 15	1.38	0.2737	Y 20	10.80	0.8210	PT 40	9.27	0.8210
-X 10	19.00	6.8420	Y 25	9.27	0.8210	PB 40	0.02	0.0000
-X 5	35.50	10.9472	Y 30	5.18	0.8210	PT 60	0.40	0.1368
-X 0	43.50	15.5998	Y 35	5.48	0.8210	PB 60	0.06	0.0000
X 5	42.00	20.1156	Y 40	2.50	0.5775	PT 80	0.01	0.1368
X 10	53.50	23.6734	Y 45	0.99	0.4105	PB 80	0.02	0.0000
X 15	49.25	28.4629	Y 50	3.92	0.4105	PT 100	0.01	0.0000
X 20	48.00	23.6734	Y 55	1.85	0.1368	PB 100	0.00	0.0000
X 25	63.23	22.3050	Y 60	1.23	0.0000	PT 120	0.06	0.0000
X 30	58.50	25.7260	Y 65	0.70	0.0000	PB 120	0.02	0.0000
X 35	39.50	10.8104	Y 70	0.53	0.0000	PT 140	0.01	0.0000
X 40	28.75	9.8525	Y 75	0.21	0.0000	PB 140	0.07	0.0000
X 45	16.00	4.6526	Y 80	0.10	0.0000			
X 50	15.50	2.8736	Y 85	0.24	0.0000			
X 55	12.67	3.1473	Y 90	0.23	0.0000			
X 60	8.08	1.9158	Y 95	0.04	0.0000			
X 65	3.19	1.2316	Y100	0.04	0.0000			
X 70	4.06	0.9579						
X 75	0.89	2.0526						
X 80	0.81	0.5475						
X 85	0.08	0.2737						
X 90	0.07	0.0000						
X 95	0.03	0.0000						
X100	0.01	0.0000						
X110	0.03	0.0000						
X120	0.18	0.0000						
X130	0.13	0.0000						
X140	0.11	0.0000						
X150	0.01	0.0000						
X160	0.07	0.0000						
X170	0.06	0.0000						
X180	0.39	0.0000						
X190	0.40	0.0000						
X200	0.00	0.0000						
X210	→	0.0000						
X220	→	0.0000						
X230	→	0.0000						
X240	No deposit	0.0000						
X250	No deposit	0.0000						
X260	No deposit	0.0000						
X270	No deposit	0.0000						
X280	No deposit	0.0000						
X290	←	0.0000						
X300	←	0.0000						

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 11

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	0.00	0.0000	Y 0	4.08	0.9579	PT 0	0.50	0.2737
-X 30	0.00	0.0000	Y 5	10.64	6.1578	PB 0	0.03	0.0000
-X 25	0.04	0.0000	Y 10	11.82	7.5262	PT 20	8.69	9.5788
-X 20	0.08	0.0000	Y 15	8.75	6.2947	PB 20	0.01	0.1368
-X 15	0.16	0.0000	Y 20	11.91	4.6526	PT 40	6.84	3.8315
-X 10	0.10	0.0000	Y 25	11.78	5.6105	PB 40	0.02	0.0000
-X 5	0.09	0.0000	Y 30	9.08	5.1999	PT 60	0.45	0.5475
X 0	0.24	0.1368	Y 35	7.87	1.6421	PB 60	0.00	0.0000
X 5	8.46	8.4841	Y 40	1.13	1.5052	PT 80	0.09	0.0000
X 10	13.33	10.5367	Y 45	0.62	0.1368	PB 80	0.00	0.0000
X 15	19.50	9.8525	Y 50	2.38	1.2316	PT 100	0.03	0.0000
X 20	21.50	16.0104	Y 55	0.71	0.2737	PB 100	0.01	0.0000
X 25	32.75	18.3366	Y 60	0.48	0.4105	PT 120	0.00	0.0000
X 30	23.00	11.9051	Y 65	0.17	0.1368	PB 120	0.00	0.0000
X 35	14.37	4.5157	Y 70	0.17	0.0000	PT 140	0.00	0.0000
X 40	9.63	2.7369	Y 75	0.12	0.0000	PB 140	0.00	0.0000
X 45	6.35	2.1894	Y 80	0.06	0.0000			
X 50	6.47	2.0526	Y 85	0.14	0.0000			
X 55	4.29	1.6421	Y 90	0.01	0.0000			
X 60	3.08	1.2316	Y 95	0.03	0.1368			
X 65	2.43	1.0947	Y100	0.00	0.1368			
X 70	0.65	0.2737						
X 75	0.25	0.0000						
X 80	0.12	0.0000						
X 85	0.05	0.0000						
X 90	0.07	0.0000						
X 95	0.05	0.0000						
X100	0.02	0.0000						
X110	0.02	0.1368						
X120	0.15	0.5474						
X130	0.01	0.0000						
X140	0.04	0.1368						
X150	0.36	0.0000						
X160	0.03	0.0000						
X170	0.02							
X180	0.00							
X190								
X200	↑	↑						
X210								
X220								
X230	No deposit	Nil						
X240								
X250								
X260								
X270								
X280								
X290								
X300	↓	↓						

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 12

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	0.04	0.0000	Y 0	2.23	1.3684	PT 0	0.95	1.2316
-X 30	0.06	0.0000	Y 5	3.42	3.8315	PB 0	0.00	0.1368
-X 25	0.07	0.0000	Y 10	4.46	3.0105	PT 20	12.27	5.0631
-X 20	0.11	0.0000	Y 15	9.50	7.5262	PB 20	5.62	0.6842
-X 15	0.20	0.0000	Y 20	1.23	1.6421	PT 40	5.40	3.9684
-X 10	0.39	0.2737	Y 25	1.15	1.3684	PB 40	0.04	0.1368
-X 5	0.86	1.0947	Y 30	2.86	4.7884	PT 60	0.42	0.5474
X 0	2.78	2.0526	Y 35	2.69	1.7789	PB 60	0.00	0.0000
X 5	7.17	3.4210	Y 40	0.69	0.1368	PT 80	0.41	0.2737
X 10	18.71	12.1788	Y 45	0.71	0.6842	PB 80	0.00	0.0000
X 15	21.40	13.4104	Y 50	1.05	0.8210	PT 100	0.82	0.9579
X 20	17.83	10.5367	Y 55	2.38	2.0526	PB 100	0.00	0.0000
X 25	14.12	8.4841	Y 60	2.42	0.9579	PT 120	0.05	0.2737
X 30	12.67	8.3473	Y 65	3.70	2.4631	PB 120	0.05	0.1368
X 35	11.33	5.6105	Y 70	3.80	1.9158	PT 140	0.19	0.2737
X 40	6.50	4.9263	Y 75	1.57	1.3684	PB 140	0.00	0.0000
X 45	3.54	1.0947	Y 80	2.88	2.8736			
X 50	3.32	1.3684	Y 85	1.25	1.0947			
X 55	3.52	1.3684	Y 90	0.73	0.5474			
X 60	2.75	0.9579	Y 95	1.05	0.8210			
X 65	3.40	0.8210	Y100	0.56	0.5474			
X 70	2.26	1.5052						
X 75	2.82	2.3263						
X 80	2.90	2.1894						
X 85	3.32	1.5052						
X 90	3.02	2.3263						
X 95	2.28	1.6421						
X 100	2.52	2.1894						
X 110	2.62	1.6421						
X 120	2.02	0.5475						
X 130	1.28	0.5475						
X 140	0.38	0.1368						
X 150	0.40	0.0000						
X 160	0.10	0.0000						
X 170	0.08	0.0000						
X 180	0.01	0.0000						
X 190	0.18	0.0000						
X 200	0.10	0.0000						
X 210	0.00							
X 220	↓ No deposit →	↓ Nil →						
X 230								
X 240								
X 250								
X 260								
X 270								
X 280								
X 290								
X 300								

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 13

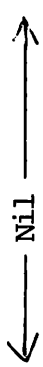
SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	0.00	0.0000	Y 0	0.00	0.0000	PT 0	0.00	0.0000
-X 30	0.00	0.0000	Y 5	0.00	0.0000	PB 0	0.00	0.0000
-X 25	0.00	0.0000	Y 10	0.00	0.0000	PT 20	0.00	0.0000
-X 20	0.00	0.0000	Y 15	0.03	0.0055	PB 20	0.02	0.0014
-X 15	0.00	0.0000	Y 20	0.00	0.0000	PT 40	0.56	0.6472
-X 10	0.00	0.0000	Y 25	0.00	0.0000	PB 40	0.00	0.0000
-X 5	0.00	0.0000	Y 30	0.25	0.2162	PT 60	20.48	12.2637
X 0	0.00	0.0000	Y 35	0.01	0.0082	PB 60	1.08	0.5309
X 5	0.01	0.0041	Y 40	1.48	1.1741	PT 80	6.91	3.6044
X 10	0.00	0.0000	Y 45	0.73	0.5569	PB 80	0.50	1.0851
X 15	0.00	0.0000	Y 50	0.70	0.3380	PT 100	10.46	5.8404
X 20	0.00	0.0000	Y 55	0.70	0.5638	PB 100	0.00	0.0000
X 25	0.03	3.6112	Y 60	0.09	0.0410	PT 120	6.50	2.7259
X 30	0.18	0.1409	Y 65	0.20	0.0944	PB 120	0.28	0.1327
X 35	13.10	8.9248	Y 70	0.18	0.0930	PT 140	2.95	1.6681
X 40	8.84	6.5150	Y 75	0.06	0.1300	PB 140	0.72	0.3229
X 45	12.30	8.1383	Y 80	0.22	0.3366			
X 50	8.81	5.7733	Y 85	0.42	0.2983			
X 55	6.97	5.0850	Y 90	0.19	0.2340			
X 60	8.17	21.5757	Y 95	0.42	0.3229			
X 65	12.11	16.9600	Y100	1.13	0.8990			
X 70	6.70	14.2533						
X 75	8.71	21.0105						
X 80	11.80	21.1679						
X 85	9.00	15.7914						
X 90	6.94	11.0964						
X 95	11.80	21.1364						
X100	9.45	23.4203						
X110	12.70	21.9041						
X120	11.20	18.7759						
X130	9.36	8.9453						
X140	6.67	3.8630						
X150	7.71	4.3351						
X160	4.46	2.5986						
X170	4.61	2.3181						
X180	5.24	3.0625						
X190	4.95	3.0365						
X200	3.67	1.7132						
X210	2.84	0.9743						
X220	1.31	0.6185						
X230	1.39	0.6869						
X240	2.01	0.9223						
X250	2.03	1.0564						
X260	1.05	0.4735						
X270	0.41	0.2012						
X280	0.42	0.1642						
X290	0.23	0.1204						
X 300	0.39	0.2559						
	0.09	0.0315						
	0.07	0.0287						

SUMMARY DEPOSIT DATA

HUGHES 500 CALIBRATION - LEITRIM - SEPT/OCT '77

TRIAL NO. 14

SAMPLE	LINE X		SAMPLE	LINE Y		SAMPLE	POLE SERIES	
	DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC		DROPS/CM^2	OZ/AC
-X 35	0.00	0.0000	Y 0	0.17	0.1368	PT 0	0.12	0.0000
-X 30	0.00	0.0000	Y 5	4.56	0.9579	PB 0	0.04	0.0000
-X 25	0.00	0.0000	Y 10	4.18	1.2316	PT 20	0.92	0.5474
-X 20	0.00	0.0000	Y 15	1.05	0.1368	PB 20	0.00	0.0000
-X 15	0.00	0.0000	Y 20	8.00	3.0105	PT 40	11.67	4.3789
-X 10	0.00	0.0000	Y 25	12.00	0.0000	PB 40	0.02	0.0000
-X 5	0.00	0.0000	Y 30	14.87	3.6947	PT 60	14.86	3.9684
X 0	0.14	0.0000	Y 35	7.07	2.6000	PB 60	0.03	0.0000
X 5	0.76	0.1368	Y 40	5.10	2.0526	PT 80	2.92	0.9579
X10	0.97	0.1368	Y 45	7.78	3.4210	PB 80	0.01	0.0000
X15	1.73	0.4105	Y 50	6.17	3.0105	PT 100	0.42	0.1368
X20	6.28	1.6421	Y 55	0.58	0.2737	PB 100	0.00	0.0000
X25	13.12	4.6526	Y 60	0.09	0.0000	PT 120	0.02	0.0000
X30	16.28	5.8842	Y 65	0.21	0.1368	PB 120	0.00	0.0000
X35	24.60	8.2104	Y 70	0.27	0.0000	PT 140	0.04	0.0000
X40	25.80	11.3578	Y 75	0.04	0.0000	PB 140	0.00	0.0000
X45	35.50	11.4946	Y 80	0.00	0.0000			
X50	26.75	8.3473	Y 85	0.01	0.0000			
X55	26.25	10.2630	Y 90	0.01	0.0000			
X60	21.40	6.8420	Y 95	0.00	0.0000			
X65	14.71	4.3789	Y100	0.01	0.0000			
X70	8.83	2.7368						
X75	7.78	2.3263						
X80	3.41	0.5474						
X85	1.98	0.2737						
X90	0.57	0.1368						
X95	0.64	0.1368						
X100	0.38	0.0000						
X110	0.43	0.0000						
X120	0.18	0.0000						
X130	0.05	0.0000						
X140	0.03	0.0000						
X150	0.00	0.0000						
X160								
X170								
X180								
X190								
X200								
X210								
X220								
X230								
X240								
X250								
X260								
X270								
X280								
X290								
X300								



APPENDIX II. MMD AND NMD CURVES

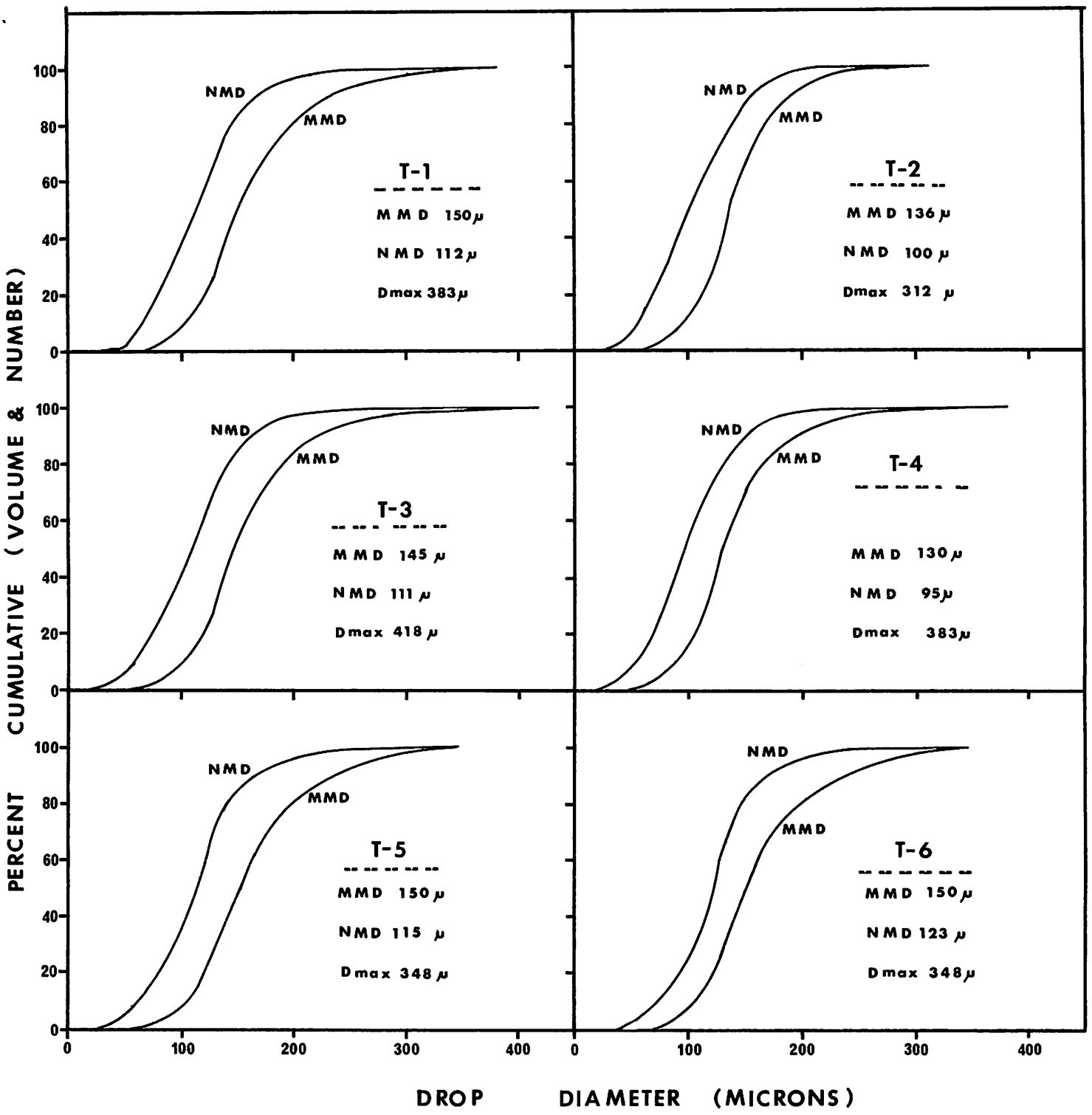


FIG.4 MMD and NMD GRAPHS--WATER TRIALS

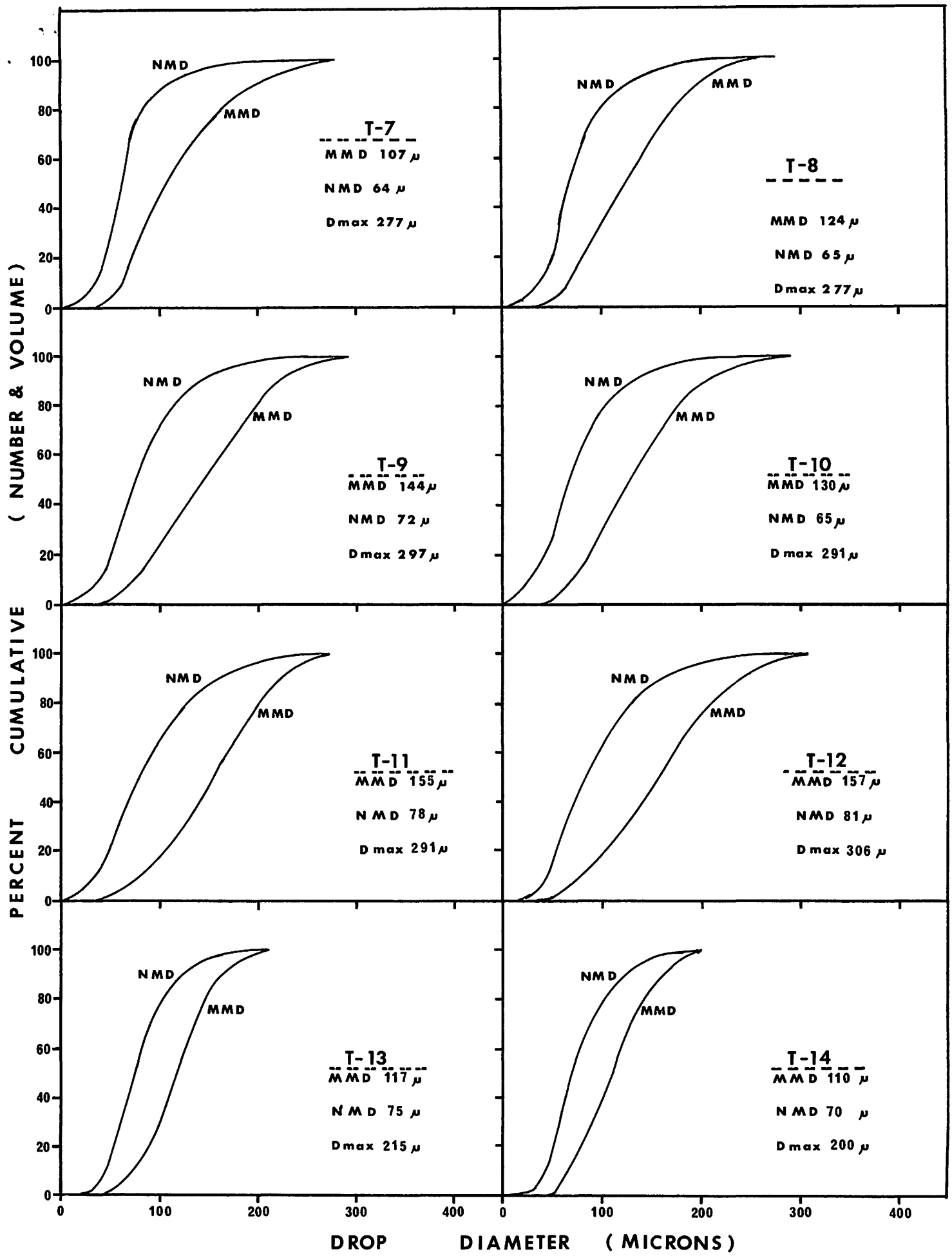


FIG.5 MMD & NMD GRAPHS ---OIL TRIALS---

APPENDIX III. DEPOSIT DISTRIBUTION

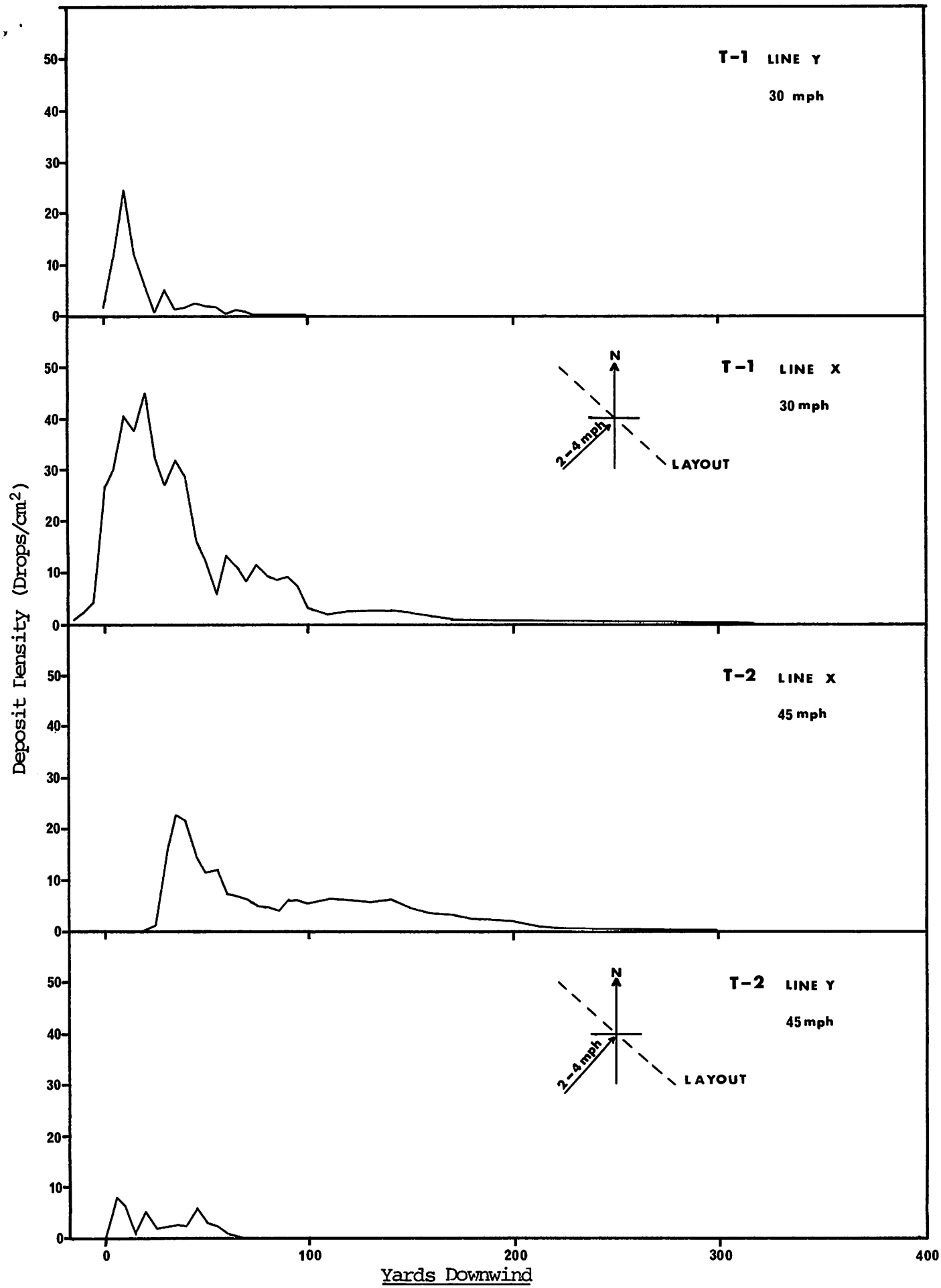


Fig. 6 Deposit Density Across Layout

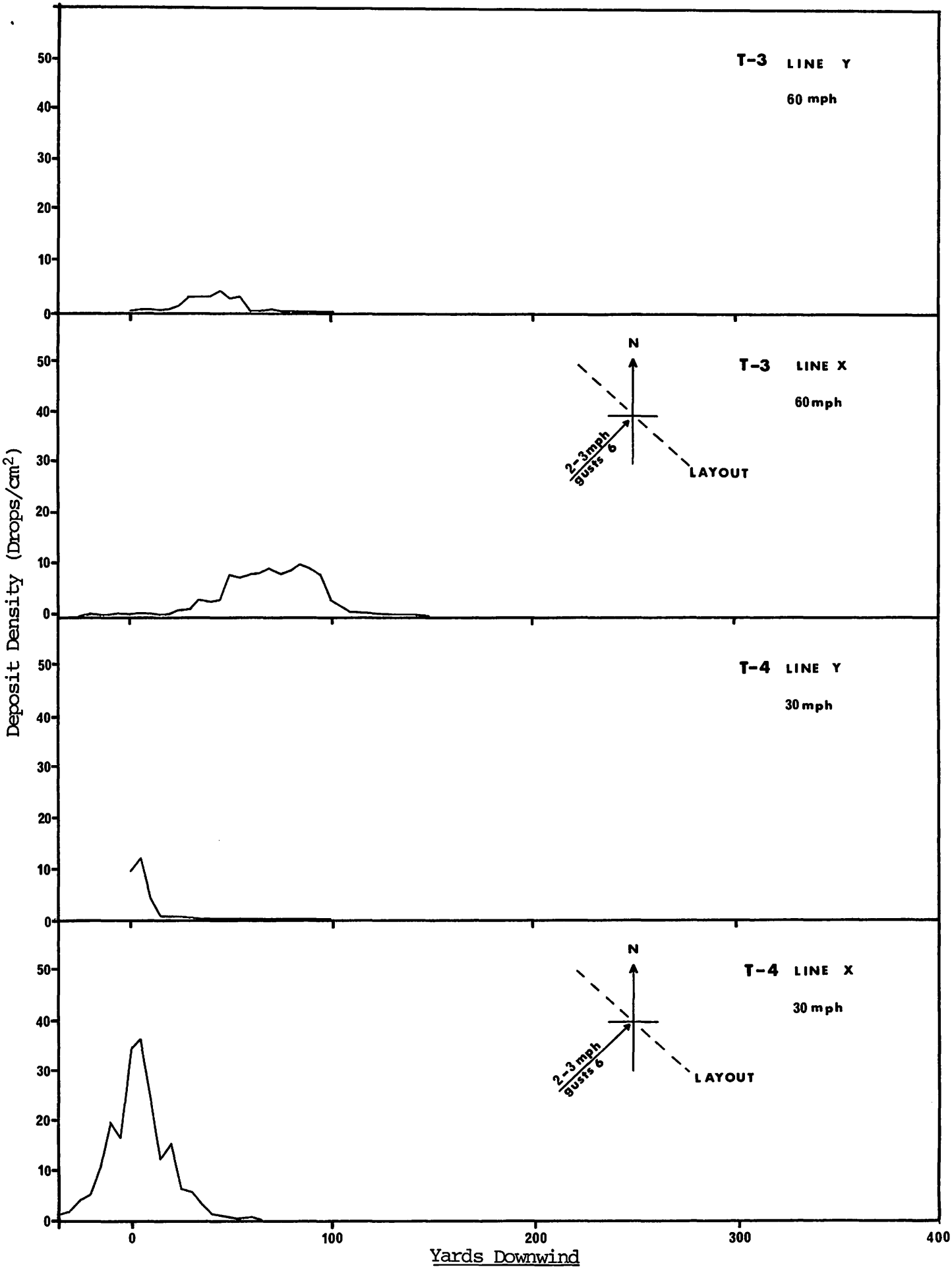


Fig. 7 Deposit Density Across Layout

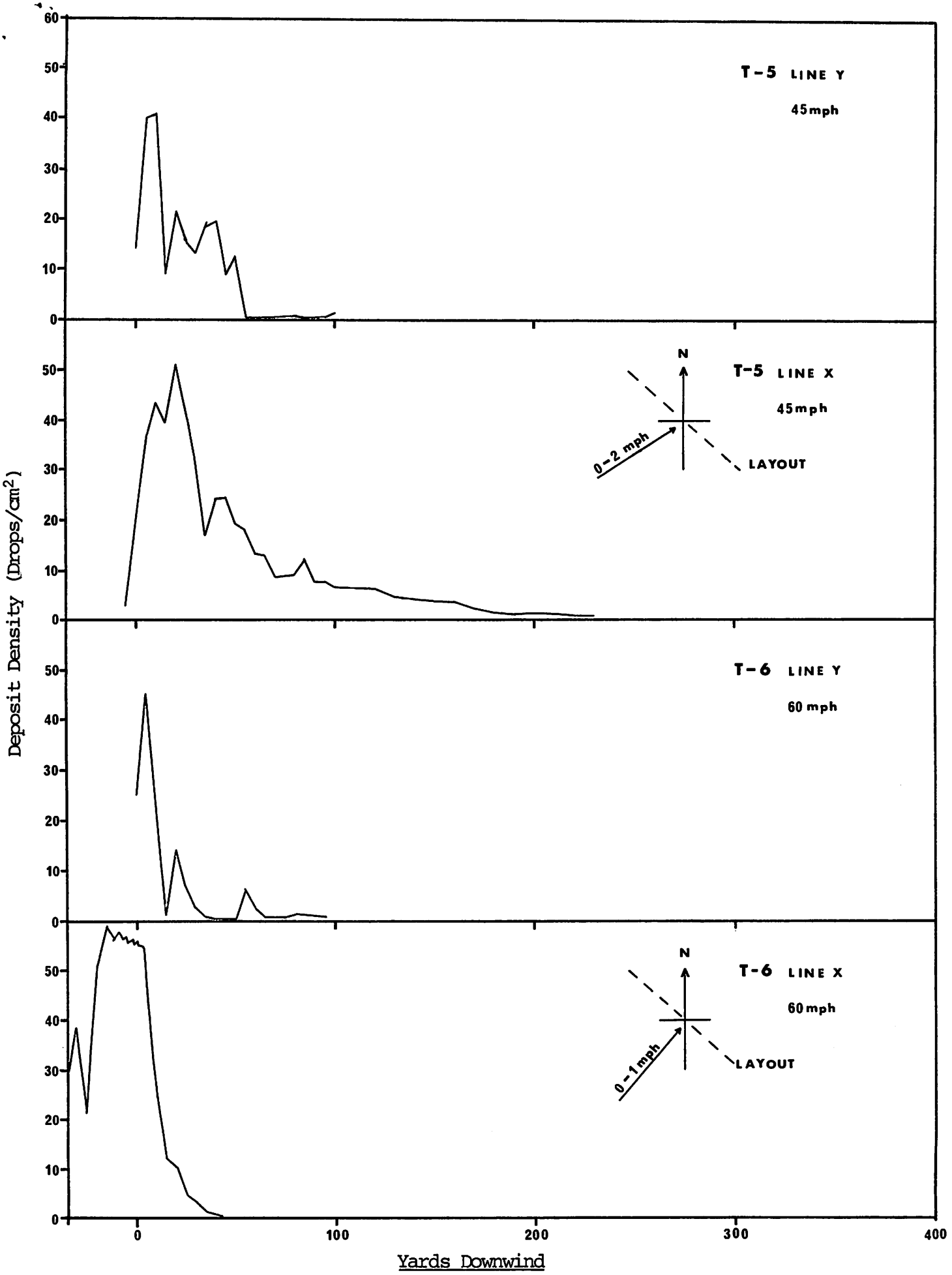


Fig. 8. Deposit Density Across Layout

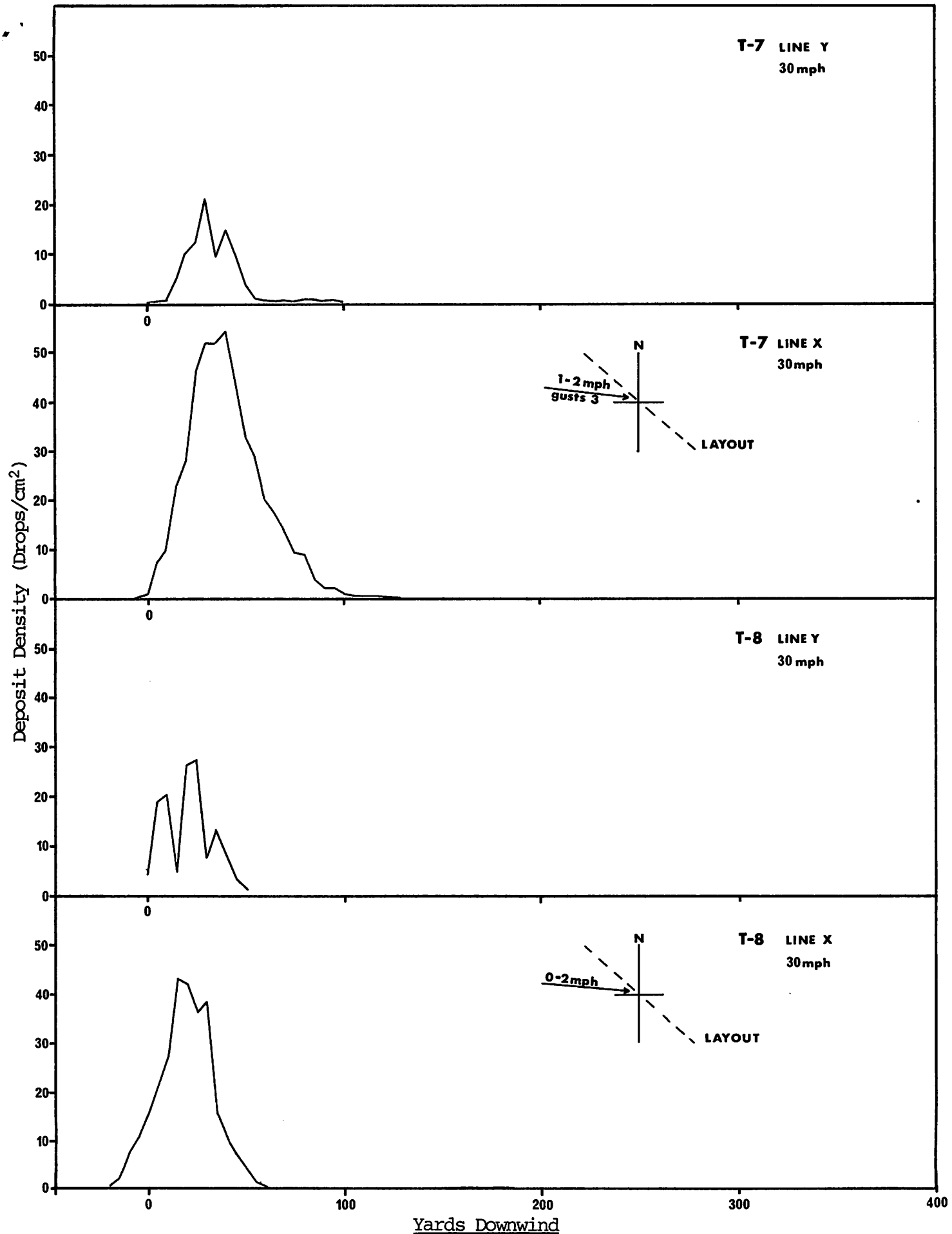


Fig. 9 Deposit Density Across Layout

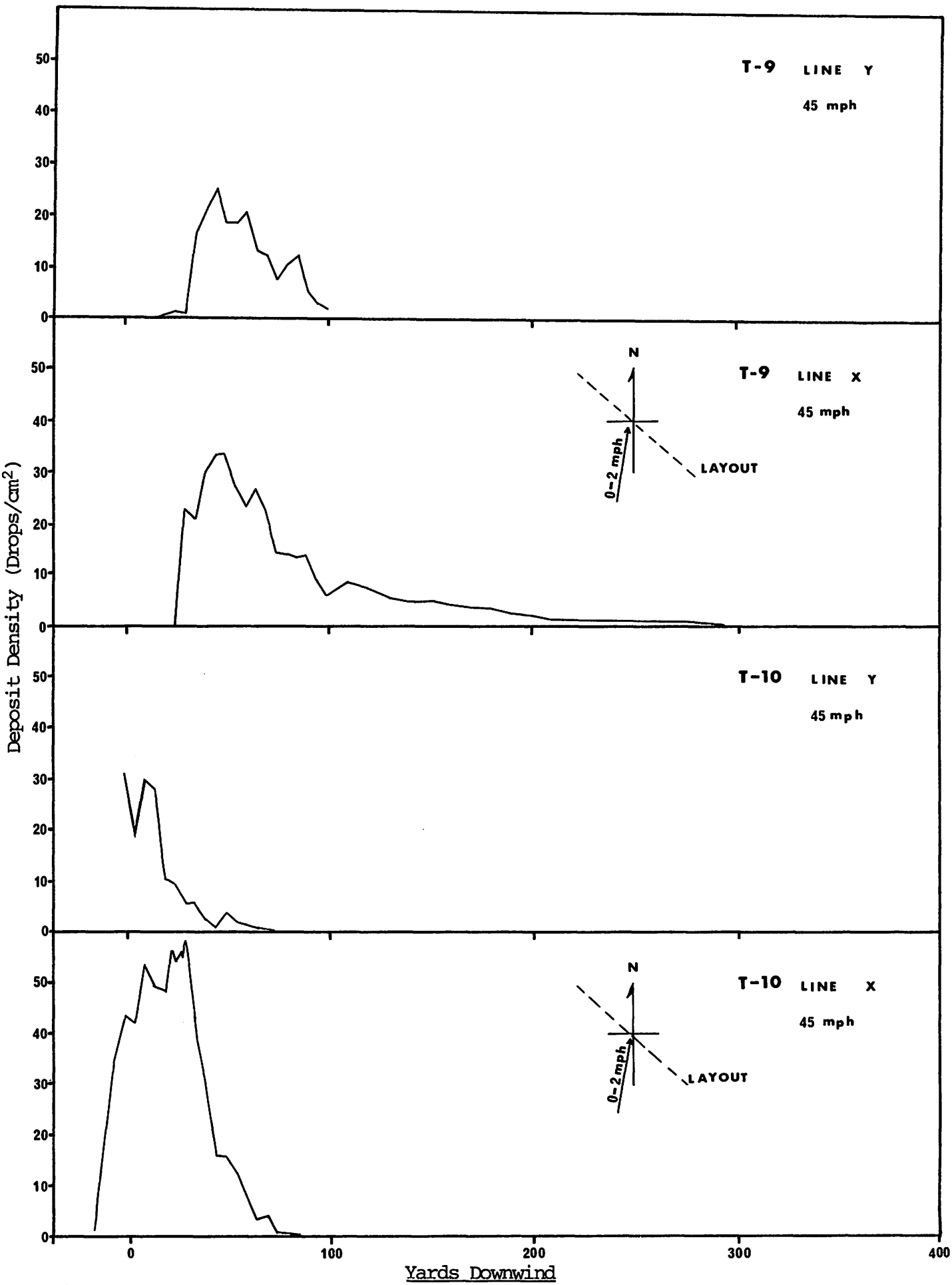


Fig. 10 Deposit Density Across Layout

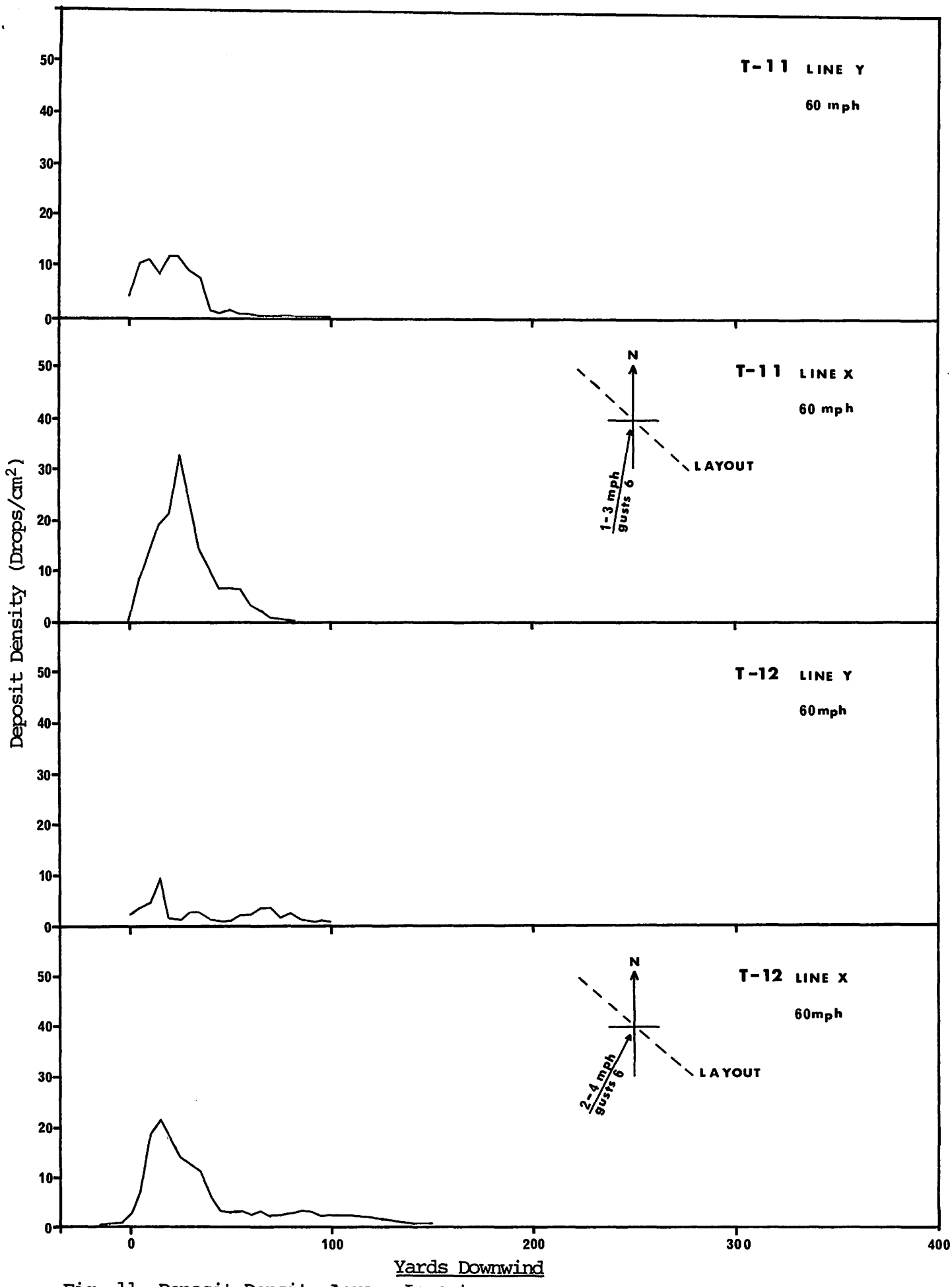


Fig. 11 Deposit Density Across Layout

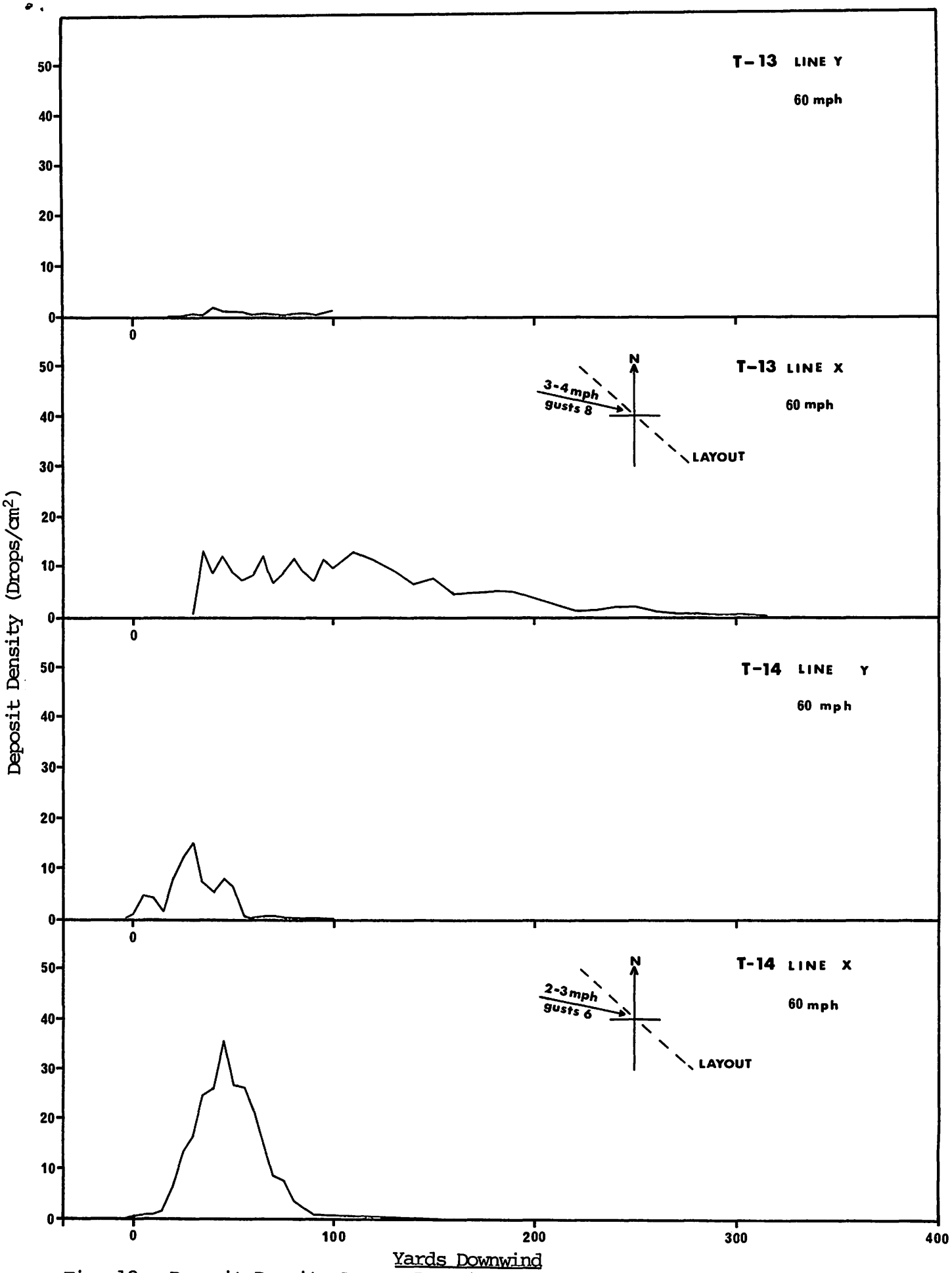


Fig. 12 Deposit Density Across Layout