S E N I O R T H E S I S

THREE METHODS OF STREET CLEANING

A Comparative Study of Motor-Driven and Horse-Drawn Flushing and Vacuum Cleaning of Paved Streets in the City of Los Angeles.

Throop College of Technology,
Pasadena, California.

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GENERAL INDEX

I. INTRODUCTION

- I N T R O D U C T I O N -

One of the most interesting and at the same time comparatively undeveloped studies along engineering lines is that which has to do with the general subject - "Street Cleaning". At the present time there is no particular detail of municipal government receiving more scientific consideration than that of cleaning paved streets in a sanitary manner. Because of the very nature of the work it has, in the past, been assumed to have no technical difficulties that could not be surmounted by the unskilled labor doing the work. Nevertheless, it has been found by experience that the processes of street cleaning, like most similar work, however simple it may appear on the surface, can be properly studied and its problems solved only by careful and complete observation involving engineering methods.

With the demand for higher efficiency in municipal affairs and the resulting analysis of the several activities of municipal service, the street cleaning branch was found to be one of the most fruitful fields for improvement in method and reduction in cost. Although scores of investigations have been made by competent engineers, the results obtained and the conclusions drawn by them have, up to the present time, not been sufficiently exhaustive to establish definite standards for this work.

The subject of street cleaning includes a multitude of detail, involving many processes of doing the work. Some of these are supplemental to other processes and are intended to perform only a certain portion of all of the work to be done. For this reason the thesis has been confined to a limited but thorough study and comparison of the two methods in use in Los Angeles for the removal of street dust, which is, from the health standpoint, the most dangerous element of street dirt.

These two methods involve three types of equipment, and are as follows:

(1) Flushing by the use of Motor-Driven Flushers;

(2) Flushing by the use of Horse-Drawn Flushers; and

(3) Cleaning by the Vacuum Method, using a motor-driven vehicle.

The time required for the study and analysis of this phase of street cleaning did not permit of any similar study of hand-sweeping. This is the means employed for the removal of heavy street dirt, or litter, and is supplemental to the flushing and vacuum-cleaning described herein.

The flushing tests were made in the city of Los Angeles and the vacuum-cleaning tests were made in Pasadena, California. The latter test may be termed "incomplete" due to the fact that the number of tests were limited and that only one vacuum cleaner was available at the time the investigation was made. However, the tests obtained from the one machine clearly indicate the efficiency of the method.

Many striking conclusions may be drawn from the results obtained from the tests. The more important of these are as follows:

a. The cost of flushing by the use of a two-wagon battery is 33 per cent less than the cost of flushing by the use of one motor flusher.

b. The horse-drawn flushers remove 57 per cent of the dirt as compared with 24.5 per cent removed by the motor flushers.

c. The aggregate daily performance of a two-wagon battery is 22 per cent greater than that of one motor flusher.

The City of Los Angeles pays approximately fifteen dollars ($15.00) per 8-hour day for one motor-driven flusher, and only ten dollars ($10.00) per 8-hour day for a battery of two horse-drawn flushers.

The ordinary Senior College thesis contains material which generally is not taken any too seriously and therefore usually proves itself of doubtful material value. An attempt has been made in this study to procure data which, because of its reliable utility, might be available for a definitely useful purpose.

The investigation has proven to be an ideal study in its relation to the course "Engineering and Economics" offered at Throop College, and only further proves that "Engineering without Economics" does not furnish an accurate basis for scientific determinations. The two are mutually dependent and any attempt to separate them must of necessity work towards an unsubstantial and consequently a weak foundation.

S. R. Searl.

Note - All tests were made in conjunction with the Efficiency Department of the City of Los Angeles.

Note - While all of the data accompanying this report could not have been obtained by any one person in much less than five months' time, I think I may safely claim credit for having materially assisted in the procurement of all of the details herein presented, and beg leave to call attention to this phase of the situation to the letter signed by Jesse D. Burks, Efficiency Director of the City of Los Angeles, and presented herewith.

November 4, 1916.

TO WHOM IT MAY CONCERN:-

Mr. Sidney R. Searl was associated with the Efficiency Department of the City of Los Angeles from July 25th to September 1st, 1916. During that time Mr. Searl spent the full working hours of every working day assisting in the Department's comparative test of horse-drawn flushing, motor-driven flushing, and vacuum cleaning of streets. Mr. Searl's work consisted of making observations and time studies of each of the types of street cleaners, of drawing charts, making calculations, and offering general assistance and advice in the conduct of the test. Mr. Searl was closely in touch with all details of the test and rendered very valuable assistance.

Very truly yours,

Director.

II. GENERAL SUMMARY

MOTOR-DRIVEN AND HORSE-DRAWN STREET FLUSHERS IN LOS ANGELES

With Some Data Concerning Vacuum Cleaning of Streets

I. GENERAL SUMMARY

This thesis presents the results of a study of three different methods used in cleaning the paved streets of Los Angeles, namely:

1. By motor-driven flusher.
2. By a battery of two horse-drawn flushers.
3. By a "vacuum" street cleaning machine.

The thesis includes all details necessary for a complete check upon the methods used and the conclusions reached in the study. To serve the purposes of the general reader who may not care to go fully into matters of technical detail, and to afford a general background for those readers who may have a technical interest in the mass of detailed data presented, the present general summary is given as a preface to the report proper.

To the reader who is interested in ascertaining most directly the results of the study, four questions will at once present themselves. These are:

1. What was done in conducting the test?
2. Which type of street cleaning is the cheapest?
3. Which type of cleaning is most effective?
4. What changes in equipment and methods were suggested by the test?

These four questions will be briefly answered in turn.

1. What was Done?

a. Four widely separated flushing routes were cleaned first by motor-driven flusher and one week later by horse-drawn flushers. The work of each flusher was closely observed and a record kept of all pertinent data, including the time consumed in the various details of the work, the areas flushed, and the pressure at the hydrants.

b. The routes were closely inspected before and after each flushing. Before and after flushing, samples of dust were obtained from equal areas on the street's surface. This dust was weighed and screened.

c. A few inspections and dust tests were made in Pasadena, where the vacuum street cleaner was operating; no vacuum machine at present being in operation in Los Angeles.

d. From the data of time, area, water consumption, and expense for labor and services, the three types of cleaning were then compared as to their cost to the city per 1000 square yards cleaned.

e. From the amounts of dust obtained on equal street areas before and after cleaning, a similar comparison was made concerning the effectiveness of each type in removing dust.

f. From the inspections made before and after cleaning, the three types of cleaners were compared as to their effectiveness in removing manure and other coarse material.

g. Observations made during the test and data collected indicated the desirability of making certain changes in equipment and methods in handling this kind of street cleaning work.

2. Which Type of Cleaning is the Cheapest?

Under substantially identical conditions, with the men aware of the observations, the three methods rank as follows in cost:

a. Vacuum machine = approximately 80% of horse-drawn flusher cost.
b. Horse-drawn flusher = 100% of horse-drawn flusher cost.
c. Motor-driven flusher = 140% of horse-drawn flusher cost.

This does not mean that vacuum cleaning and horse-drawn flushing will always be less expensive than motor-driven flushing irrespective of the methods used in handling the vehicles. It means that with the vehicles now used in Los Angeles, at the prices paid for their service, and with the methods observed, the horse-drawn flushers were actually more economical than the motor-driven flushers, and that the vacuum cleaner was more economical than either type of flusher.

3. Which Type of Cleaning is Most Effective?

a. Removal of Dust from Street Surface (exclusive of gutters)

1) None of the three cleaning methods removes all dust.
2) The motor-driven flusher removes from 15% to 40%; averaging about 25% of the dust.
3) The horse-drawn flushers remove from 45% to 75%; averaging about 55% of the dust.
4) Three tests of the vacuum machine in Pasadena showed 36%, 52%, and 64% of dust removed; averaging about 50%. Because of the small number of these vacuum cleaning tests, and because they were made in Pasadena and not in Los Angeles, their results are not necessarily conclusive for vacuum cleaning in Los Angeles.

b. Composition of Street Dust Before and After Cleaning

1) Considering the likelihood of its being driven into the air by traffic, the dust remaining on the street after cleaning is of practically the same composition as the dust found before cleaning, under any of the three cleaning methods.

2) More accurately compared with its original composition, the dust remaining after cleaning by any of the three methods contains a slightly lower percentage of material retained on screens from #10 to #50 inclusive, and a slightly larger percentage of all finer material.

3) For each type of cleaner the percentage of very fine dust removed (i.e. dust passing a 200-mesh screen) is slightly less than the percentage of all dust removed.

4) In short, each of the cleaning methods seems to have a little more effect upon the larger particles of dust than upon the smaller particles.

c. Manure Removal

1) None of the three cleaning methods completely removes manure from the surface of the street.

2) Vacuum cleaning is much more effective in this respect than either type of flushing. The horse-drawn flushers have more effect upon manure piles than has the motor-driven flusher. (Conclusions concerning manure removal are based upon careful inspection by observation; not upon definite measurement.)

4. What Changes in Equipment and Methods were Suggested by the Test?

a. Filling Equipment

1) The fittings and check valves used in the hose of the horse-drawn flushers greatly reduce the flow of water through the hose. By increasing the size of these fittings and checks, the time for filling the tanks can be reduced.

2) Whether or not the time saved would compensate for the expense of re-fitting the hose is a question which should be determined by a special test.

b. Careful Routing

Both types of flushers can be more effectively routed. Briefly stated, this would involve a close study of each route to learn just what is the reasonable time in which it should be done. On the basis of such observations, steps might then be taken to see that the route was flushed in the established time.

c. Careful Determination of Cleaning Period

1) It was found during the test that various streets flushed at the same intervals of time contained greatly different quantities of dust. Apparently either some were being flushed too often or others were not being flushed often enough.

2) A determination of the proper time interval between cleanings, based on the actual amount of dust found on the street, would correct either a too frequent or an inadequate service. This of course applies to all types of cleaning.

d. Restriction of Cleaning to Those Parts of a Street Which Become Dusty

1) On many streets heavily traveled by motor vehicles, the center of the street is kept entirely free from dust by the action of the air currents set up by traffic. On such streets, all of the dust lies within eight or ten feet of the curb. Evidently, on such streets, cleaning for the purpose of removing dust should be confined to the parts of the street on which dust is found.

2) At present the horse-drawn flushers flush the entire street and the motor-driven flushers flush all of the street except the aprons and, in some instances, the car tracks.

3) By eliminating the clean areas from the flushing work, better results could be obtained for the same money or the same results for less money. This conclusion applies to all types of cleaning.

e. More Advantageous Storage Points for Horse-drawn Flushers

1) At present horse-drawn flushers are kept at only two corrals -- at 15th and San Pedro, and at Yale near Alpine. The drivers work eight-and-one-half hours, including all time away from the corral (except for lunch).

2) Evidently, for outlying routes, a large part of the daily time is spent in going to and from the route. A few properly located storage points in outlying districts would largely eliminate this unproductive traveling time.

f. Use of a Single Horse-drawn Flusher in Certain Localities

1) On 23rd street, a battery of two horse-drawn flushers operating in the usual way removed approximately 66% of the dust on the surface of the street, exclusive of the gutters.

2) On the same street at the same place two weeks later, a single horse-drawn flusher removed approximately 59% of the dust. At the point of test, 23rd street is paved with very smooth asphalt and is 36 feet wide.

3) The results of this test suggest that, in favorable localities, one flusher might be practically as effective as two. This is a matter for further experimental consideration.

5. Estimated Cost of Machine-Cleaning All Streets

The total area to be cleaned being approximately 496,712,200 square yards per year for the entire city.

Cleaning Method	Cost per 1000 sq.yds.	Cost per Year	Saving per Year over			
			Vac. Clnr.	"Horse-Drawn" Excluding Time to and from Corral	"Horse-Drawn" Including Time to and from Corral	"Motor-Driven"
Vacuum Cleaning	11.65¢	$ 57,900	--	$10,300	$17,600	$43,600
Horse-drawn Flushing including time to and from corral	13.71¢	$ 68,200	--	--	$ 7,300	$33,300
Horse-drawn Flushing including time to and from corral	15.20¢	$ 75,500	--	--	--	$26,000
Motor-driven Flushing	20.44¢	$101,500	--	--	--	--

These figures do not include the cost of hauling material after it is collected on the street or of hand-patrol sweeping by day men.

TABLE A

Because the men were aware of close observation throughout the test, the costs obtained were probably as low as could be hoped for under the present methods. The table below gives an estimate of the total cost per year of cleaning all streets by the various methods based on the costs as determined in this test.

Estimating 496,712,200 square yards to be cleaned per year, we get the following:

Cleaning Method	Cost per 1000 sq.yds.	Cost per Year	Saving per Year over			
			Vac. Clnr.	"Horse-Drawn" Excluding Time to and from corral	"Horse-Drawn" Including Time to and from corral	"Motor-Driven"
Vacuum Cleaning	11.65¢	$57,900	—	$10,300	$17,600	$43,600
Horse-drawn Flushing Including time to and from corral	13.71¢	$68,200	—	—	$ 7,300	$33,300
Horse-drawn Flushing Including time to and from corral	15.20¢	$75,500	—	—	—	$26,000
Motor-driven Flushing	20.44¢	$101,500	—	—	—	—

Details of above table

Costs per 1000 square yards - see Table 8, page 65.

III. CONCLUSIONS

CONCLUSIONS

1. The city can operate a battery of two horse-drawn flushers per 1000 square yards flushed for less than the cost of using the rented motor-driven flushers in the same work.

Basis of Conclusion

	Cost per 1000 Square Yards Flushed				
	Route I	Route II	Route III	Route IV	All Routes
Motor-driven flusher	18.30¢	30.40¢*	19.70¢	18.60¢	20.44¢
Battery of Two Horse-drawn Flushers (eliminating cost of time to and from corral)	12.10¢	14.20¢	15.20¢	13.72¢	13.71¢
Battery of Two Horse-drawn Flushers (including cost of time to and from corral)	14.18¢	15.40¢	16.25¢	15.15¢	15.20¢

(For details of the above table, see Tables 9, 10, and 11, on pages 65-66.)

Compared to the Motor-driven Flusher -

The battery of horse-drawn flushers requires less time per 1000 square yards flushed.

The battery of horse-drawn flushers requires less water per 1000 square yards flushed.

(During the test the horse-drawn battery averaged, per 1000 square yards flushed, 220 seconds spent on the route as compared to 268 seconds spent on the route by the motor flusher. Approximately 360 gallons of water per 1000 square yards flushed were used by the horse-drawn battery and approximately 450 gallons per 1000 square yards flushed were used by the motor-driven flusher.)

(For details of above figures, see Table 4 on page 55 and Table 1 on page 45.)

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* This high cost was obtained on Central Avenue. It is due to the driver's attempting to really remove manure by flushing. He often backed up in order to flush some manure pile twice. The effect on manure was about that obtained by the battery of two horse-drawn flushers.

2. The cost to the city per 1000 square yards cleaned is less for the vacuum cleaner than for either type of flusher.

Basis of conclusion -- Cost table above.

Contract price per 1000 sq. yds. for vacuum cleaning - 10.50¢
Other charges - 1.15¢
Total - 11.65¢

(For details of above figures, see Table 12 on page 66.)

3. Dust Removal from the Surface of Paved Streets

a. Neither the motor-driven flusher, the battery of horse-drawn flushers, nor the vacuum cleaner removes all dust from the surface of the street.

b. The battery of two horse-drawn flushers does better work in dust removal than does a single motor-driven flusher.

Basis of Conclusion

Street (exclusive of gutters)	% (by weight) of Dust Remaining after Flushing	
	One Motor-driven Flusher	Battery of Two Horse-drawn Flushers
Western Ave. (near 3rd)	57.0%	26.4%
Hayden St.	85.0%	51.5%
7th Street	58.3%	49.2%
Figueroa	83.4%	(No test made)
Western Ave. (near 4th)	62.9%	" " "
Sunset Blvd.	87.7%	" " "
23rd St.	(No test made)	33.5%

(For details of above figures, see Table 27 on page 148.)

c. After flushing by either type of flusher, the dust remaining on the street (exclusive of the gutters) has

1) A slightly smaller percentage of all dust particles up to and including those retained on #50 screen.

2) A slightly larger percentage of all dust particles passing a #50 screen.

Basis of Conclusion - See averages of screening tests, pages 46 & 48.

d. From a few tests made in Pasadena, the vacuum cleaner seems to be about on a par with the battery of horse-drawn flushers in dust-removing efficiency.

Basis of Conclusion

Street (Pasadena)	% of Dust (by weight) Remaining after Vacuum Cleaning (in Pasadena)
Walnut (exclusive of gutters)	36.3%
South side of California (exclusive of gutters)	63.6%
North side of California " " " . . .	48.2%
West side of Raymond (gutters only)	43.1%
East side of Raymond " "	34.4%

(For details of above figures, see Table 27, page 148.)

4. Removal of Manure

a. Neither type of flusher satisfactorily removes manure. The work of the battery of horse-drawn flushers is better in this respect than is the work of the motor-driven flusher.

Basis of conclusion - Inspections made before and after flushing by each type on the test routes.

b. Judging from a few observations made in Pasadena, the vacuum cleaner is appreciably more effective in removing manure than is either type of flusher, although it by no means removes all manure.

5. The cost of horse-drawn flushing may be reduced below that ordinarily obtained.

Basis of conclusion

Total cost of flushing by horse-drawn battery, based on Board of Public Works' figures for February, 1916 = 23.44¢ per 1000 square yards flushed. (For details see page 68.)

Total cost of flushing by horse-drawn battery during test (including time to and from corral) = 15.20¢ per 1000 sq.yds. flushed.

(For details of the above figures, see Table 10 on page 66.)

(Note.- The means suggested for decreasing the cost of flushing by horse-drawn battery are:

a. Use of such check valves and fittings for the hose that the opening through the hose will not be reduced below 2½-inch diameter.

b. Careful routing of flushers, including a determination of the work which should be accomplished in eight hours.

c. Careful determination of the proper frequency of flushing for each street flushed.

d. Restriction of flushing to only those portions of a street which become dusty.

e. Storage of the flushers near the starting and ending points for those routes which are in outlying districts.

f. In certain favorable localities the use of only one horse-drawn flusher instead of two.

For a brief discussion of each of the above, see pages 8-9.)

IV SPECIFICATIONS of VEHICLES

COMPLETE SPECIFICATIONS OF THE SANITARY HORSE-DRAWN AUTOMATIC STREET FLUSHING MACHINE

(26 of which are at the present time being used by the Street Department in the City of Los Angeles.)

Note - This type of horse-drawn flusher was used for all tests.

In short, the method used is that of utilizing air pressure secured by forcing water into a closed tank against the confined air.

The tank has a water capacity of 600 gallons, and is made of boiler steel. It is so constructed that the necessary air pressure is automatically obtained from the fire hydrants when filling with water. No auxiliary machinery, such as engine, pump, or air compressor, is required. The pressure on the city water mains does the entire work. The outlet valve is controlled by a lever at the driver's seat, adjusted so that the operator has perfect control over the water issuing from the flushing nozzle. The truck is thoroughly ironed throughout; Sarven patent type wheels; 2½-inch axles; springs of special design; tubular steel doubletrees; and all valves are made of brass.

Detailed instructions for operating are as follows:

It is necessary to see that both outlet or flushing heads are closed, and the two valves on top of the tank stand as follows: Valve next to driver's seat, known as valve No. 1, open; the other, valve No. 2, closed.

1st. The hose is attached to the hydrant, and the machine is filled with water until the gauge at the rear end of the machine registers 80 per cent of the pressure on the hydrant (for example, if the water pressure on the hydrant is 60 pounds per square inch, when the gauge indicates 48 pounds in taking the initial air pressure, turn off the water at the hydrant), then close valve No. 1, which will hold the compressed air in the air compartment while the water compartment is draining of water.

2nd. To drain the tank of water, open both flushing heads; immediately thereafter open valve No. 2, thereby permitting the water compartment to empty of water, displacing the water by another atmosphere coming in through valve No. 2. When the tank is empty, valve No. 2 and the flushing heads are then closed.

3rd. The tank is again connected with the hydrant; immediately the water is turned on, valve No. 1 is opened and the tank is permitted to fill with water, taking whatever pressure there may be on the hydrant up to 60 pounds. This completes the operation of what is known as "charging" the machine with the initial air pressure.

The machine is set in operation by opening the outlet valve leading to the flushing nozzle through which the water is directed under pressure in a flat sheet at a uniform angle against the surface of the street. This operation is continued until the gauge at the driver's seat registers 10 pounds, which indicates that the machine is empty of water, with the exception of a few gallons which it is necessary to have remain in the dome or water seal under the rear end of the tank, in order that the pressure may not escape. The tank is again filled with water without any further manipulation of valves Nos. 1 and 2.

These valves need only be touched twice during the day's work. In other words, only two "charge" loads are necessary during the eight-hour working day.

Important suggestions for operating are as follows:

Never use more than 60 pounds working pressure.

Never permit the tank to entirely empty of water, other than at the end of the day's work.

Drain air chamber of any water that may have been forced over, by opening drain cock in the bottom of the front end of the tank, when the machine is not in commission. Regulate the flow of the water from flushing head by operating lever when working close to curb, if any danger of throwing water on sidewalk.

COMPLETE SPECIFICATIONS OF THE MORELAND 4-TON STREET FLUSHER

(5 of which are at the present time being used by the Street Department in the City of Los Angeles.)

Note - This type of motor was used for all tests.

CHASSIS CAPACITY - 8000 pounds.

LOADING SPACE (back of seat) - 14 feet.

MOTOR - Special Moreland 4-cylinder, water-cooled, enclosed type, long stroke; bore, 4-3/4"; stroke, 6-3/4"; fitted with Moreland gasifier.

H. P. - 36.1 S. A. E. rating.

COOLING SYSTEM - Large capacity, highly efficient radiator, swivel suspension centrifugal pump system.

IGNITION - High tension dual.

CLUTCH - Multiple disc, asbestos to steel. Enclosed in aluminum housing.

TRANSMISSION - Sliding gear, selective type, four speeds forward, one reverse. Timken bearings throughout.

DRIVE - Special shaft from transmission to worm drive rear axle.

FRAME - Special alloy pressed steel, 7" deep. All holes drilled, hot riveted, frame heavily gusseted.

DRIVE:

The main drive shaft of the chassis passes through the hollow shaft of the pump, having a universal joint and a bearing at each end to prevent the shaft striking the tube.

There is a two-speed transmission mounted in front of the pump, which allows the pump to be cut off from the engine, or to be driven at two different speeds.

OPERATION:

The water is drawn into the pump from the tank through a 4-inch pipe with a flexible connection, allowing for slight body movement. From the pump the water is forced into a main pipe 3½ inches in diameter. This main pipe runs forward to a header casting.

The flusher nozzles are five in number, mounted fan shape on the header casting at the front of the chassis. Each nozzle is equipped with a valve, so that any or all may be cut out. The main flushing valve is operated from the driver's seat.

An indicator is provided on the tank, to give warning when the tank is about full.

A water gauge is placed just back of the driver's seat to show when the tank is about empty.

The filling hose is equipped with a quick operating connection, and a check valve to prevent the water in the hose from rushing out on the filling operator.

The speed of the vehicle while flushing is from two to four miles per hour. When running idle, i.e. when the centrifugal pump is disconnected, the maximum speed of the flusher is ten miles per hour, a special governor being attached for this regulation.

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AXLES - Front, Timken drop forged, heat treated alloy steel, I-beam section. Rear, Timken-David Brown full floating worm drive axle, mounted on Timken bearings.

TIRES - Any standard make, pressed-on type, front, 36" x 5" single; rear, 38" x 5" dual.

WHEEL BASE - 16 feet.

TREAD - Front, 62"; rear, 70".

WEIGHT OF CHASSIS - 6800 pounds.

EQUIPMENT - Mechanical horn, full set of tools, including jack, grease gun, and all necessary wrenches.

COLOR - Chassis finished in priming coat and two coats gray lead.

PRICE - $3400. f.o.b. factory, Los Angeles, California.

TANK:

Capacity - 1200 gallons.

Note - Speed reduction allows increased rating to carry 1200 gallons of water.

Length - 14 feet.

Material - Sheet steel, rigidly constructed. The bottom plates are heavier than the rest of the tank, which enables them to assist in carrying the load.

Large air vents and filling connections are provided. The tank is mounted on five heavy wooden sills, well braced. The tank is equipped with three splash plates.

PUMP:

The pump is a two-stage centrifugal, designed and built especially for the work. Equipped with a hollow shaft.

Capacity - 350 to 400 gallons per minute. At a nominal speed of about 1400 R.P.M. will develop 65 to 70 pounds pressure.

The pump is mounted on three point suspension, guaranteeing perfect alinement.

COMPLETE SPECIFICATIONS OF THE CALIFORNIA VACUUM STREET CLEANER

Mounted on a 1½-Ton Moreland Truck - Standard Chassis.

Note - This type of Vacuum Cleaner was used for all tests. However, the new machines to be used in the City of Los Angeles will be mounted on 2½-ton Moreland trucks.

CHASSIS CAPACITY - 3000 pounds.

LOADING SPACE (back of seat) - 11 feet.

MOTOR - Continental 4-cylinder, monobloc, water-cooled, enclosed type, unit power plant; bore, 4-1/8"; stroke, 5-1/4"; fitted with Moreland gasifier.

H. P. - 27.3 S. A. E. rating.

COOLING SYSTEM - Large capacity, highly efficient radiator, swivel suspension, centrifugal pump system.

IGNITION - High tension magneto.

CLUTCH - Multiple disc, asbestos to steel. Enclosed in aluminum housing with motor and transmission.

TRANSMISSION - Sliding gear, selective type. Three speeds forward, one reverse. Timken bearings throughout.

DRIVE - Special shaft from transmission to worm drive rear axle.

FRAME - Special alloy pressed steel, 5" deep. All holes drilled, hot riveted, and frame heavily gusseted.

AXLES - Front, Timken drop forged, heat treated alloy steel, I-beam section. Rear, Timken-David Brown full floating worm drive axle, mounted on Timken bearings.

TIRES - Any standard make, pressed-on type. Front, 34" x 3½"; rear, 34" x 5" single.

WHEEL BASE - 12 feet, 6 inches.

TREAD - 58 inches.

WEIGHT OF CHASSIS - 3700 pounds.

EQUIPMENT - Mechanical horn, full set of tools, including jack, grease gun, and all necessary wrenches.

COLOR - Chassis finished in priming coat and two coats gray lead.

PRICE - $1975. f.o.b. factory, Los Angeles, California.

Details of the Pollett Patent - Operation, etc.

The bin is composed of two compartments, the upper and the lower. The upper compartment is designed to receive all manure, litter, and other heavy material removed from the street. The lower compartment is designed to collect all dust removed from the street that is not deposited in the upper compartment. The dimensions of the bin are 6' x 5' x 7'. The lower compartment is a trough, 25" deep, 60" wide, and 7½' long. Practically all of the material is deposited in the upper compartment of the bin. Sixty (60) gallons of water are carried in the lower compartment through which the return current of air is directed by means of a baffle plate, the lower edge of which is approximately one inch below the level of the water. By this arrangement the fine dust is extracted from the current of air, and is collected in the bottom of the lower compartment as mud.

A specially designed blower is used, displacing 6800 cubic feet of air per minute. It is driven by a 20 H. P. marine type, 4-cylinder gas engine, this engine being mounted in front of the bin. The engine and the blower are mounted on the same foundation. The air is drawn by the blower from the upper compartment, creating a partial vacuum therein.

The only opening by which air may enter the compartment, to replace the air removed, is through a slot in the suction head, approximately 3/4 inch wide, running the entire length of the suction head. It is this action of the air rushing through the suction head to the upper compartment that removes dirt and litter from the street and carries it to this compartment.

The suction head is 13 feet long, 20 inches wide, and 3 inches in height, cleaning in one stroke a strip 13 feet wide. There is 18 inches side play in the suction head. This is provided in order that the machine may thoroughly clean the gutter without injuring the apparatus. In other words, a slight variation in the guiding of the vehicle will cause no damage to the suction head. Further, small rollers, running against the curb, are placed at either end of the suction head.

The suction head is connected to the body of the machine by a collapsible canvas pipe 8 inches in diameter. All the air entering the suction head through the slot, together with all material removed from the street by the air rushing into the suction head, enters the upper compartment through this pipe.

A guide, composed of a long iron rod with a short chain attached at the end, is connected to the vehicle in front of the driver's seat. This guide enables the driver to keep the suction head within one or two inches of the curb at all times.

The working speed of the machine is controlled by the operator and ranges from $2\frac{1}{2}$ to $4\frac{1}{2}$ miles per hour, according to the volume of dirt on the street being cleaned. For running to and from work the suction head is raised, which will permit a speed of 10 miles per hour.

There are four independent flexible brushes made of spring steel.

These brushes are placed at an angle with the line along which the machine is traveling, and 10 inches in front of the suction head. They do not revolve, but scrape the surface for the purpose of loosening any material that might adhere to the street.

After having gathered two cubic yards, the litter must be dumped.

The current of air that picks up the sweepings deposits about 98 per cent in the large compartment; the remaining part, which is the finest of dust, follows the return current of air out through a pipe into a bin (7 feet long and 20 inches wide) which is located inside the lower compartment. The water in this bin is about one inch deep, the sides of which are four inches above the bottom of the lower bin. This causes the return current of air to pass through one inch of water, washing it free from fine dust before it escapes.

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V ILLUSTRATIONS

The Moreland 1200 Gal. Street Flusher.
All 5 Nozzles Operating.

STAGG
L. A.

The Sanitary Automatic Street Flusher.
Showing General Construction.

The Sanitary Automatic Street Flusher.
A Battery of Two in Operation.

The Sanitary Automatic Street Flusher.
A Battery of Four in Operation.

B - The Street Shown in the Preceding View
After Having Been Flushed.

The California Vacuum Street Cleaner.

The California Vacuum Street Cleaner.

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VI DESCRIPTION OF TEST

DESCRIPTION OF TEST

At the time the test began (July 26, 1916,) the City of Los Angeles was flushing its paved streets by two methods, namely: (1) motor-driven flushers and (2) batteries of horse-drawn flushers consisting of two vehicles each. Also, advertisements had been published asking for bids for mechanical dry cleaning of paved streets; bids to be based on a given price per 1000 square yards cleaned.

Flushers Used and Basis of Pay

The motor flushers used are five in number, manufactured by the Moreland Truck Company, of Los Angeles, and operated by Tryon & Brain, contractors. They are of 1200 gallons capacity each, and are designed to be used either as street sprinklers or as flushers, the discharge taking place under pressure created by a centrifugal pump in the discharge main, the pump receiving its power from the truck engine. The city is under contract (expiring in March, 1916,) with Tryon & Brain to use all five trucks as street sprinklers at least eight hours per day, it being optional with the city to use them on certain holidays and in rainy weather. The contract specifies that if the city so desires it may use the trucks sixteen hours per day, as sprinklers or as flushers or both. For eight hours per day actual work on the sprinkling or flushing route the contractors receive $15.65 per truck, and for sixteen hours per day actual work on the routes, $29.42. The city is using the trucks eight hours in the daytime as sprinklers and eight hours in the night as flushers.

The horse-drawn vehicles used are 600-gallon Studebaker and Sanitary "Automatic Flushers"; the pressure for flushing being air pressure obtained by "charging" at the hydrants. The flushers are owned by the city and the teams are owned by the drivers. The city pays its drivers $5.00 per eight hours of work for his services and that of the team. The motor-driven flushers are paid only for time spent on the flushing route, while the teams are paid for all time away from the city corrals. Horse-drawn flushers are kept at only two corrals (the 15th St. and the Yale St.).

Method of Flushing

The motor flushers were equipped with five flushing nozzles placed in front of the machine in a fan-shaped cluster. On broad streets the nozzles on one side of the cluster only are used and one-half of the street is flushed at one operation. On narrow streets all five nozzles are used and the entire street is flushed at one operation.

The horse-drawn flushers work in batteries of two each. Only one flushing nozzle is used and the two halves of all streets are covered separately. One flusher goes ahead, flushing a strip from the middle of the street to the curb. The other flusher follows in a path lying closer to the curb, so that the strip flushed by it has already, in part, been covered by the other flusher. In this manner the surface of the street nearer the curb which carries a large proportion of the dust is flushed twice.

Object of Test

In view of the bids for dry cleaning to be received and the contemplated use of both flushing and dry cleaning for paved streets, it seemed desirable to conduct a test for the following purposes:

a. To learn the cost to the City of Los Angeles of flushing 1000 square yards of pavement by the motor-driven flushers now used and by the horse-drawn flushers now used.

b. To learn the cleaning efficiency of the motor-driven flushers and the horse-drawn flushers now used in Los Angeles.

c. To learn what conditions, if any, may be so changed or controlled as to increase the economy or cleaning efficiency of either type of flusher.

METHOD OF TEST

General Plan

Costs.- For the purpose of determining costs, the general plan was to have identical routes covered by both motor-driven flushers and a battery of two horse-drawn flushers. Observers were with the vehicles in each case, in order that there might be no doubt as to what actually occurred, and that a detailed analysis might be made of any difference in cost between the two types of vehicles.

Efficiency of Performance

The "dirt" on paved streets consists almost entirely of manure and of light, small-weight particles of material which may be classed as "dust." In this test the effect of flushing on each of these two general classes of street dirt was investigated separately.

The Effect of Flushing on Manure was determined by inspection only. Because of the bulk of the material, the eye can readily see whether or not it has been removed and may judge, at least roughly, as to the extent to which it has been disturbed. Inspections were made before and after flushing by each type of flusher, and notes were taken of the location and condition of all manure piles on the route. These inspections were made as nearly before dark as possible on the night during which the flushing was done. Early next morning the route was again covered and by referring to the notes of the previous night the effect of the flushing was determined.

In Determining the Effect of Flushing on Street Dust a quantitative test was made. A detailed description of the method is given later. The theory upon which it was based is that, by weighing the dust obtained from parts of a small area free from manure, the dust on the uncleaned similar parts of the area can be determined with a fair degree of accuracy. Then after the area has been flushed, by weighing the dust remaining, a fairly close estimate of the percentage of dust removed by the flushing may be obtained.

Quantitative tests were made before and after flushing by each type of flusher. Also a few such tests were made in Pasadena on streets cleaned by the vacuum cleaner.

Filling Equipment

The motor-driven flushers observed were all equipped with 3-inch hose for filling the tank. The openings in the hydrants are 2½ inches. The hose of one motor-flusher was equipped with a check valve whose opening was not less than 2½ inches, and with a patent "quick coupler" for attaching the hose to the hydrant. The other three motor-driven flushers observed were operating without check valves and with the ordinary type of coupling.

The horse-drawn flushers are ordinarily equipped with 2½-inch hose inside of which are check valves which cut down the opening through the valve to 1½-inch diameter. The hose is equipped with the ordinary type of coupling which fits inside of the 2½-inch hose, reducing its actual diameter at the coupling to about 2 inches.

We wished to investigate the relative cost of flushing by the two types of vehicles operating under as nearly as possible the same external conditions. Evidently large fittings and a proper size of check valve may be used as readily on a horse-drawn flusher as on a motor-driven flusher. For this reason it was desirable to equip the horse-drawn flushers used in the test with hose which would not cut down the effective opening below 2½ inches, which is the opening of the hydrant. With this in view, 2½-inch canvas fire hose with fire couplings and no check valves* were provided for the wagon flushers. This hose had an uninterrupted opening of 2½ inches throughout. It was used on Routes I and II. However, it was found that the canvas hose was unsuited to the purpose, and because of the man's efforts to keep from getting wet, much time was lost in uncoupling the hose. Without consulting those conducting the test, the flushing foreman removed the canvas hose and replaced it with the ordinary type, check valve and all. Therefore, Routes I and II were covered by the wagon flushers using hose without check valves, and Routes III and IV by wagon using the ordinary small-opening checks.

Routes

Four widely separated routes normally being flushed by motor-driven flushers were selected for the test. These routes were chosen with the purpose of embracing as many different conditions as possible in a limited time. The streets in each route follow:

Route I - Western Ave. from Adams to Santa Monica Boulevard
Serrano from 5th to 6th
Oxford from 5th to 6th

---

* Canvas hose was used because the fire hose fittings would not go on the rubber hose. Check valves are needed to prevent the men from getting wet when loading. Evidently hose and check valves of sufficient size may be provided for wagon flushers. To save the expense of so equipping the wagons solely for the purpose of the test and yet to approximate the condition of proper opening through the hose, we proposed to conduct the test with the hose described above.

Route II - Central Avenue from Washington to Slauson
38th St. from Central Ave. to Long Beach Ave.
Ascot from 38th St. to 43rd St.

Route III- North Broadway from Avenue 18 to Prichard
Prichard from North Broadway to Mission Road
Workman from Manitou to Pasadena Avenue
Avenue 26 from Griffin to Daly
Daly from Pasadena Avenue to North Broadway
Avenue 20 from North Main to San Fernando Road
Hayden from Avenue 20 to Avenue 23
One side of Pasadena Ave. from Ave. 18 to Ave. 20

Route IV - 9th Street from Figueroa to Vermont
7th Street from Figueroa to Vermont

(Note - On some of the streets in the above routes the car tracks were not flushed, while in other streets they were. Just what portions of the streets were flushed will be found under the heading "Detailed Data and Calculations," pages 152-155.)

Time Studies

An observer followed a motor flusher over each route, making detailed notes of the path followed and of the time consumed in the various elements of the work. The following observations were made and recorded:

1. Time spent in moving forward to load
2. Time spent in moving backward to load
3. Time spent standing at hydrant
    a. Before water began to flow
    b. During water flow
    c. After water ceased to flow
4. Time spent in moving forward to the point at which flushing begins
5. Time spent in moving backward to the point at which flushing begins
6. Time spent in flushing
7. Time spent in turning
    a. To load
    b. To flush
8. Time spent in delays
    a. Repairing
    b. Traffic
    c. Other
9. Path of flusher
10. Location of hydrants used
11. Whether or not tank was empty at beginning of filling

At the next regular flushing time (one week later), the same route was flushed by a battery of two horse-drawn flushers. Two observers followed the flushers, one with each wagon, taking notes of the details of the work similar to those taken for the motor-driven flusher, as follows:

1. Time spent going from corral to the flushing route
2. Time spent going from route to corral
3. Time spent in going to the hydrant to load
    a. Moving
    b. Waiting for other flusher to get out of the way
4. Time spent in standing at hydrant
    a. Before water begins to flow
    b. During water flow
    c. After water ceased to flow
5. Time spent in moving from hydrant to flushing point
6. Time spent in flushing
7. Time spent in turning
    a. To load
    b. To flush
8. Time spent in delays
    a. Repairing
    b. Traffic
    c. Other
9. Path of flusher
10. Location of hydrants used
11. Pressure in flusher tank at beginning and end of each filling

Inspection

For the purpose of determining to what extent flushing removed manure, each route covered during the test was inspected both before and after each flushing. Flushing occurred at night. Inspections were made just before dark and early the next morning.

Dust Test

On each of the four routes a section of street was selected for use in determining the percentage of dust removed by flushing. The section selected was 50 feet long and free from visible litter. Its width was the width of the street (or that part of the street which was flushed) less a gutter strip at each curb. The gutter strips were excluded from the test area because of the deposits that might occur in them from the flushing of other sections of the street, and because usually they would not be dry in time for a proper completion of the test. The test area was divided into five equal sections, each 10 feet wide. Assume them as numbered consecutively 1 to 5. Sections 1 and 5 were cleaned very carefully before flushing as late in the evening as was possible, to avoid interference from traffic and to approximate as closely as possible the street condition at the time of flushing. Soft, fine-haired push brooms were used. The sweeping was carefully and thoroughly done and the cleanings were collected and so marked as to identify the section of their origin.

Early the following morning, after the street had been flushed and had dried out, and before the regular hand-sweeper and the full flow of traffic had come on, Section 3 was cleaned in the same manner. Sections 2 and 4 were not used except to provide areas contiguous to Section 3 which would correspond to the rest of the street.

The materials collected were carefully weighed and screened. The average of the collections from Sections 1 and 5 was used as closely

approximating the weight and composition of dirt on Section 3 before flushing. The weight and composition of dirt on Section 3 after flushing was obtained by direct experiment as explained above.

(Note - The relative positions of sections cleaned were sometimes changed from that given above, when such change was made necessary by litter occurring on one of the test sections before completion of the test. The detailed description of each dust test made is given on pages 69-121.)

VII DISCUSSION OF RESULTS

DISCUSSION OF RESULTS

In considering the results of this test, one should bear in mind the following:

1. Total costs of flushing consist of

   a. Time Costs

      1) Rent of vehicle and driver for motor-driven flusher
         Wages of driver with team for horse-drawn flusher

      2) Foreman's wages (for both types of flushers)

      3) Maintenance, depreciation, and interest
         (for horse-drawn flushers only)

      4) Workmen's compensation insurance on all labor
         working directly for the city

      5) Administration expense on all of above items

   b. Water Costs

      1) Production cost of water used
      2) Administration expense on above cost

   c. Yardage Costs

      1) Culvert and catch basin cleaning
      2) Sweeping gutter deposits

2. Total cost of vacuum cleaning consists of

   a. Yardage Costs

      1) Contract price per 1000 square yards cleaned

   b. Time Costs

      1) Foreman's wages and workmen's compensation insurance
      2) Administration

   In this report the elements of cost are given separately and in detail.

3. The "time data" were obtained in a short test during which the drivers of both types of flushers were aware of observation, which tends to give minimum values of time for both types. This is entirely desirable, since it gives a comparison between the two types of equipment unaffected by variations in the honesty and industry of the driver. The waste of time by the men is a problem of administration and not one of equipment. In any case the results for the two types of flushers are directly comparable.

4. All drivers were aware that the routes flushed were being inspected for the purpose of determining the effectiveness of flushing. None of them, however, were aware of the nature of the dust test or that any particular small part of the route was to be especially examined.

5. The quantitative dust tests show a high percentage of good results for this class of experimental work. Out of twenty-three separate tests only four gave apparently unreasonable results, showing more dust on the street after flushing than before. Two of the four were made during a high wind on East First Street, the street carrying very little dust and being under very heavy traffic. The other two were on Central Ave., which is a heavily traveled street, especially in the very early morning hours. Although, as explained in connection with the details of each test (see pages 84 and 105), these apparently unreasonable results may be entirely reasonable, we considered it best to neglect them. This is fair to each type of flusher, as each showed to equal disadvantage in such results.

6. At the time that the battery of horse-drawn flushers was covering the routes at lower cost than the motor-driven flusher, it was also doing a higher quality of work.

7. Although the official day for the horse-drawn flushers is eight hours, for some time past the men doing this work have been voluntarily donating to the city the services of themselves and their teams during one-half hour extra time each day. If this fact were considered, the actual cost of covering the test routes by the horse-drawn battery would be still less than the figures given in this report.

8. Not only the average for all routes showed the horse-drawn flushing as cheaper, per 1000 square yards, than the motor-driven flushing, but the same thing was true to a greater or less degree upon each of the four routes tested.

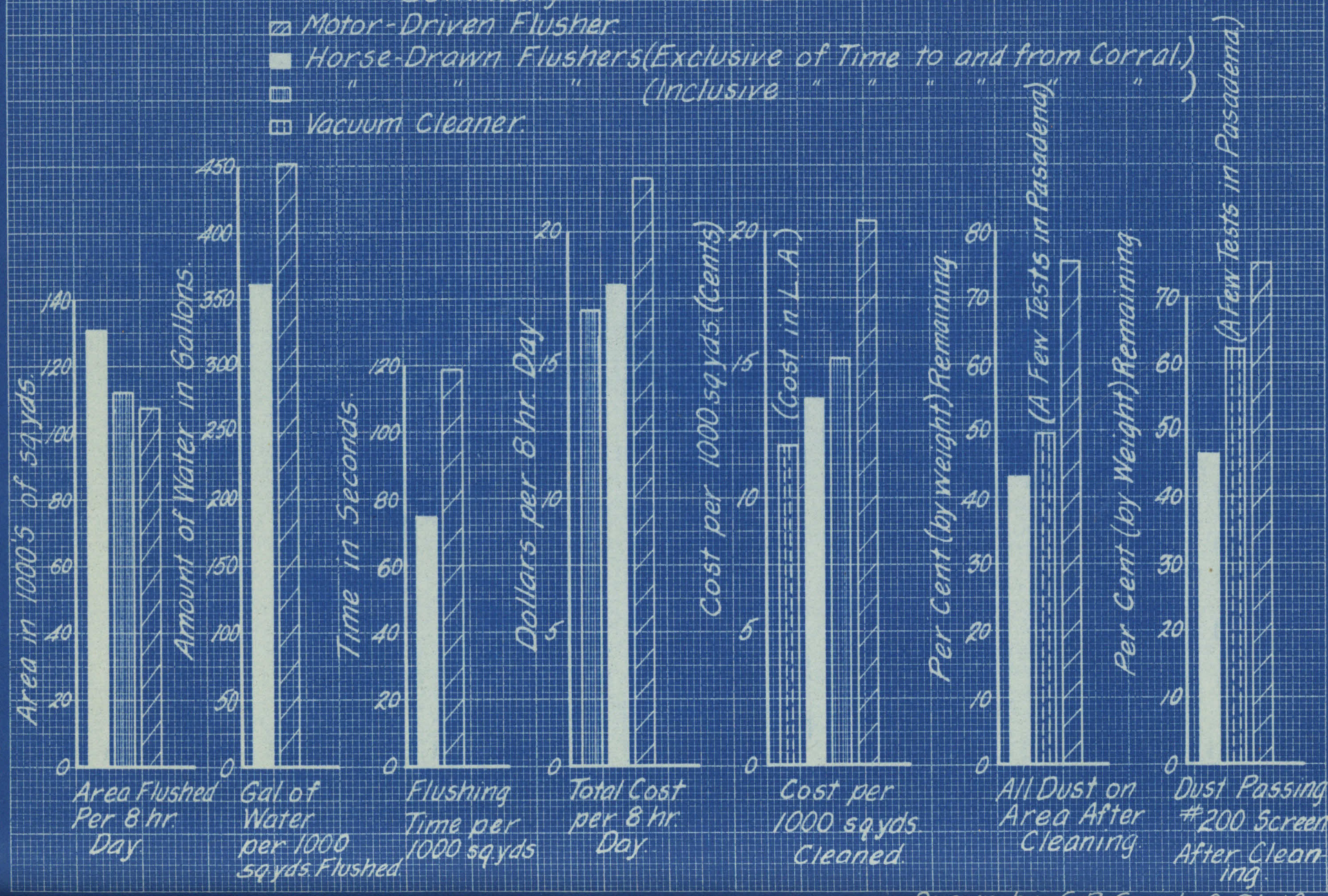
In the following pages the more important results obtained in this test are discussed in detail.

DISCUSSION OF AVERAGE RESULTS

Street Cleaning Methods.

(Motor-Driven Flusher, Battery of Two Horse-Drawn Flushers, Vacuum Cleaner.)

Summary of Tests.



Drawn by S. A. Searl 8-31-16.

CHART NO. 1. SUMMARY OF TESTS - SHOWING COMPARATIVE PERFORMANCE AND UNIT COSTS OF MOTOR-DRIVEN FLUSHER, HORSE-DRAWN FLUSHER, AND VACUUM CLEANER

The more important findings of the test, shown graphically by this chart, are the following:

1. The average area flushed per 8 hours by the horse-drawn battery was greater than that flushed by the motor-driven flusher. This was true per 8 hours of actual work on the route by the horse-drawn battery and also per 8 hours of work including the time to and from the corral.

2. The motor-flusher used more water per 1000 square yards flushed than the horse-drawn flusher.

Note. Some of the water used by the motor flusher does not strike the pavement, but is sprayed over the curb and sidewalk. On narrow streets the quantity of this wasted water is considerable.

3. The time used in the actual flushing of the street was greater for the motor-driven flusher than for the horse-drawn battery; that is, the speed of the motor-driven flushers while flushing was less than the speed of the horse-drawn flushers while flushing.

4. The total cost per 8-hour day is greater for the motor-driven flusher than for the battery of two horse-drawn flushers.

This total cost per day for the horse-drawn battery is greater when we exclude the time to and from the corral than when we include this time. This apparently contradictory fact is due to costs other than those dependent upon time, namely: cost of water and cost of gutter and culvert cleaning; so that 8 hours spent in actual flushing work by the teams so increases the yardage flushed that the additional gutter and culvert cleaning and the additional water used causes the total cost of the 8 hours spent on the route to exceed the total cost of 8 hours including the time going to and from the corral.

The cost per 1000 sq. yds. flushed, of course, is less when all of the time is spent on the route than when part of the time is used in going to and from the corral.

5. Considering all costs per 1000 sq. yds. cleaned, the motor-driven flusher is the most expensive. The horse-drawn flusher battery, inclusive of the time to and from the corral, comes next in order of expense; then the horse-drawn battery, exclusive of the time to and from the corral; and last, the vacuum cleaner as the least expensive method.

6. The motor-driven flusher left on the street a greater percentage of dust than the horse-drawn battery. The result of a few dust tests on streets in Pasadena covered by the vacuum cleaner must be used with some caution, for the reason that conditions may differ somewhat. The data are given as the best that were available.

The percentage of very fine dust (passing a 200-mesh screen) removed by each type of cleaner was roughly equal to the percentage of total dust removed. The tests show the three cleaning methods ranking in the same order for this fine dust as as they did for all dust; that is, the motor-driven flusher removed less of the fine dust than the vacuum cleaner, and the vacuum cleaner removed less than the horse-drawn battery.

For the reason stated above, the results of the vacuum machine tests are not entirely conclusive.

STREET CLEANING METHODS

Summary of Tests

Item	One Motor-driven Flusher	Battery of Two Horse-drawn Flushers		Vacuum Cleaner
		Inclusive of Time to and from corral	Exclusive of Time to and from corral	
Area Flushed per 8-hr. day (square yards)	107,450	112,226	151,129	---
Gallons of Water per 1000 square yards flushed	452	365	363	---
Flushing Time per 1000 square yards (seconds)	119	75	75	---
Total Cost per 8-hr. day	$21.96	$17.06	$17.98	---
Cost per 1000 square yards cleaned	20.44¢	15.20¢	13.71¢	11.65¢
% of all Dust remaining after cleaning	75.8%	45.2%	45.2%	49.4%
% of Dust passing No. 200 screen remaining after cleaning	75.0%	46.3%	46.3%	62.0%

Table No. 1

Details of above table

"Areas flushed" - See pages 35, 123, 134, 136, and 152 - 155

"Gallons of Water" - See pages 123, 134, 136, and 137 - 145

"Flushing Time" - See Table No. 4 page 55, and page 134

"Cost per 8 hours" - See pages 124 - 127

"Cost per 1000 sq.yds." - See tables Nos.8,9,10,11, and 12 on pages 65 and 66

"% of all dust remaining" - See Table No. 14, page 73

"% of dust passing No. 200 screen," etc. - See Table No. 15 on page 76

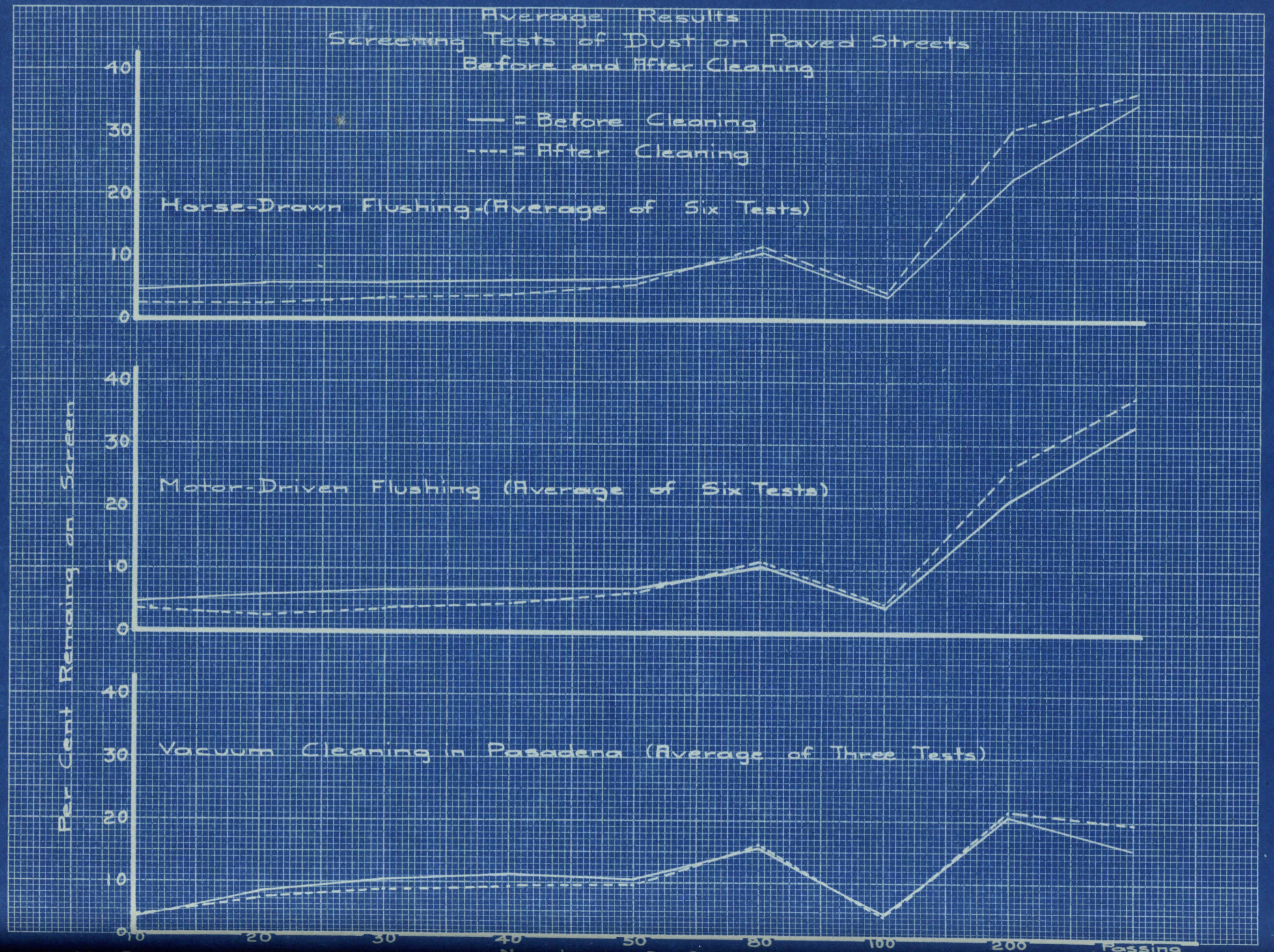

Average Results
Screening Tests of Dust on Paved Streets
Before and After Cleaning
—— = Before Cleaning
---- = After Cleaning
Horse-Drawn Flushing-(Average of Six Tests)
Motor-Driven Flushing (Average of Six Tests)
Vacuum Cleaning in Pasadena (Average of Three Tests)
Per Cent Remaining on Screen
40
30
20
10
0
10
20
30
40
50
80
100
200
Passing

CHART NO. 2

AVERAGE RESULTS

Screening Tests of Dust on Paved Streets Before and After Cleaning

Chart No. 2 shows for each type of cleaner the average results of a study concerning the composition of the dust on the street before and after cleaning.

Note that the vertical scale of this chart is uniform and that vertical distance is proportional to "per cent by weight remaining on screen." However, the horizontal scale is not uniform, and horizontal distance here has no significance except that it isolates the data for each screen. Therefore the shapes of the curves as affected by horizontal distance are of no importance; the important thing being the relative vertical position of the "before" and "after" curves.

After flushing by either type, the dust remaining, compared to its original composition, contains a slightly smaller percentage of material retained on screens Nos. 10, 20, 30, 40, and 50; and a slightly larger percentage of material retained on screens Nos. 80, 100, 200, and passing No. 200. In short, the finer particles of dust are less affected by flushing than are the larger particles.

The same thing is true of the vacuum cleaner, but to a less degree. It seems to remove more nearly an even percentage of all sizes of materials than the flushers.

TABLE NO. 2

AVERAGES OF SCREENING TESTS

No. of Screen	% by Weight Remaining on Screen					
	One Motor-driven Flusher		Battery of Two Horse-drawn Flushers		Vacuum Cleaner in Pasadena	
	Before Flushing	After Flushing	Before Flushing	After Flushing	Before Cleaning	After Cleaning
# 10	4.69%	3.59%	4.35%	2.20%	3.63%	3.87%
# 20	5.80%	2.68%	5.66%	2.22%	8.18%	7.23%
# 30	6.80%	3.82%	5.74%	3.23%	10.33%	8.73%
# 40	6.97%	4.27%	6.01%	3.93%	11.20%	9.26%
# 50	6.83%	6.18%	6.50%	5.77%	10.28%	9.60%
# 80	10.69%	11.08%	10.61%	11.51%	15.48%	16.00%
#100	4.04%	4.63%	3.74%	4.08%	4.85%	4.37%
#200	21.18%	26.20%	22.52%	30.33%	20.43%	21.17%
Passing) #200)	33.00%	37.56%	34.87%	36.73%	15.62%	19.77%
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

TESTS USED IN ABOVE AVERAGES

Motor-driven Flusher:

Tests on Western Ave. (2), Hayden St., 7th St., Figueroa St., and Sunset Blvd. - 6 in all

Battery of Horse-drawn Flushers:

Tests on 23rd St. (1), Western Ave. (2), Central Ave. (west side), Hayden St., and 7th St. - 6 in all

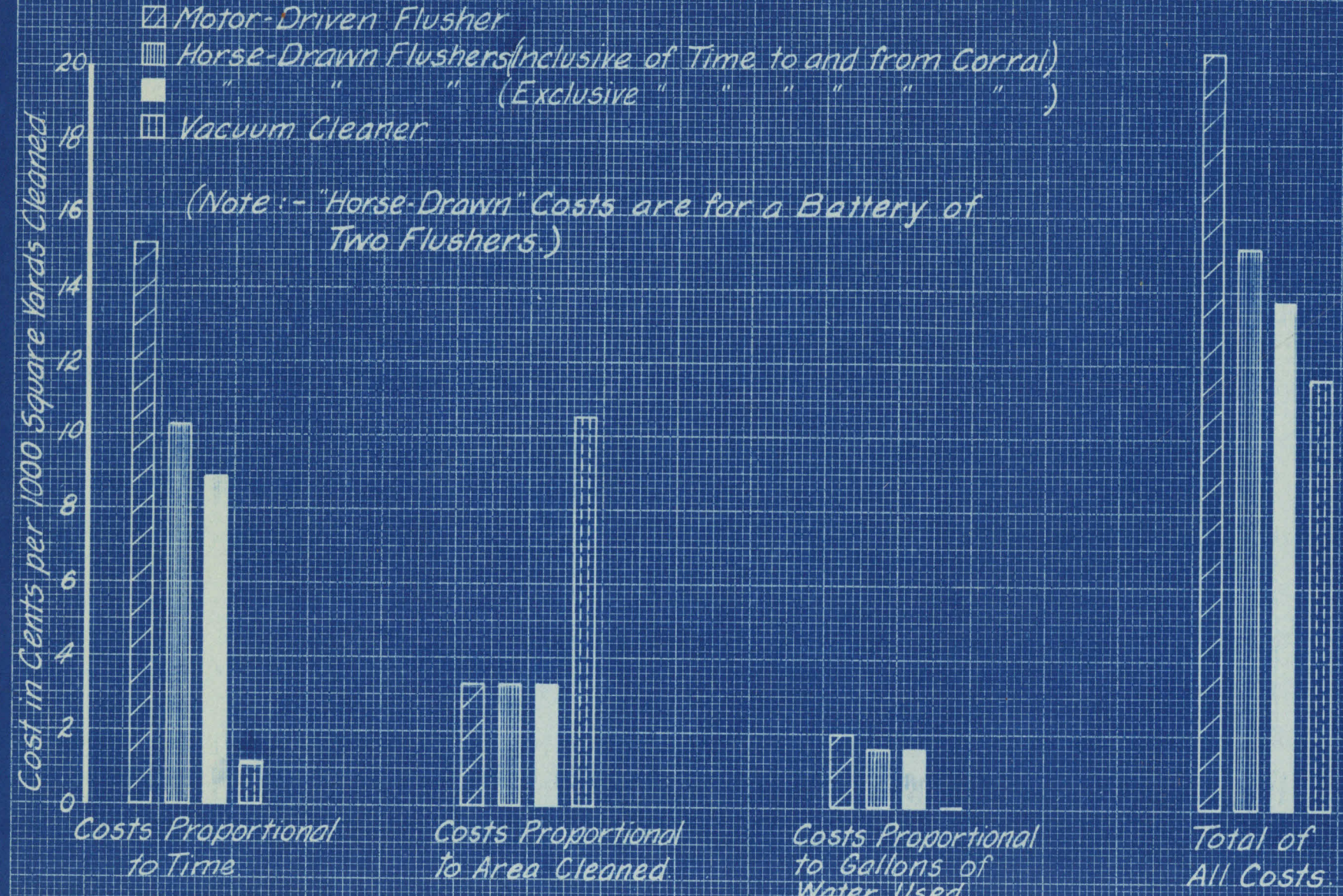
Vacuum Cleaner in Pasadena:

Test on Walnut St., and California St. (2) - 3 in all

(For details of above, see Table No. 27 on pages 148-151)

DISCUSSION OF COSTS

Analysis of Difference in Cost per 1000 Sq Yds Cleaned Between Motor-Driven Flusher, Horse-Drawn Flushers, and Vacuum Cleaner



Drawn by S. R. Sear 9-2-16.

CHART NO. 3

Analysis of Difference in Cost per 1000 Square Yards Cleaned Between Motor-Driven Flusher, Battery of Two Horse-Drawn Flushers, and Vacuum Cleaner

All costs of flushing streets fall in three broad divisions:

1. Costs that are due to the passage of time and are therefore proportional to time.
2. Costs which are due to the extent of area cleaned (gutter sweeping and culvert cleaning).
3. The cost of water used.

Chart No. 3 shows the relative value of each of these costs for the motor-driven flusher, the battery of horse-drawn flushers, and the vacuum cleaner.

Considering first only the motor-driven flusher and the battery of horse-drawn flushers, it will be noted that the motor-driven flusher is more expensive both in "time costs" and in "water costs," and has equal value with the horse-drawn battery in "yardage costs."

Considering also the vacuum cleaner, it will be noted that almost all of its costs are due to "yardage costs." This is caused by the nature of the contract for vacuum cleaning, which is based upon yardage. The only other costs for the vacuum cleaner are certain "time costs" due to necessary supervision.

The sum of all costs per 1000 sq. yds. cleaned by each type is also shown on the chart. The motor-driven flusher is the most expensive, the horse-drawn battery (inclusive of time to and from corral) comes next, the horse-drawn battery using all its time on the route comes third, and last and least expensive is the vacuum cleaner.

TABLE NO. 3

Costs Segregated According to Governing Factor

	Total Time Cost per 1000 sq.yds.	Total Yardage Costs per 1000 sq.yds.	Total Water Costs per 1000 sq. yds.	Total All Costs per 1000 sq.yds.
Battery of Two Horse-drawn Flushers (Exclusive of Time to and from Corral)	8.85¢	3.27¢	1.59¢	13.71¢
Battery of Two Horse-drawn Flushers (Inclusive of Time to and from Corral)	10.34¢	3.27¢	1.59¢	15.20¢
One Motor-driven Flusher	15.19¢	3.27¢	1.98¢	20.44¢
Vacuum Cleaner	1.15¢	10.50¢	0	11.65¢

(For details of above, see pages 124-133)

CHART NO. 4

Analysis of Differences in Time Costs Between Motor-Driven and Horse-Drawn Flushers

In analyzing the elements of total cost of flushing, it was found that of the three costs - time costs, water costs, and yardage costs - the time cost was by far the most important. Therefore, it was desirable to further analyze time costs to ascertain just where occurred the difference in cost between the horse-drawn battery and the motor-driven flusher.

The first step was to compare for the horse-drawn battery and the motor-driven flusher the actual number of seconds spent by each in the detail operations. Chart No. 4 shows the result of this step. For the purpose of the chart the time of the horse-drawn flusher for each operation was taken as 100% and the time of the motor-driven flusher for the same operation was expressed in terms of that per cent. This chart does not give absolute values of the time, but simply relative values.

The chart shows that five operations performed by each type of vehicle are performed in less time by the horse-drawn battery than by the motor-driven flusher. These operations are:

Moving to the hydrant
Necessary time spent at hydrant before water begins to flow into the tank
Moving away from the hydrant to the point where flushing begins
Actual flushing
Time spent in minor repairs

There were two divisions of time which were identical in value for the two types of vehicle; that is, necessary time at the hydrant after the water ceased flowing into the tank, and unavoidable delays on the route.

In six elements of work the motor-driven flusher spent less time than the horse-drawn battery. These items are:

Turning for the purpose of loading
Waiting at the hydrant for another vehicle to get out of the way
Time during the flow of water into the tank
Turning for the purpose of flushing
"Charging" time, and
Traveling time; that is, time to and from corral

Three of these items - waiting at hydrant, charging time, and traveling time - are necessarily zero for the motor-driven flusher. That leaves three operations - turning for the purpose of loading, time during the flow of water into the tank, and turning for the purpose of flushing - which were performed by both the motor-driven flusher and the battery of horse-drawn flushers and which showed the motor-driven flusher to consume less time in each. The decreased time of the motor-driven flusher in turning was due solely to the fact that the motor-driven flushers very seldom make a turn of 180 degrees because of the excessive time necessary to make such a turn. Their method is to move backwards rather than make a turn either for purposes of loading or for purposes of flushing. When backing, the motor-flushers move very slowly. As compared to the horse-drawn battery, this is not a saving in time, which is shown clearly by this chart in the greatly increased time of the motor-driven flushers compared to the horse-drawn battery in the "moving" time. This leaves one operation - time during the flow of water into the tank - performed by both types of vehicle and showing an advantage for the motor-driven flusher in time consumed. A later analysis of costs of these individual times (see Chart No. 5) shows that the cost to the city during the time of water flow into the tank is greater for the motor-driven flusher than for the horse-drawn battery. The increased cost of motor-driven flusher per unit of time more than offsets the saving in time which it effects.

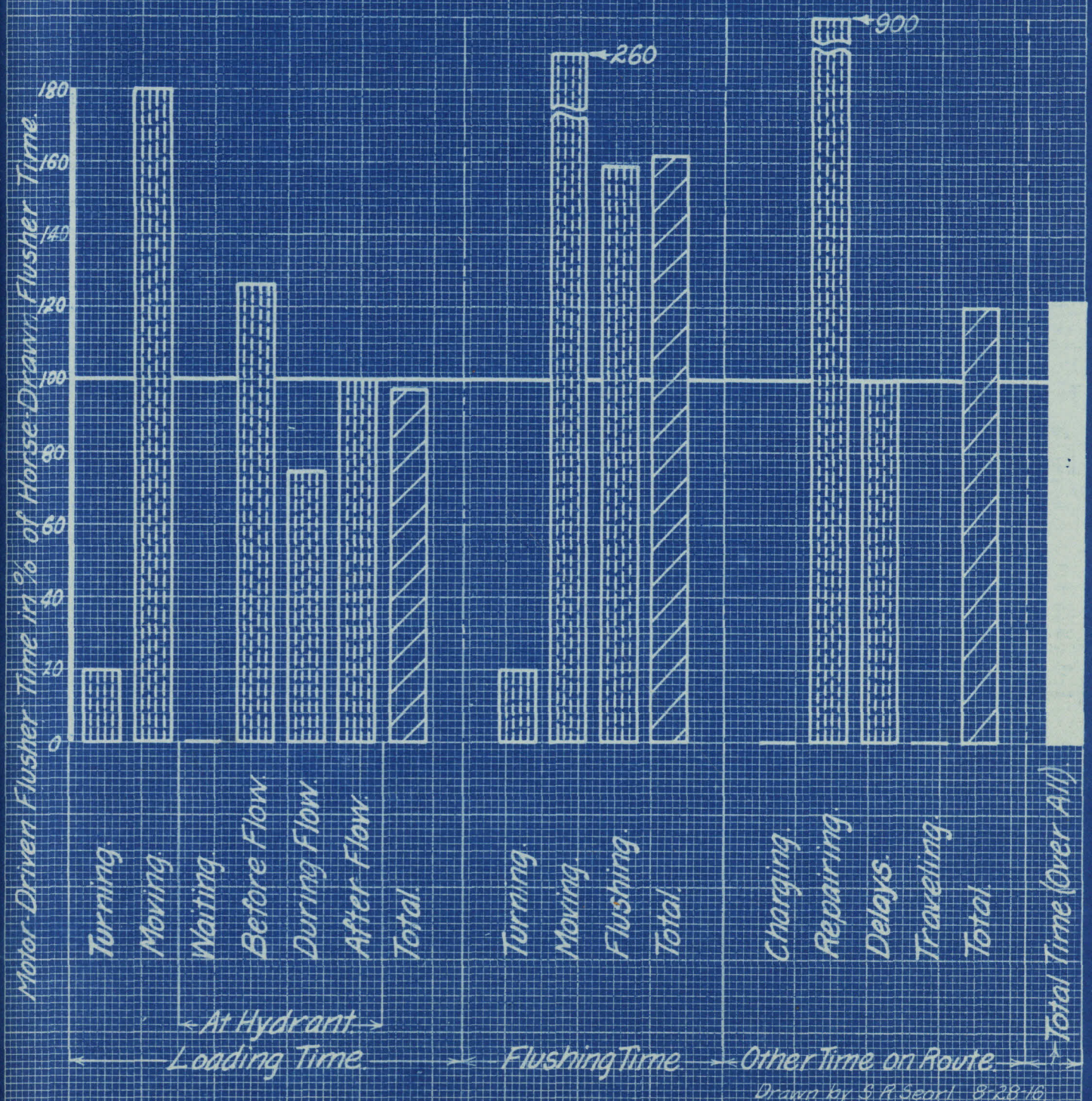
Summarized, the motor-driven flusher spent less time than the horse-drawn battery in six operations, the same time in two operations, and more time in five operations. The net result over all was that the motor-driven flusher spent more time per 1000 square yards flushed than did the battery of horse-drawn flushers.

The various time elements reduced to terms of cost to the city are compared in Chart No. 5.

Elements of Working Time per 1000 Square Yards Flushed.
("Working Time" = Time on Flushing Route).

Motor-Driven Flusher Compared to Battery of Two Horse-Drawn Flushers

100% = Time of Horse-Drawn Battery.



Drawn by J. R. Scott 8-28-16

Chart No. 4.

TIME ANALYSIS

	Percentage of Total Time			Seconds per 1000 Yards Flushed		
	Battery of Two Horse-drawn Flushers			Battery of Two Horse-drawn Flushers		
	Exclusive of time to and from corral	Inclusive of time to & from corral	One Motor-driven Flusher	Exclusive of time to & from Corral (seconds)	Inclusive of time to & from corral (seconds)	One Motor-driven Flusher (seconds)
Going to Hydrants:						
Turning 180°	2.3%	1.9%	0.2%	5	5	1
Moving	4.3%	3.5%	6.9%	9	9	18
Waiting	1.5%	1.2%	0.0%	3	3	0
At Hydrants:						
Before inflow	8.5%	7.4%	8.8%	19	19	24
After inflow	9.6%	8.2%	7.9%	21	21	21
During inflow	28.9%	24.5%	17.7%	63	65	47
Going from Hydrants:						
Turning 180°	2.2%	1.9%	0.4%	5	5	1
Moving	4.6%	3.9%	9.8%	10	10	26
Flushing	33.9%	29.2%	44.4%	75	75	119
Charging	2.6%	2.3%	0.0%	6	6	0
Repairing	0.3%	0.4%	3.2%	1	1	9
Traffic delays	0.7%	0.8%	0.6%	2	2	2
Other delays	0.1%	0.0%	0.1%	0	0	0
Traveling on route	0.5%	0.4%	0.0%	1	1	0
Traveling to and from corral	0.0%	14.4%	0.0%	0	37	0
Total	100.0%	100.0%	100.0%	220	257	268
Summary of above						
Going to Hydrants	8.1%	6.6%	7.1%	17	17	19
At Hydrants	47.0%	40.1%	34.4%	103	103	92
Going from Hydrants	6.8%	5.8%	10.2%	15	15	27
Flushing	33.9%	29.2%	44.4%	75	75	119
To and from Corral	0.0%	14.4%	0.0%	0	37	0
Other Time	6.2%	3.9%	3.9%	10	10	11

Table No. 4

(For basic figures on the above table, see Tables Nos. 16, 25, and 26, pages 136, 146 and 147. For method, see page 134)

CHART NO. 5

Analysis of Difference in Time Costs Between Motor-Driven and Horse-Drawn Flushers (continued)

Chart No. 4 showed the motor-driven flusher compared with the horse-drawn battery in regard to the relative time consumed in the various operations necessary to flushing. Chart No. 5 here discussed compares the two types of vehicles in regard to actual cost of the time used in various operations.

The chart shows that the elements of operation during which the motor-driven flusher is more expensive than is the battery of horse-drawn flushers are eight in number, as follows:

Moving to the hydrant
Necessary time at hydrant before water begins to flow
Time at hydrant during the water flow
Necessary time at hydrant after water ceases to flow
Time moving from the hydrant to point of flushing
Time during flushing
Repairing time
Time of delays

In six of the operations the time of the motor-truck costs the city less than does the time of the horse-drawn battery in the same operations. These time divisions are:

Turning for the purpose of loading
Waiting at the hydrant for another vehicle to get out of the way
Turning for the purpose of flushing
"Charging" time
Traveling time on the route
Time spent in going to and from corral

It will be noted that three of these divisions, namely - waiting at the hydrant for another vehicle to get out of the way, "charging" time, and time to and from corral - are necessarily zero for the motor-driven flusher; also that all the times mentioned in which the motor-driven flusher is operated at less cost than is the battery of horse-drawn flushers, are small items when compared to the total cost.

The net effect of all time elements is to make the time of the motor-driven flusher much more expensive per 1000 square yards cleaned than the time of the battery of horse-drawn flushers. This is because (1) of the comparative high cost of the motor-driven flusher per unit of time; (2) in many operations the motor-driven flusher consumes more time; and (3) because (with one exception) the operations in which the motor-driven flusher saves time are of comparatively little importance.

Analysis of Differences in Time Costs

Between Motor-Driven and Horse-Drawn Flushers.
Note - "Water Costs" and "Culvert and Gutter Cleaning Costs" are not considered here.

■ Horse-Drawn Flushers (Exclusive of Time to and from Corral.)
▨ " " " (Inclusive " " " " " " ")
▨ Motor-Driven Flusher

One Motor-Driven Flusher
V.S
Battery of Two Horse-Drawn Flushers.

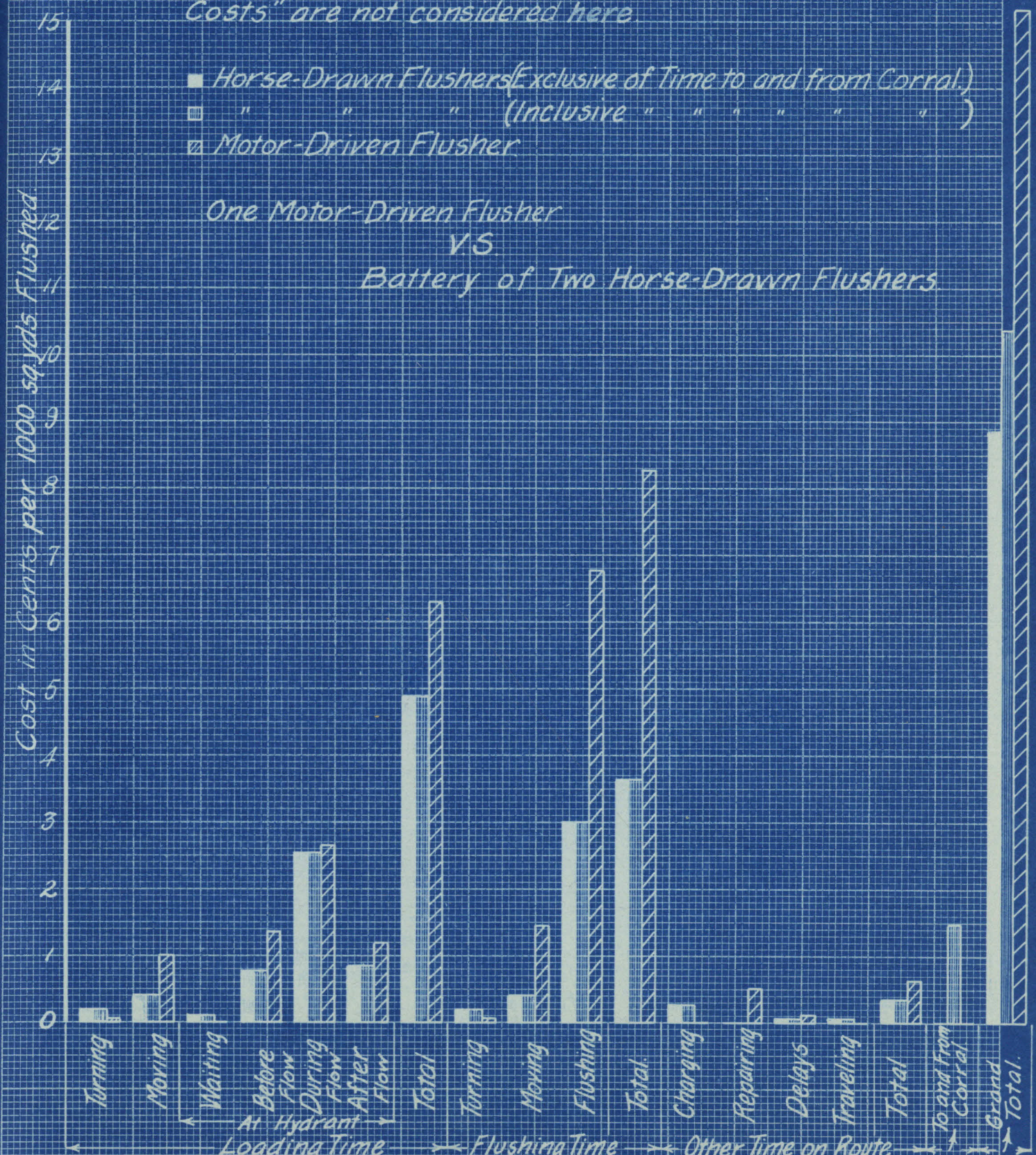


Chart No. 5.

Drawn by S. R. Searl 8-31-16.

ANALYSIS OF THE COST OF TIME DETAILS

Operation	Time Cost per 1000 Sq.Yds. Flushed		
	Battery of 2 Horse-drawn Flushers		One Motor-driven Flusher
	Exclusive of time to and from corral	Inclusive of time to and from corral	
Going to Hydrant:			
Turning 180°	.201¢	.201¢	.056¢
Moving	.362¢	.362¢	1.020¢
Waiting	.121¢	.121¢	.000¢
At Hydrant:			
Before inflow	.764¢	.764¢	1.360¢
After inflow	.845¢	.845¢	1.190¢
During inflow	2.530¢	2.530¢	2.670¢
Going from Hydrant:			
Turning 180°	.201¢	.201¢	.056¢
Moving	.402¢	.402¢	1.475¢
Flushing	3.019¢	3.019¢	6.740¢
Charging	.245¢	.245¢	.000¢
Repairing	.040¢	.040¢	.510¢
Traffic Delays	.080¢	.080¢	.113¢
Other Delays	.000¢	.000¢	.000¢
Traveling on Route	.040¢	.040¢	.000¢
Traveling to and from corral	.000¢	1.490¢	.000¢
Total Time Costs	8.85¢	10.34¢	15.19¢

Summary of Above			
Going to Hydrant	.684¢	.684¢	1.076¢
At Hydrant	3.139¢	3.139¢	5.220¢
Going from Hydrant	.603¢	.603¢	1.531¢
Flushing	3.019¢	3.019¢	6.740¢
To and from Corral	.000¢	1.490¢	.000¢
Other Time	.405¢	.405¢	.623¢

Table No. 5

(Above figures are based on Table No. 4, page 55, and "time cost" given in Table No. 3, page 52.)

CHART No. 6

Relative Importance of Cost Details Segregated According to Elements of Work

In considering the various elements of work which are incidental to flushing, it is interesting to know which elements are the most costly. Chart No. 6 shows the cost of these various elements drawn to the same scale and placed in their order of importance for the purpose of comparison.

For the motor-driven flusher the "time spent in flushing" is by far the most important cost, having a value of twice the value of the next highest cost. Next in importance comes culvert and gutter cleaning, then the time during the flow of water into the tank, the time spent at the hydrant other than during water flow, the time spent going to and from the hydrant, the cost of the water, the delays for repairs, traffic delays, and the time spent in turning 180 degrees, in the order named.

For the horse-drawn battery the cost of culvert and gutter cleaning comes first, then the time spent in flushing, time spent at the hydrant during the flow of water into the tank, the time spent at the hydrant other than during water inflow, the cost of the water, the time spent in each of the following operations, in the order named - going to and from the corral, going to and from the hydrant, turning 180 degrees, "charging," waiting at the hydrant for the other team to get out of the way, traffic delays, running on the route.

Relative Importance of Cost Details.

Segregated According to Elements of Work.

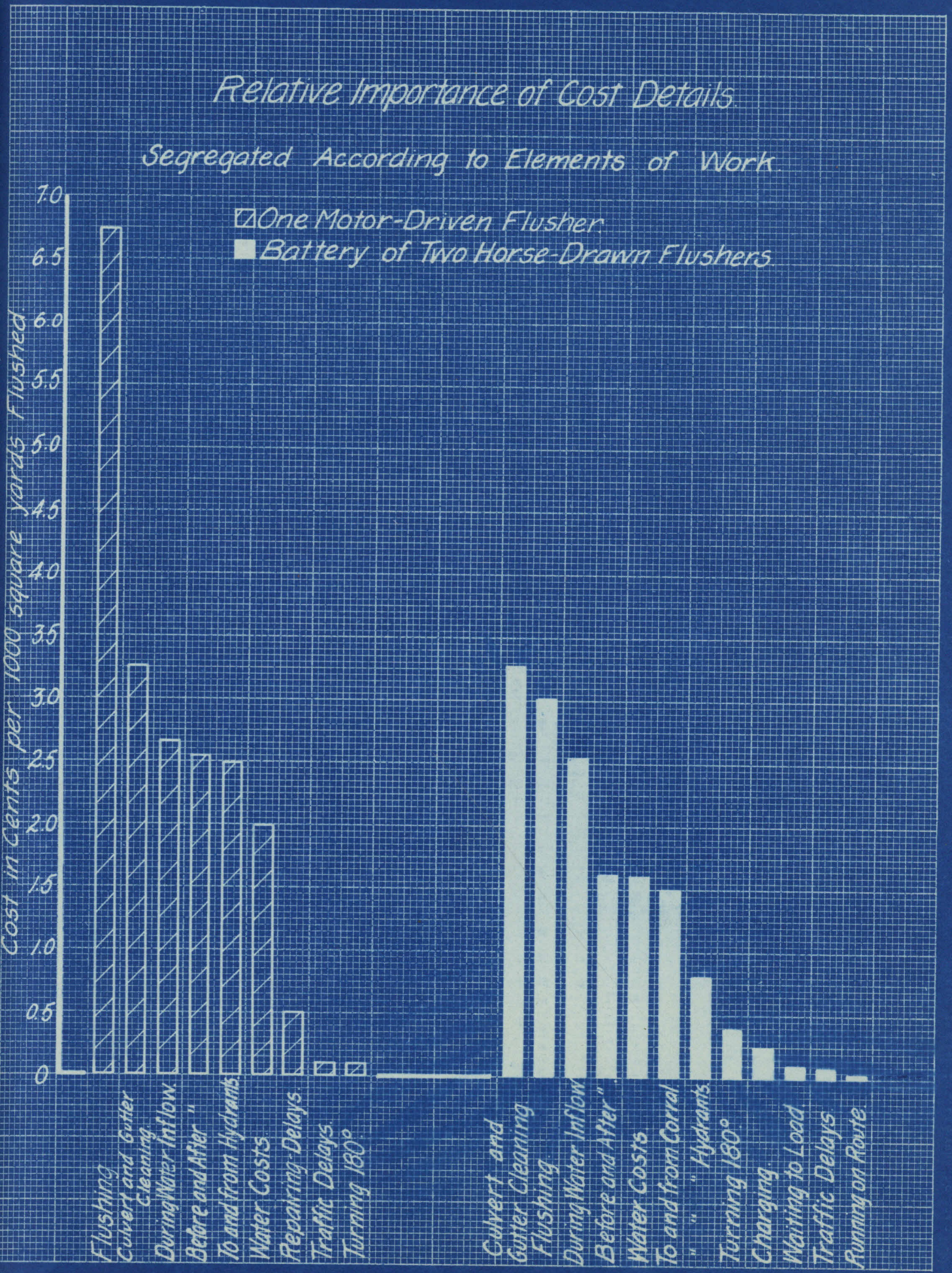


Chart No. 6.

Drawn by S. R. Searl
9-2-16.

COST OF VARIOUS DETAILS INCIDENTAL TO FLUSHING

(Listed in the Order of Their Importance)

One Motor-driven Flusher

Item	Cost per 1000 sq.yds. flushed
Time Spent in Flushing	6.740¢
Culvert and Gutter Cleaning	3.270¢
Time at Hydrants During Water Flow Into Tank	2.670¢
Time at Hydrants Before and After Water Inflow	2.550¢
Time Going To and From Hydrants	2.495¢
Water Costs	1.980¢
Time Spent in Repairing	.510¢
Time Spent in Traffic Delays	.113¢
Time Spent in Turning 180°	.112¢
Total	20.440¢

Battery of Two Horse-drawn Flushers

Item	Cost per 1000 sq.yds. flushed
Culvert and Gutter Cleaning	3.270¢
Time Spent in Flushing	3.019¢
Time at Hydrants During Water Flow into Tank	2.530¢
Time at Hydrants Before and After Water Inflow	1.609¢
Water Costs	1.590¢
Time Going To and From Corral	1.490¢
Time Moving To and From Hydrants	.804¢
Time Turning 180°	.402¢
Time Charging Air Chamber	.245¢
Time Waiting for Other Flusher	.121¢
Time of Traffic Delays	.080¢
Time Traveling on Route	.040¢
Total (Inclusive of "To and From Corral")	15.20¢
Total (Inclusive of " " " ")	13.71¢

Table No. 6

(Above figures based on Tables Nos. 3 and 5, pages 52 and 58.)

Chart No. 7

RELATIVE IMPORTANCE OF COST ELEMENTS

(Segregated According to Objects of Expenditure)

Chart No. 7 gives the relative importance of the various ways in which money is spent in connection with flushing. It shows that costs for direct labor are by far the most important for each type of flushing. "Gutter and culvert cleaning" and "water costs" come second and third, respectively, but are very much less than the direct labor costs. The remaining items are of still less importance.

Relative Importance of Cost Elements

Segregated According to Objects of Expenditure

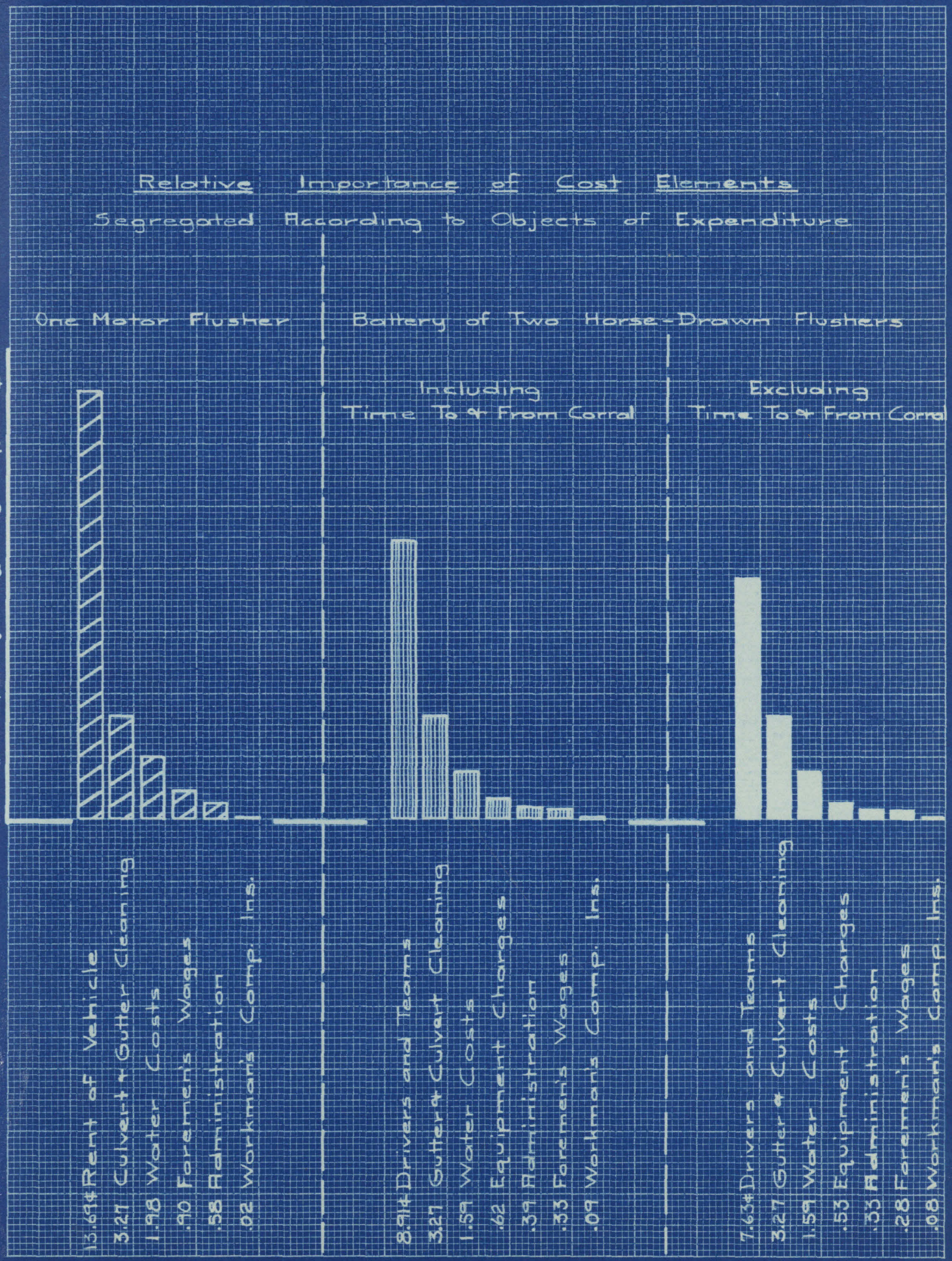


Chart No. 7

Table No. 7

RELATIVE IMPORTANCE OF COST ELEMENTS

Segregated According to Objects of Expenditure

- - - - - -

Motor-driven Flusher	Cost per 1000 sq.yds.flushed
Rent of Motor	13.69¢
Cleaning Gutters and Culverts	3.27¢
Water Costs	1.98¢
Foreman	.90¢
Administration	.58¢
Workmen's Compensation Insurance	.02¢
Total	20.44¢

Battery of Two Horse-drawn Flushers Inclusive of time to and from corral	Cost per 1000 sq.yds. flushed
Drivers and Teams	8.91¢
Gutter and Culvert Cleaning	3.27¢
Water Costs	1.59¢
Equipment Charges	.62¢
Administration	.39¢
Foremen	.33¢
Workmen's Compensation Insurance	.09¢
Total	15.20¢

Battery of Two Horse-drawn Flushers Exclusive of time to and from corral	Cost per 1000 sq.yds. flushed
Drivers and Teams	7.63¢
Cleaning Gutters and Culverts	3.27¢
Water Costs	1.59¢
Equipment Charges	.53¢
Administration	.33¢
Foremen	.28¢
Workmen's Compensation Insurance	.08¢
Total	13.71¢

(Above figures based on Tables Nos. 9, 10, and 11, pages 65-66)

COST TABLES

Following are some tables giving detailed costs for each type of flusher for each route tested and for the total of all routes tested; also a table showing detailed cost to the city of "vacuum" cleaning.

TABLE NO. 8

SUMMARY OF COSTS

	Cost per 1000 square yards Flushed				
	Route I	Route II	Route III	Route IV	All Routes
Motor-driven Flusher	18.30¢	30.40¢	19.70¢	18.60¢	20.44¢
Battery of Two Horse-drawn Flushers (eliminating cost of time to and from Corral)	12.10¢	14.20¢	15.20¢	13.72¢	13.71¢
Battery of Two Horse-drawn Flushers (including cost of time to and from Corral)	14.18¢	15.40¢	16.25¢	15.15¢	15.20¢

Estimated cost to the city of vacuum cleaning = 11.65¢ per 1000 sq. yds. cleaned.

(Table 8 is a summary of Tables 9, 10, 11 and 12 immediately following)

TABLE NO. 9

Cost of Wagon Flushing During Test Peridd
(Exclusive of Traveling Time to and from Corral)

	Route I	II	III	IV	Total
Teams (@ $10.00 per 8 hrs.)	$8.150	$6.630	$9.370	$9.180	$33.330
Foreman (@ $.37 per 8 hrs.)	.300	.244	.346	.340	1.230
Maintenance of Equipment(@ $.36 per 8 hrs)	.293	.238	.338	.331	1.200
Depreciation of Interest(@ $.34 per 8 hrs)	.275	.225	.318	.312	1.130
Water (@ $.0421 per 1000 gals.)	1.610	1.352	2.088	1.620	6.670
Workmen's Compensation Insurance(1.857%)	.086	.070	.098	.096	.350
Administration (4%)	.417	.341	.490	.462	1.710
Culvert and Catch Basin Cleaning (@ $.0124 per 1000 sq.yds.)	1.562	1.033	1.355	1.460	5.410
Sweeping of Gutter Deposits (@ $.0203 per 1000 sq.yds.)	2.560	1.690	2.220	2.390	8.860
Total Cost	$15.253	$11.823	$16.623	$16.191	$59.89
Cost per 1000 sq.yds. flushed	12.10¢	14.20¢	15.20¢	13.72¢	13.71¢

(Method of calculating above table given on pages 124-127)

TABLE NO. 10

Cost of Wagon Flushing During Test Period

(Inclusive of Traveling Time to and from Corral)

Route -	I	II	III	IV	Total
Teams (@ $10.00 per 8 hrs.)	$10.400	$7.510	$10.360	$10.630	$38.900
Foreman (@ $.37 per 8 hrs.)	.386	.278	.384	.392	1.440
Maintenance of Equipment (@ $.36 per 8 hrs.)	.375	.270	.373	.382	1.400
Depreciation & Interest (@ $.34 per 8 hrs.)	.354	.254	.352	.360	1.320
Water (@ $.0421 per 1000 gals.)	1.610	1.352	2.088	1.620	6.670
Workmen's Compensation Insurance (1.857%)	.109	.080	.109	.112	.410
Administration (4%)	.514	.380	.532	.524	1.950
Culvert and Catch Basin Cleaning (@ $.0124 per 1000 sq.yds.) . . .	1.562	1.033	1.355	1.460	5.410
Sweeping of Gutters (@ $.0203 per 1000 sq.yds.)	2.560	1.690	2.220	2.390	8.860
Total Cost	$17.870	$12.847	$17.773	$17.870	$66.360
Cost per 1000 sq.yds. flushed	14.18¢	15.40¢	16.25¢	15.15¢	15.20¢

(Method of calculating above table given on pages 124-127)

TABLE NO. 11

Cost of Motor Flushing During Test Period

Motor (@ $14.71 per 8 hrs.)	$15.100	$12.300	$14.250	$14.400	$56.050
Foreman (@ $.96 per 8 hrs.)	.987	.803	.930	.940	3.660
Water (@ $.0421 per 1000 gals.)	2.230	1.512	2.088	1.970	7.800
Workmen's Compensation Insurance (1.857%)	.019	.016	.018	.017	.070
Administration (4%)	.732	.584	.692	.692	2.700
Culvert and Catch Basin Cleaning (@ $.0124 per 1000 sq.yds.)	1.562	.696	1.355	1.467	5.080
Sweeping of Gutter Deposits (@ $.0203 per 1000 sq.yds.)	2.560	1.140	2.220	2.390	8.310
Total	$23.190	$17.051	$21.553	$21.876	$83.670
Cost per 1000 sq.yds. flushed	18.30¢	30.40¢	19.70¢	18.60¢	20.44¢

(Method of calculating Table No. 11 given on pages 124-127)

TABLE NO. 12

Estimated Cost to the City of Vacuum Cleaning

Item	Cost per 1000 sq. yds. Cleaned
Contract Price	10.50¢
Foremen's Wages	.69¢
Workmen's Compensation Insurance	.01¢
Administration	.45¢
Total	11.65¢

(Detailed calculations for Table No. 12 given on pages 128-133)

Some Comparison of Costs Figured on Various Bases

In Table No. 13, following, three groups of costs are compared

Group 1 consists of those items used by the Board of Public Works in its report on horse-drawn flushing costs in February, 1916. These items are "teams and drivers," "foremen," "maintenance of equipment," and "depreciation and interest." Their report also included an item for "broom men" which is not included here because the use of broom men in connection with flushing has been discontinued.

Group 2 consists of the items of cost which the Efficiency Department considers as applicable to flushing. These items are all of those given above in Group 1 plus "water costs," "workmen's compensation insurance," "administration," and that part of "culvert cleaning" and "gutter sweeping" which is caused by flushing.

Group 3 consists of those items which should be considered in comparing the cost of flushing to any bid for machine cleaning based on a price per 1000 square yards cleaned. These items are the same as those in Group 2 except supervision and administration, which items would also apply to machine cleaning but would not be included in bids.

(For methods of calculating figures in Table 13, see pages 124-127)

Table 13

Item	Battery of 2 Horse-drawn Flushers			
	Performance of Feb. 1916, as given by B.P.W. Report	Performance During the Present Test		Performance of One Motor-driven Flusher During the Present Test
		Including Time to and from Corral	Excluding Time to and from Corral	
Cost per 8-hr. day of items in Group 1 above (Items used by B.P.W.)	$11.08	$11.07	$11.07	$15.67
Cost per 8-hr. day of items in Group 2 above (Items used by Efficiency Dept.) . . .	$15.21	$17.06	$17.98	$21.96
Area flushed per 8-hr. day (sq.yds.)	64,866	112,226	131,129	107,450
Gals. of water per M sq.yds. flushed, Estimating 500 gals. per load	518.4 gals.	--	--	--
Estimating on the basis of the present test (gallons)	435.5	362.8	362.8	452.3
Cost of Group 1 per M sq.yds.flushed (Items used by B.P.W.)	17.60¢	9.86¢	8.44¢	14.59¢
Cost of Group 2 per M sq.yds.flushed (Items used by Eff. Dept.)	23.44¢	15.20¢	13.71¢	20.44¢
Cost of Group 3 per M sq.yds. flushed (Items comparable to bids for machine cleaning)	22.10¢*	14.42¢*	13.04¢*	18.86¢*

* These costs are made up as follows:

	2-wagon Battery			Motor
	February	Test includ.trav.	Test-Start on Route	Test-Start on Route
Teams or Motor	15.42¢	8.91¢	7.63¢	13.69¢
Maintenance	.55¢	.32¢	.27¢	--
Depreciation and Interest	.52¢	.30¢	.26¢	--
Water - at cost of produc.	2.18¢	1.53¢	1.53¢	1.90¢
Workmen's Compensation Insurance	.16¢	.09¢	.08¢	--
Culvert Cleaning	1.24¢	1.24¢	1.24¢	1.24¢
Sweeping Gutter Deposits	2.03¢	2.03¢	2.03¢	2.03¢
	22.10¢	14.42¢	13.04¢	18.86¢

Average - 13.73¢

DETAILS OF QUANTITATIVE DUST TESTS

In the following sheets are given the details of all dust tests made. In no case did the drivers of any of the flushers or of the vacuum cleaner know that any dust tests were being made, or that any particular part of the route was being especially considered by the observers.

Detailed figures for all of the charts given in this section will be found in Table 27, pages 148-151.

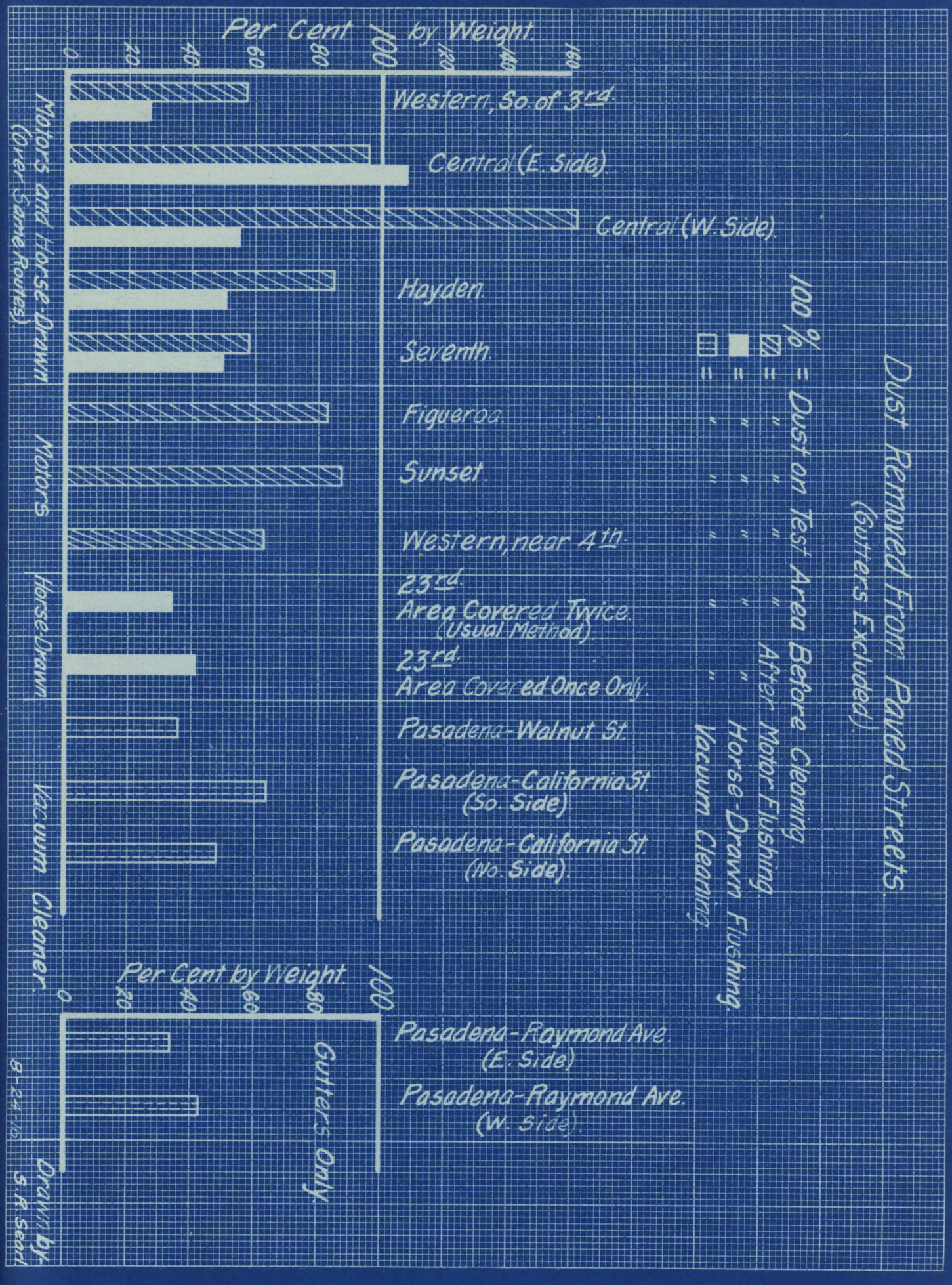


Chart No. 8
Dust Removed From Paved Streets.
(Gutters Excluded)
100 % = Dust on Test Area Before Cleaning.
" = " " " After Motor Flushing.
" = " " " Horse-Drawn Flushing.
" = " " " Vacuum Cleaning.
Per Cent by Weight.
0 20 40 60 80 100 120 140 160
Motors and Horse-Drawn (Over Same Routes)
Motors
Horse-Drawn
Vacuum Cleaner
Western, So. of 3rd.
Central (E. Side).
Central (W. Side).
Hayden.
Seventh.
Figueroa.
Sunset.
Western, near 4th.
23rd.
Area Covered Twice. (Usual Method).
23rd.
Area Covered Once Only.
Pasadena - Walnut St.
Pasadena - California St. (So. Side).
Pasadena - California St. (No. Side).
Per Cent by Weight.
0 20 40 60 80 100
Gutters Only.
Pasadena - Raymond Ave. (E. Side)
Pasadena - Raymond Ave. (W. Side).
8-24-16
Drawn by
S. R. Seaver

CHART NO. 8

Amount of Dust Removed from Paved Streets (Gutters Excluded)

Chart No. 8 summarizes the results of the tests to determine the amount of dust on the surface of the street before and after cleaning. There were five separate tests made for dust over areas cleaned by both motor-driven flushers and a battery of horse-drawn flushers. These are shown grouped together in the chart under the heading "Motors and Horse-Drawn over Same Routes." Three of these tests - Western, south of 3rd, Hayden St., and Seventh St. - show the motor-driven flusher to have removed a smaller percentage of dust than the battery of horse-drawn flushers removed. The two remaining tests on opposite sides of Central Ave. gave results which showed on one side a greater amount of dust on the area after horse-drawn flushing than before flushing; and on the other side a greater amount of dust on the area after motor-driven flushing than before flushing. These results are apparently unreasonable, but not necessarily so. Central Ave. is very heavily traveled in the early morning hours by horse-drawn vehicles. It is quite possible that dust and dirt on the wheels of these vehicles may have been loosened by the still wet pavement. The apparently muddy track of any vehicle passing over a freshly-flushed asphalt pavement is well known. Another possibility which would be evidenced in the same manner is that dirt ground into the pavement by traffic during the week may have been loosened, but not removed, by the flushing, and then further loosened by traffic after flushing. In any case, the test proves that the pavement was not free of dust immediately after flushing.

In the final consideration of the tests those which showed more dust on the area after flushing than before were neglected. Since such tests occurred for both types of flushing, no injustice was done by neglecting them.

On Figueroa St., on Sunset Blvd., and on Western Ave. near 4th, dust tests were made before and after flushing by motor-driven flusher. The results of these are grouped in the chart under the title of "Motors." In general, they check the results obtained elsewhere for the motor-driven flusher. Note the close agreement between the two tests on Western Avenue.

On 23rd St. the same area was tested twice for the results of horse-drawn flushing. The first time the section was flushed in the usual way; that is, two wagons were used and the area of the street was flushed by first one wagon and then the other. In other words, water from the flushers flowed over the area twice. In the second test the area was covered once only by one wagon. One side of the street was flushed with the nozzle in the usual position, the water being discharged under pressure. The other side of the street was flushed with the nozzle turned up so that the street received not a "cutting" swath of water, but only a heavy "washing" swath. The results of the test are shown in the chart under the title "Horse-Drawn." It is interesting to note that almost as much dust was removed by the single wagon as was removed by the battery of two wagons covering the area twice in the usual way. It is well to note here, however, that 23rd St. at the point selected for the test is a narrow street (36 feet from curb to curb)

and that the asphalt is very smooth.

Three tests were made for dust on the streets of Pasadena before and after vacuum cleaning. The first of these was on Walnut St., which has a smooth, rather soft oiled surface. The other two were made on opposite sides of California St., which is paved with asphalt and is in fair condition. The results of the test are grouped in the chart under the heading "Vacuum Cleaner."

Because the vacuum cleaner travels very close to the curb and is designed to clean gutters as well as street surfaces, two tests were made of gutter cleaning. These tests were made on Raymond Ave. at a point where the gutters were made of cement and were very smooth. The results of the test, shown in the chart under the heading of "Gutters Only," show that from 57% to 66% of the dust in the gutter was removed. These results, of course, are not to be considered as invariable, since a great deal depends upon the distribution of the dust in the gutter. If much of the dust lies very close to the curb where the suction head of the cleaner does not have full effect, the percentage of cleaning will be lower than if the dust is evenly distributed over the gutter. In these gutter tests a large percentage of the dust appeared to be very close to the curb.

Table No. 14 (Basis of Chart No. 8)

SUMMARY OF QUANTITATIVE RESULTS OF DUST TESTS

Flushers

Street (exclusive of gutters)	% (by wt.) of Dust Remaining on Area after Flushing	
	One Motor-driven Flusher	Battery of Two Horse-drawn Flushers
23rd Street	(No test made)	33.5%
Western Ave., near 3rd (west side)	---	24.5%
Western Ave., near 3rd (east side)	---	30.8%
Western Ave. (total of both sides)	57.0%	26.4%
Central Ave. (west side)	(Test unsatisfactory)	55.2%
Central Ave. (east side)	96.4%	(Test unsatisfactory)
East 1st St. (north side)	(Test unsatisfactory)	(No test made)
East 1st St. (south side)	" "	" " "
Hayden Street	85.0%	51.5%
7th Street	58.3%	49.2%
Figueroa	83.4%	(No test made)
Sunset	87.7%	" " "
Western (near 4th)	62.9%	" " "

Vacuum Cleaner (in Pasadena)

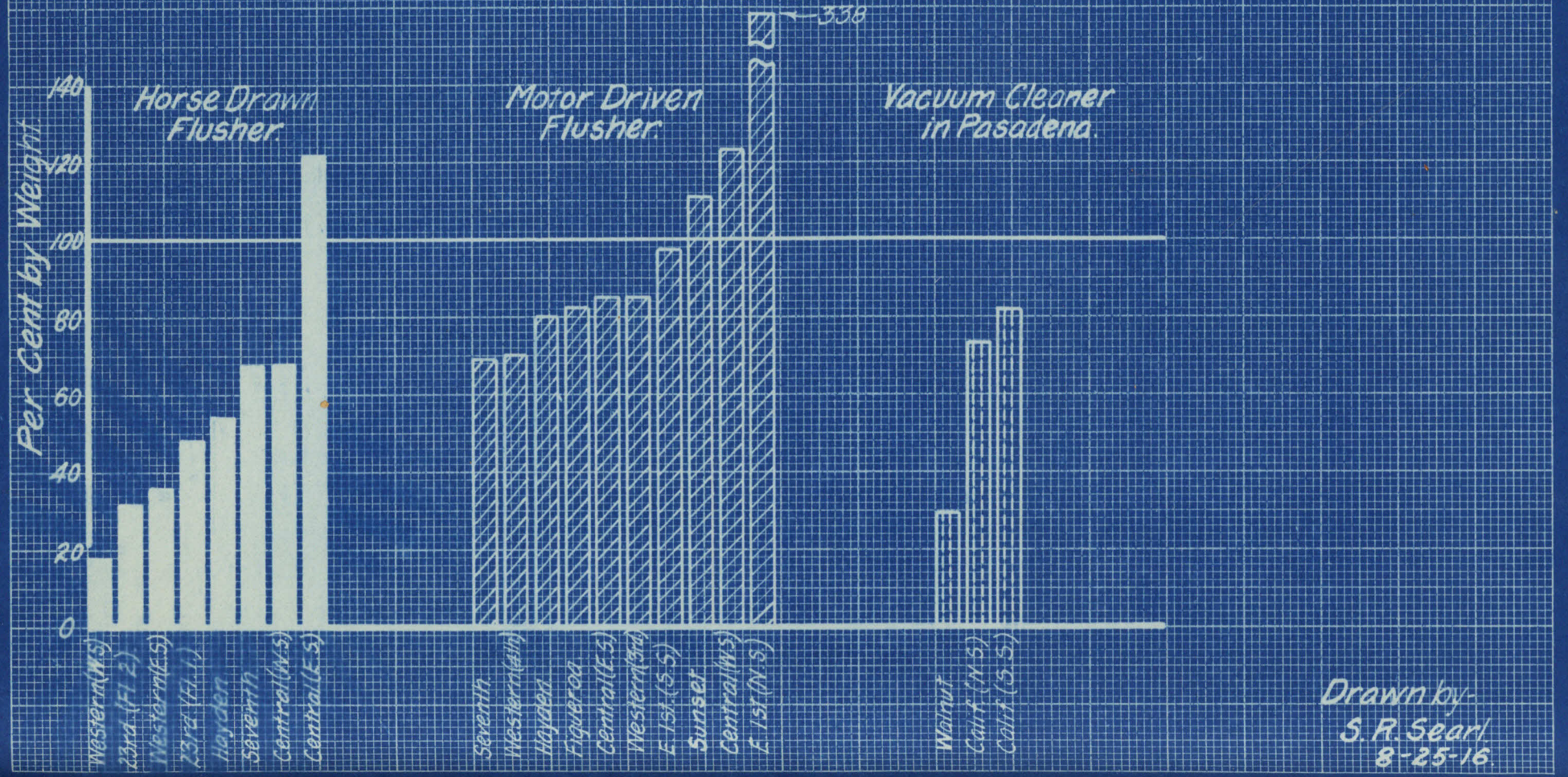
Street (Pasadena)	% (by wt.) of Dust Remaining after Vacuum Cleaning
Walnut (exclusive of gutters)	36.3%
South side of California (exclusive of gutters)	63.6%
North side " " " " "	48.2%
West side of Raymond (gutters only)	43.1%
East side " " " "	34.4%

(For details of above figures, see Table No. 27, pages 148-151)

Dust Passing the 200 Mesh Screen.

Percentage Remaining After Cleaning.

100% = Dust on Test Area Before Flushing.
☑ = " " " " After Motor Flushing.
■ = " " " " " Horse Drawn Flushing.
⊞ = " " " " " Vacuum Cleaning.



Drawn by-
S. R. Searl
8-25-16.

Chart No. 8

CHART NO. 9

Dust Passing the 200-Mesh Screen. Percentage Remaining After Cleaning

Because it is generally considered that it is the very fine dust which is objectionable, because it is driven into the air by traffic and supposedly contains more or less bacteria, it was important to learn just how much of this fine dust was removed by each type of cleaner. A study was made of the total weight of dust passing a 200-mesh screen on the pavement before and after cleaning. The results of this study are summarized in Chart No. 9. The results for each type of cleaner studied are grouped together. The chart shows that by none of the cleaning methods was all of the fine dust removed. The percentage of fine dust removed was approximately the same as the percentage of total dust removed in each case.

In removing very fine dust, the horse-drawn flusher was superior to the motor-driven flusher. The vacuum cleaner seemed to rank between the two. However, the small number of tests for vacuum cleaning, and the fact of their being made outside of Los Angeles, should be remembered.

In considering this chart, the results on the east side of Central avenue for the horse-drawn flusher, and for the motor-driven flusher the results on East First street and on Central avenue, should be neglected, as these are the tests in which more dust was found on the pavement after flushing than before.

Dust Passing the 200-mesh Screen

Percentage Remaining after Cleaning

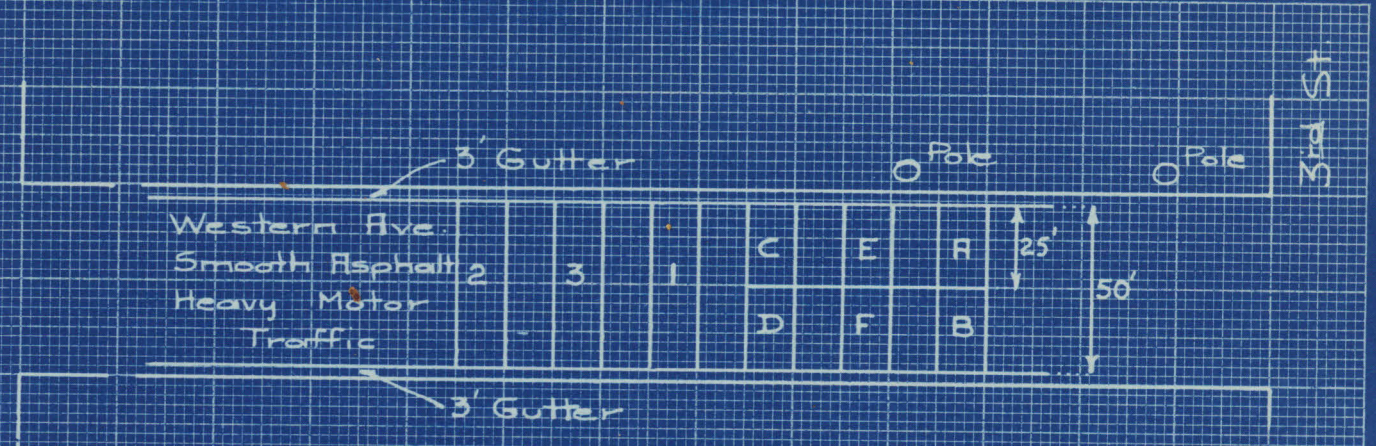
Location of Test Area	Vehicle	% by wt. of Dust passing #200 Screen remaining after cleaning
Western Ave. (W.S.)	Battery of 2 Horse-drawn Flushers	18.0%
23rd St.	" " " " "	32.0%
Western Ave. (E.S.)	" " " " "	36.0%
23rd St.	One Horse-drawn Flusher	48.5%
Hayden St.	Battery of 2 Horse-drawn Flushers	54.2%
Seventh St.	" " " " "	67.8%
Central Ave. (W.S.)	" " " " "	68.0%
" " (E.S.)	" " " " "	122.0% *
Average	" " " " "	46.3%
Seventh St.	One Motor-driven Flusher	69.0%
Western Ave. (near 4th)	" " " "	70.5%
Hayden	" " " "	80.0%
Figueroa St.	" " " "	82.0%
Central Ave. (E.S.)	" " " "	85.0%
Western Ave. (near 3rd)	" " " "	85.0%
East 1st St. (S.S.)	" " " "	97.5% *
Sunset Blvd.	" " " "	111.0% *
Central Ave. (W.S.)	" " " "	123.0% *
East 1st St. (N.S.)	" " " "	338.0% *
Average	" " " "	75.0%
Walnut St., Pasadena	Vacuum Cleaner	29.5%
California St. (N.S.) Pasadena	" "	73.5%
" " (S.S.) "	" "	82.0%
Average	" "	62.0%

* Neglected in Average.

Table No. 15 (Basis of Chart No. 9)

(All necessary data for calculating the above table is given in Table No. 27, pages 148-151)

DUST TESTS ON WESTERN AVENUE



Sections A, B, C, D, E, and F, each - 10' x 25'

Sections 1, 2, and 3 - 10' x 50'

August 1 - Sections A, B, C, and D were swept before horse-drawn flushing.

A - 26.75 gr.
B - 11.35 gr.
C - 25.05 gr.
D - 9.40 gr.

August 2 - Sections E and F were swept after horse-drawn flushing.

E - 6.6 gr.
F - 3.2 gr.

August 8 - Sections AB, CD, 1, and 2 were swept before motor-flushing.

AB - 35.60 gr.
CD - 33.70 gr.
#1 - 30.05 gr.
#2 - 32.85 gr.

August 9 - Sections EF and 3 were swept after motor-flushing.

EF - 19.75 gr.
#3 - 22.30 gr.

(Note - Sections 1, 2, and 3 were swept as a check on the lettered sections, because it was thought that the thorough cleaning received by the lettered sections in the test of the previous week might affect the total amount of dust on them.)

% Dust Remaining after Motor-Driven Flushing - 60.0% approximately

% " " " Horse-Drawn " - 26.4%

Chart No. 10

Chart No. 11

Amount of Dust Removed (Gutters Excluded) from the Surface of Western Avenue. Sections AB, CD, EF.

Chart No. 11 shows the total weight of dust on the test section before and after flushing by a motor-driven flusher and by a battery of horse-drawn flushers. It also shows the same quantities in per cent, considering the dust on the area before flushing as 100%.

This test gave good results, as all conditions were normal. The total amount of dust on the area before motor-driven flushing was approximately the same as that on the area before horse-drawn flushing. The test showed the motor-driven flusher to have removed approximately 43% of the dust from the area, and the battery of horse-drawn flushers to have removed approximately 73%.

Chart No. 12

Effect of Flushing on Dust Composition

The results of screening tests are shown in Chart No. 12.

The dust remaining after motor-driven flushing shows a slightly decreased percentage of material remaining on screens No. 10, No. 20, No. 30, No. 40, and No. 50, and a slightly increased percentage of material remaining on No. 200 and passing No. 200.

After flushing by horse-drawn battery, the dust remaining contained a slightly decreased percentage of material retained on screens No. 10, No. 20, No. 30, and No. 40. It contained a slightly increased percentage of material retained on No. 80 and No. 200. The percentage of material retained on screens No. 50, No. 100, and passing No. 200 was practically the same before and after flushing by the battery of horse-drawn flushers.

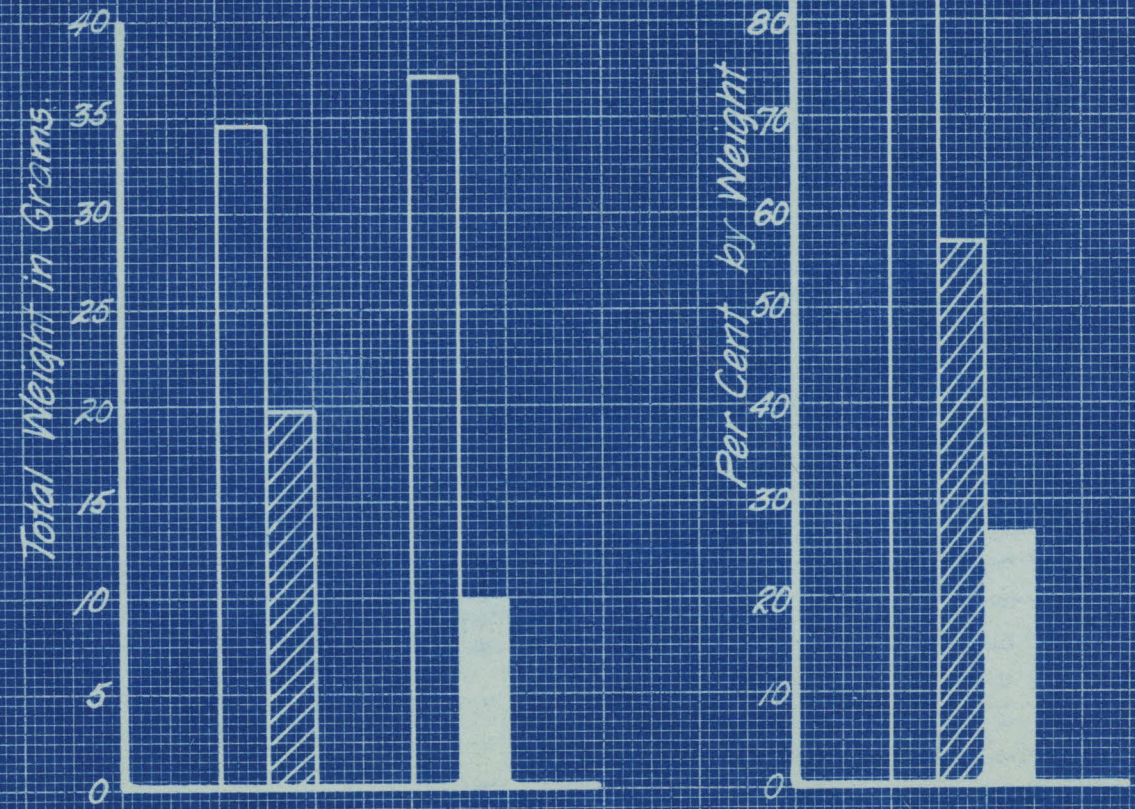
Considering the liability of its being driven into the air by traffic, the dust was of practically the same composition before and after flushing by either type of flusher.

Flushing on Paved Streets.

Amount of Dust Removed.
(Gutters Excluded)

Western Ave. - South of 3rd Street
(Sections AB, CD, and EF.)

Dust on Area Before Flushing.
" " " " After Motor Flushing.
" " " " Horse Drawn Flushing.



Drawn by-
S. R. Seoril
8-21-16.

Chart No. 11.

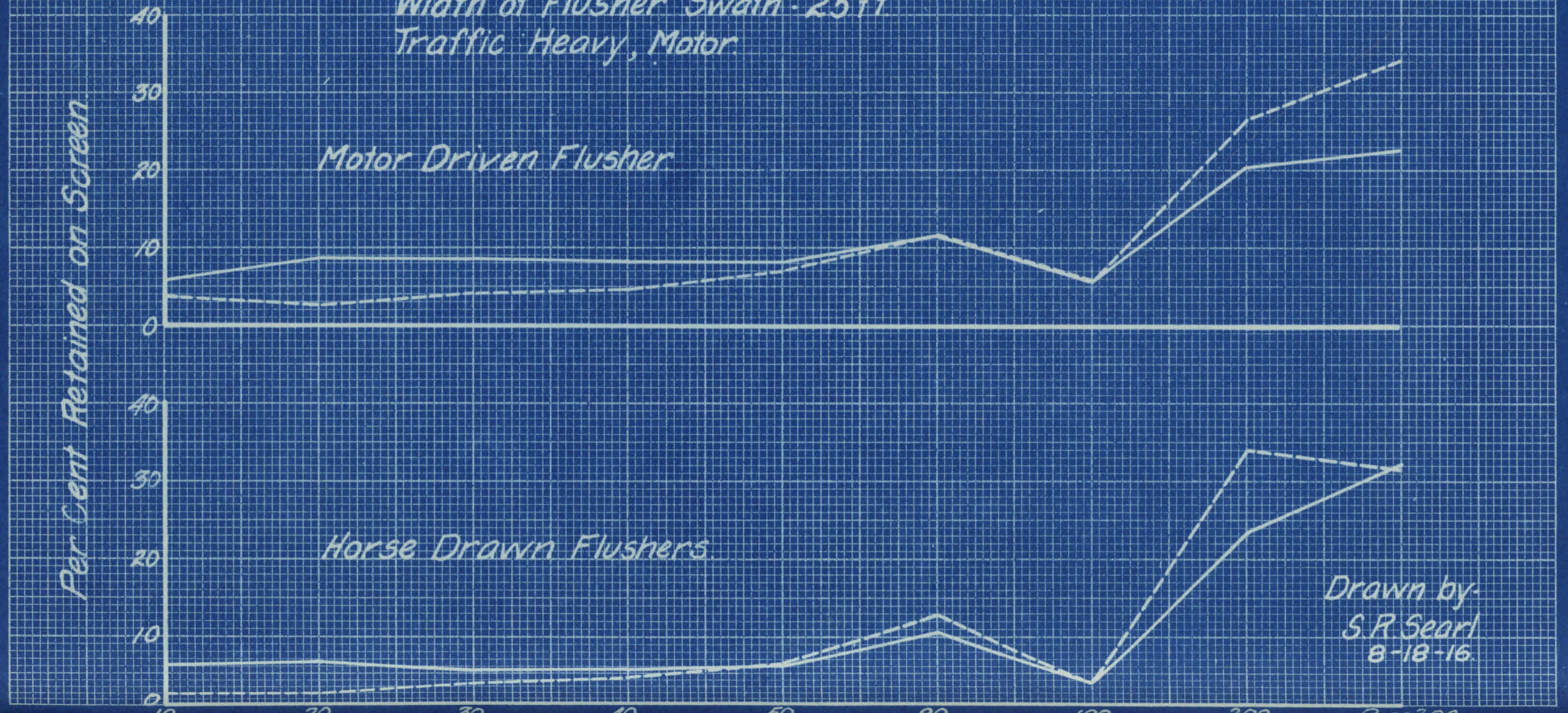
Screening Test of Dust on Paved Streets

Before and After Flushing
(Gutters Excluded)

Western Ave. - South of 3rd Street.

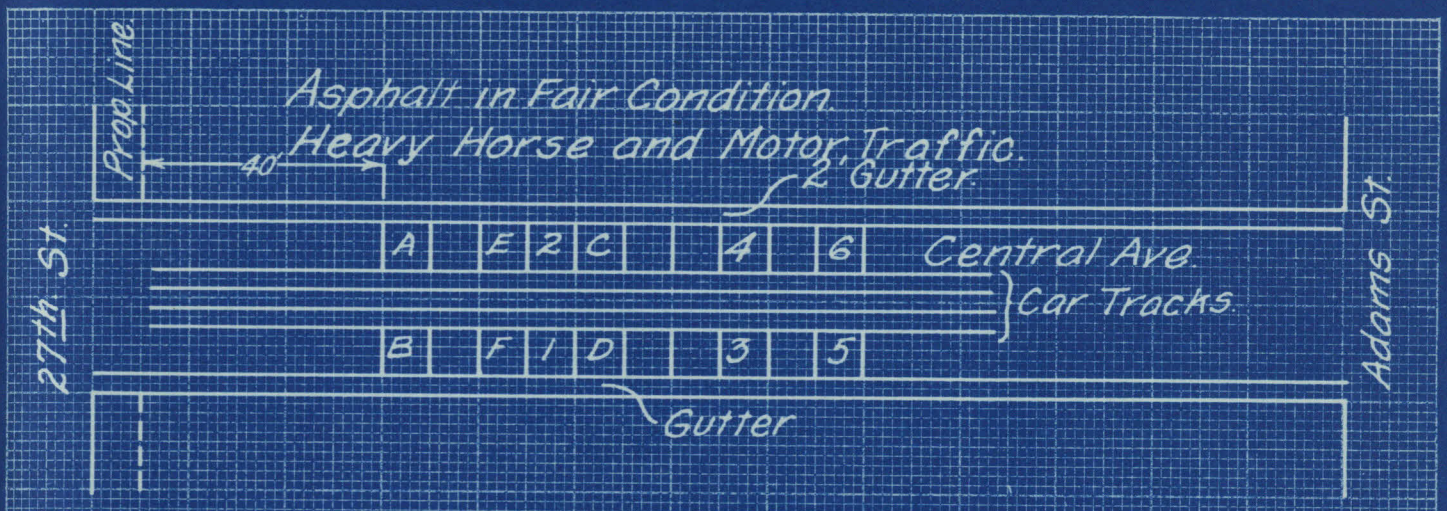
——Before Flushing.
- - - - -After Flushing.

Pavement: Asphalt.
Condition: Smooth.
Width of Flusher Swath: 25 ft.
Traffic: Heavy, Motor.



Drawn by:
S.R. Searl
8-18-16.

DUST TESTS ON CENTRAL AVENUE



Each section - 10' x 17½'

August 2 - Sections A, B, C, and D swept before horse-drawn flushing.

A - 80.60 gr.
B - 57.90 gr.
C - 60.77 gr.
D - 47.52 gr.

August 3 - Sections E and F swept after horse-drawn flushing.

E - 36.25 gr.
F - 57.00 gr.

Some fresh manure had been deposited on F and on section between B and F. This was cleaned off as carefully as possible before sweeping for dust. No fresh manure has been deposited on or near E.

August 9 - Sections 1, 2, 3, and 4 were cleaned before motor-driven flushing. These were the nearest sections free from manure.

#1 - 56.70 gr.
#2 - 48.65 gr.
#3 - 65.25 gr.
#4 - 53.45 gr.

August 10 - Sections 5 and 6 were cleaned after flushing. They were the nearest sections free from manure.

#5 - 57.30 gr.
#6 - 82.35 gr.

% Dust on Pavement after Motor-Driven Flushing - 96.4% and 161%

% " " " " Horse-Drawn " - 55.2% and 108%

Chart No. 13.

Chart No. 14

Amount of Dust Removed (Gutters Excluded) on Central Avenue East Side of Street, by Motor-Driven Flusher and by Battery of Horse-Drawn Flushers

Chart No. 14 shows the total weight of dust on the test area before and after flushing by a motor-driven flusher and by a horse-drawn battery. It also shows the same quantities expressed in per cent, 100% being taken as the amount of dust on the area before flushing.

It will be noted here that the motor-driven flusher removed a very small percentage of the dust on the test area, and that there was more dust on the area after flushing by the horse-drawn battery than before. The result for the horse-drawn flushing is apparently unreasonable, but is not necessarily so. Central Avenue is a heavily traveled street and enough dust may have been brought onto the section by traffic after the flushing to give this result. A great many peddler wagons use Central Avenue very early in the morning when the street would be still wet. Another possibility is that the water from flushing served to loosen, but not remove, dirt which had been ground into the pavement by traffic. After flushing, this dirt may have been further loosened by the early morning traffic. The apparently muddy track left by a vehicle when traveling over a freshly flushed asphalt surface is well known. Whatever the cause, the test at least shows that flushing does not completely clean the street. In drawing conclusions concerning the ability of flushers to remove dust from the surface of the street, this test for horse-drawn flushers was neglected. Similar results for motor flushers were neglected.

Chart No. 15

Effect of Flushing on the Composition of the Dust

The results of screening tests are shown in Chart No. 15.

After flushing by a horse-drawn battery, the dust remaining contained a slightly higher percentage of material retained on screen No. 200 and passing No. 200; and a slightly lower percentage of material retained on screens No. 10, No. 20, No. 30, No. 40, and No. 50. After flushing by motor-driven flusher, the dust showed a slight increase in percentage by weight remaining on No. 40, No. 50, No. 80, and No. 200; and a slightly decreased percentage retained on No. 20 and passing No. 200.

Considering the liability of its being thrown into the air by traffic, there was practically no difference in the composition of the dust on the street before flushing and after flushing by either method.

Flushing on Paved Streets.

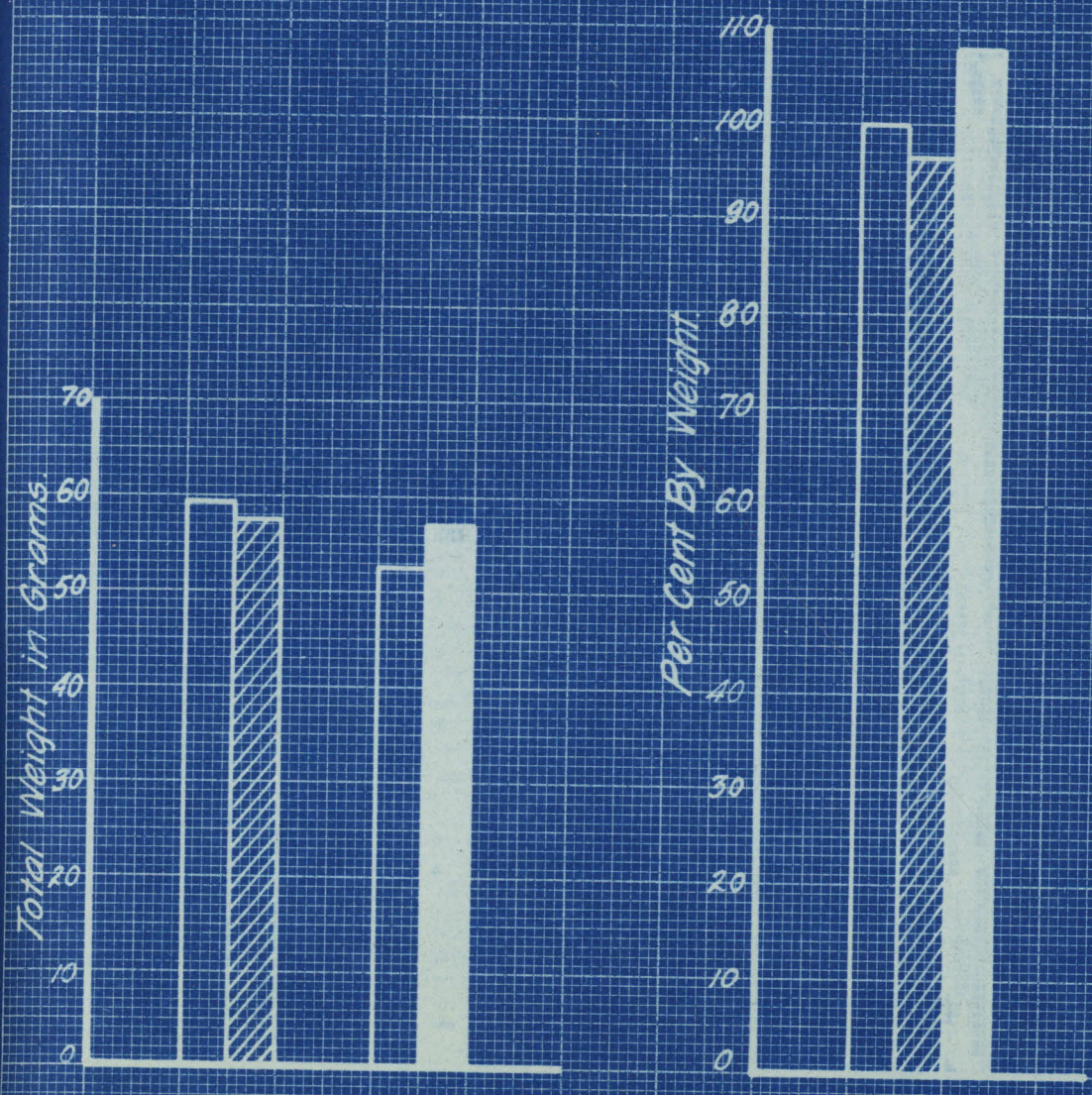
Amount of Dust Removed.

(Gutters Excluded).

Central Ave - North of 27th Street.

East Side of Street.

Dust on Area Before Flushing.
" " " After Motor Flushing.
" " " " Horse Drawn"



Drawn by-
S. R. Searl
8-21-16.

Chart No. 14.

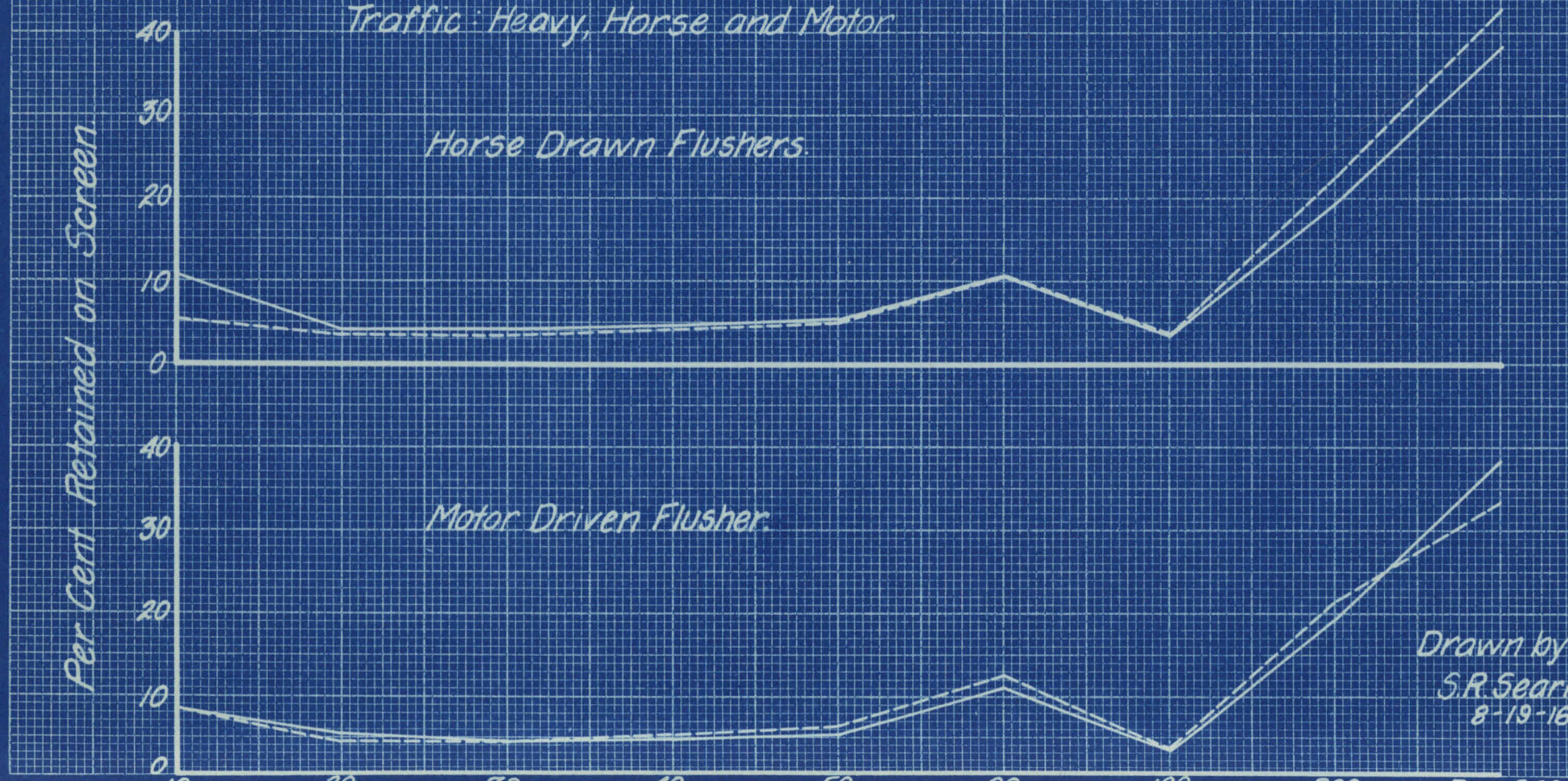
Screening Test of Dust on Paved Streets

Before and After Flushing.
(Gutters Excluded).

Central Ave. - North of 27th Street.
East Side of Street.

Pavement : Asphalt.
Condition : Fair.
Width of Flusher Swath : 17.5 ft.
Traffic : Heavy, Horse and Motor.

——— Before Flushing.
----- After Flushing.



Drawn by
S.R. Searl
8-19-16.

Chart No. 15.

Chart No. 16

Amount of Dust Removed (Gutters Excluded)

Central Avenue, West Side of Street

Chart No. 16 shows the total weight of dust on the test section before and after flushing by motor-driven flusher and by a battery of horse-drawn flushers. It also shows the same quantities in per cent, considering the dust on the area before flushing as 100%.

The test on this section gives poor results for the motor-driven flusher, showing more dust on the area after flushing than before. The remarks concerning similar results for horse-drawn flushers on the east side of Central Avenue apply here for the motor-driven flusher. (See page 65) In considering the motor-driven flusher as a dust remover, this result should be neglected.

The result for the horse-drawn flusher on this section is considered good, because during the horse-drawn test conditions on this side of the street were favorable for a good test, and the result was consistent with results obtained elsewhere. About 45% of the dust on the section was removed by horse-drawn flushing.

Chart No. 17

Effect of Flushing on Dust Composition

Chart No. 17 gives the results of the screening tests.

After horse-drawn flushing, the dust showed a slightly lower percentage retained on all screens up to and including No. 100. The percentage retained on No. 200 and passing No. 200 was slightly higher after flushing than before.

After motor-driven flushing, the dust showed a slightly higher percentage by weight retained on all screens and a lower percentage passing No. 200.

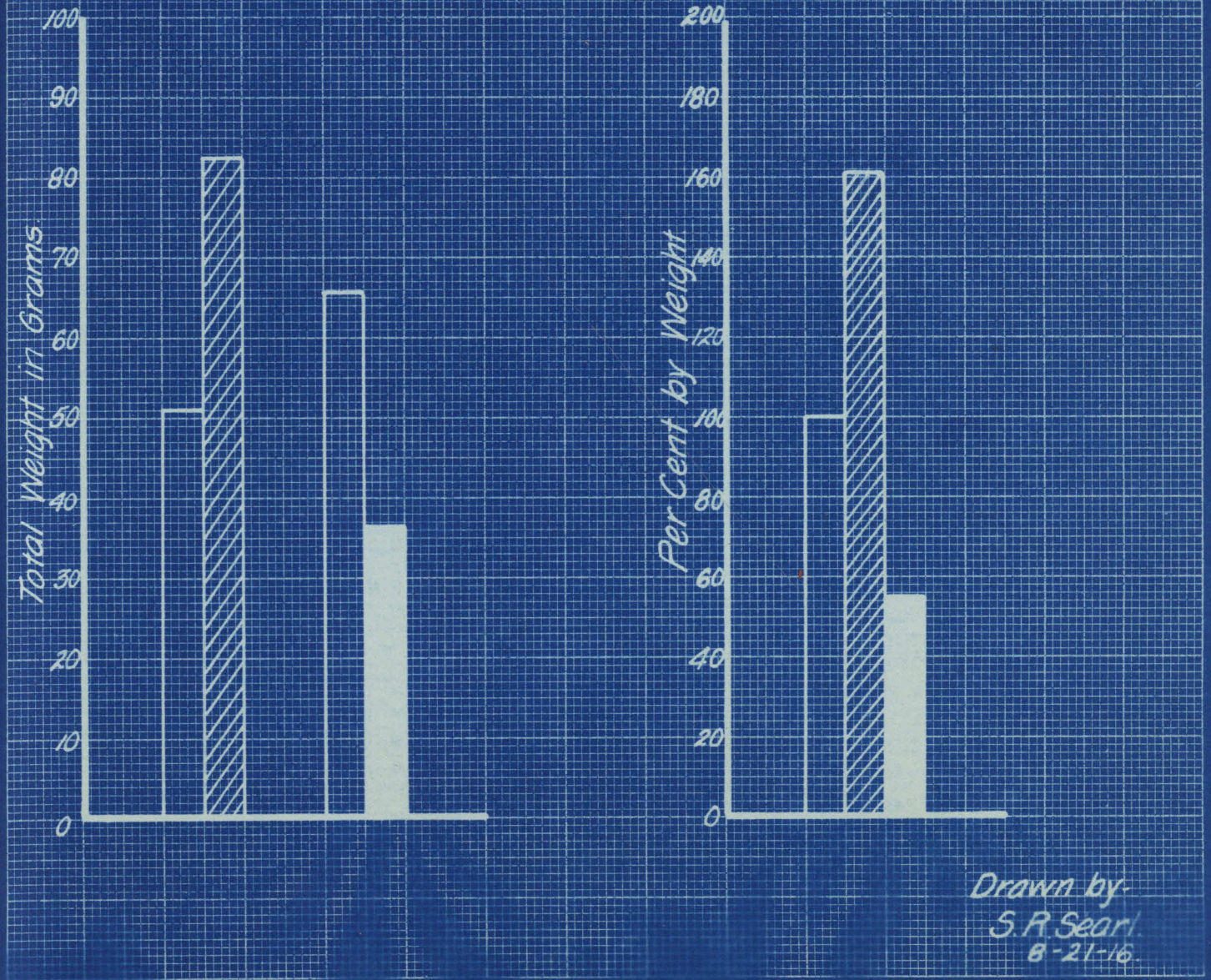
Considering the liability of its being thrown into the air by traffic, the dust remaining after flushing was practically of the same composition as that on the street before flushing.

Flushing on Paved Streets.

Amount of Dust Removed.
(Gutters Excluded).

Central Ave. - North of 27th Street.
West Side of Street.

Dust on Area Before Flushing.
" " " After Motor Flushing.
" " " " Horse Drawn Flushing.



Drawn by-
S.R Searl
8-21-16.

Chart No. 16.

Screening Test of Dust on Paved Streets

Before and After Flushing.

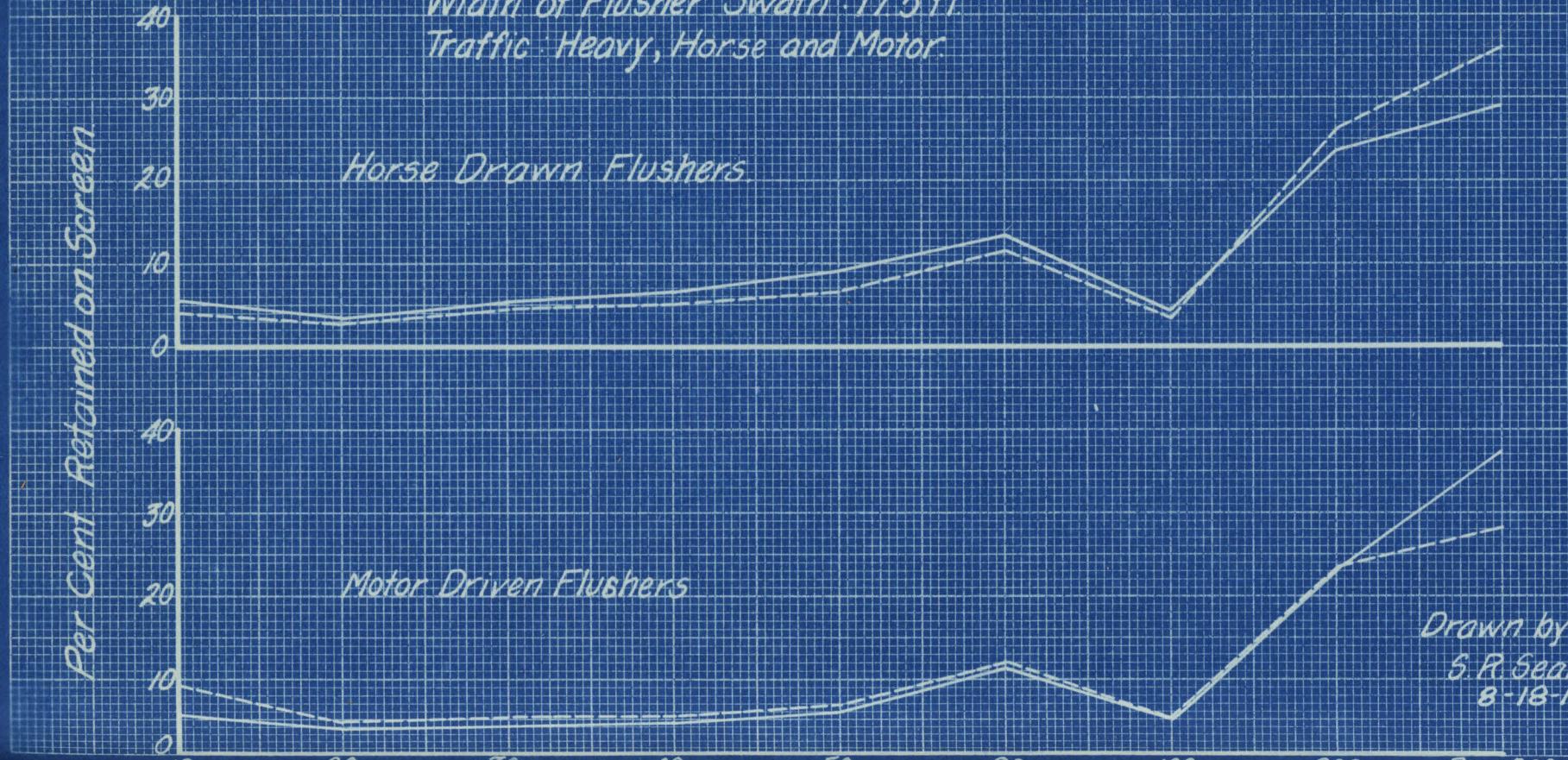
(Gutters Excluded)

Central Ave. - North of 27th Street.

West Side of Street.

Pavement : Asphalt.
Condition : Fair.
Width of Flusher Swath : 17.5 ft.
Traffic : Heavy, Horse and Motor.

——Before Flushing.
- - - -After Flushing.

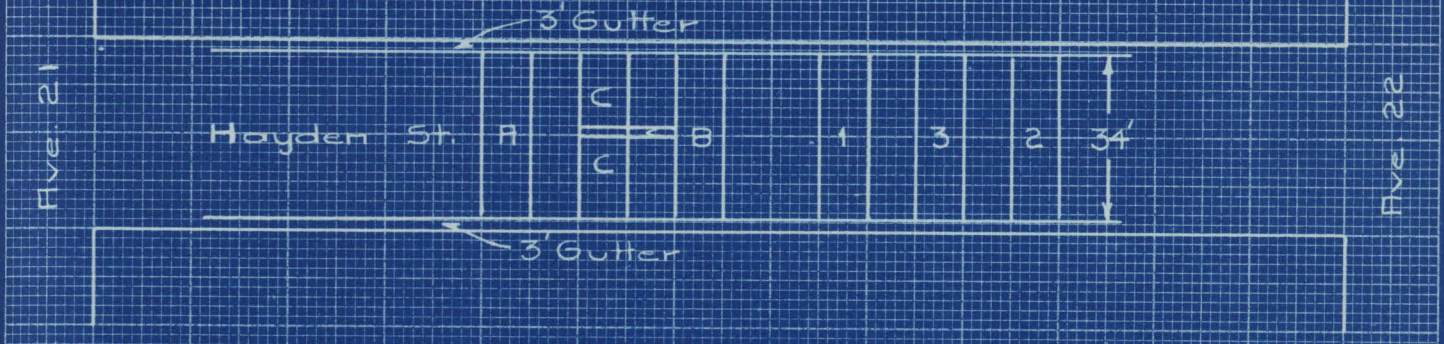


Drawn by
S. R. Beard
8-18-16.

Chart No. 17

DUST TEST ON HAYDEN STREET

Asphalt-Concrete in Good Condition
Very Light Traffic



Each section - 10' x 34'

August 4 - Sections A & B swept before horse-drawn flushing.

A - 172.47 gr.
B - 163.10 gr.

August 5 - Section C swept after horse-drawn flushing. A small part of C was still wet, and in its place a corresponding area in the next section was swept.

C - 86.25 gr.

August 10 - Sections 1 & 2 were swept before motor-driven flushing.

#1 - 128.70 gr.
#2 - 152.30 gr.

August 11 - Section 3 was swept after motor-driven flushing.

#3 - 119.20 gr.

(Sections A, B, & C were not used in the motor-driven flusher test because of fresh manure thereon.)

% Dust on Pavement after Motor-Driven Flushing - 85.0%

% " " " " Horse-Drawn " - 51.5%

Chart No. 18

Chart No. 19

Amount of Dust Removed from Test Section on Hayden Street by Motor Flusher and by Battery of Horse-drawn Flushers

Chart No. 19 shows total weight of dust on test area before flushing and after flushing; also the same quantities in per cent, using the dust on the area before flushing as 100%. The chart shows the battery of horse-drawn flushers to be appreciably superior in the matter of dust removal to the motor-driven flusher.

The conditions on Hayden Street were excellent for a comparative test. The total amount of dust on the area before flushing was approximately the same for the motor-driven and horse-drawn flushers. The chart shows that the horse-drawn battery removed approximately 48% of the dust and that the motor-driven flusher removed approximately 15% of the dust.

Chart No. 20

Effect of Flushing on Dust Composition

Chart No. 20 gives the results of screening tests.

After flushing by a battery of horse-drawn flushers, the dust remaining contained a slightly decreased percentage of material retained on screens No. 10, No. 20, No. 30, No. 40, and No. 50. There was a slightly increased percentage of material retained on screens No. 80, No. 100, No. 200, and passing No. 200.

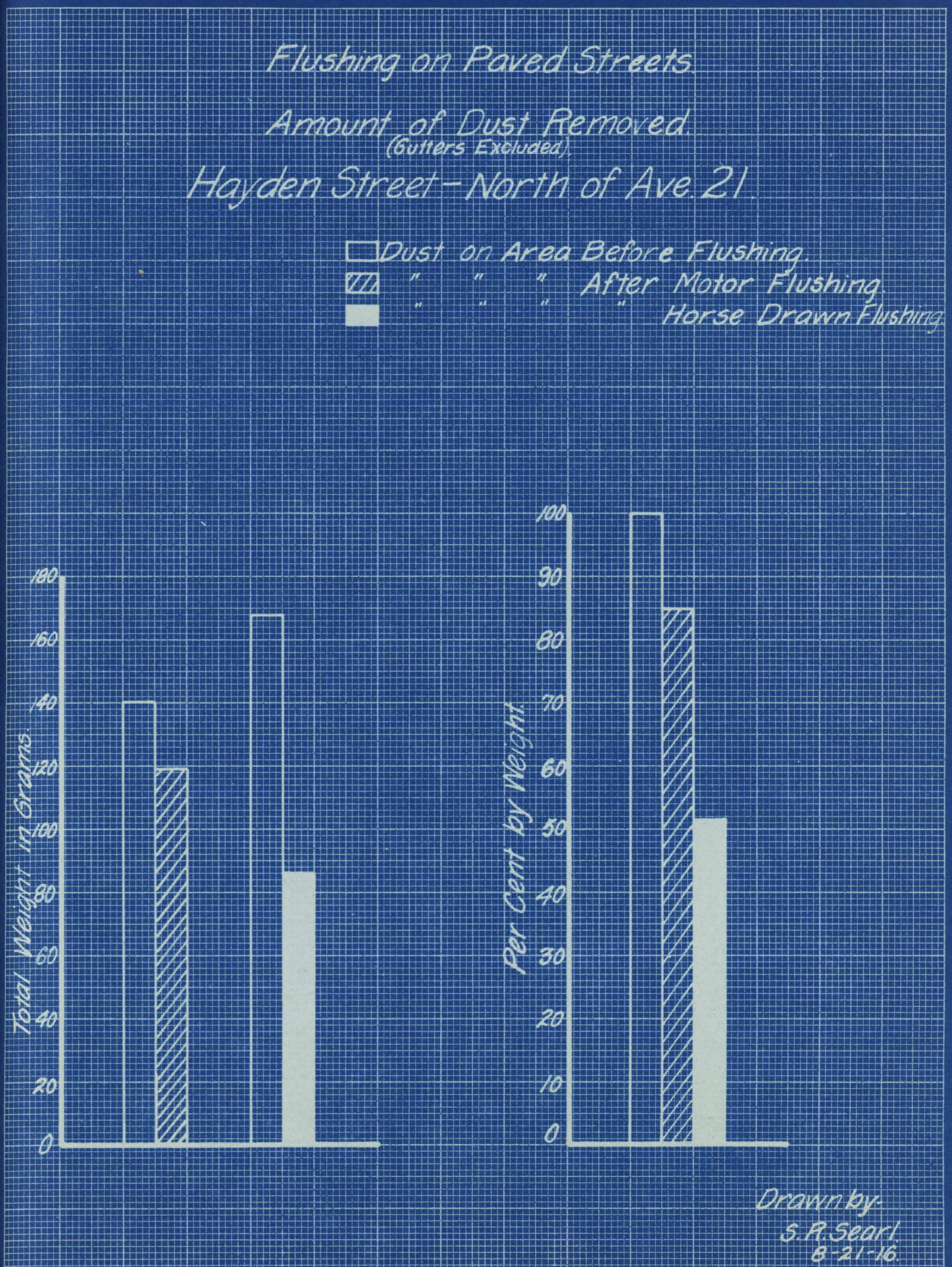
After motor-driven flushing, the dust remaining on the area showed a very slight decrease in the percentage of material retained on screens No. 20, No. 30, No. 40, and passing No. 200. There was a very slight increase in the percentage of material retained on screens No. 80, No. 100, and No. 200. The percentage of material retained on No. 10 and No. 50 was the same before and after motor-driven flushing.

Considering the liability of its being driven into the air by traffic, the dust on the street was of practically the same composition before and after flushing by either type of flusher.

Flushing on Paved Streets.

Amount of Dust Removed.
(Gutters Excluded).

Hayden Street - North of Ave. 21.



Drawn by.
S. R. Searl.
8-21-16.

Chart No. 19.

Part 20

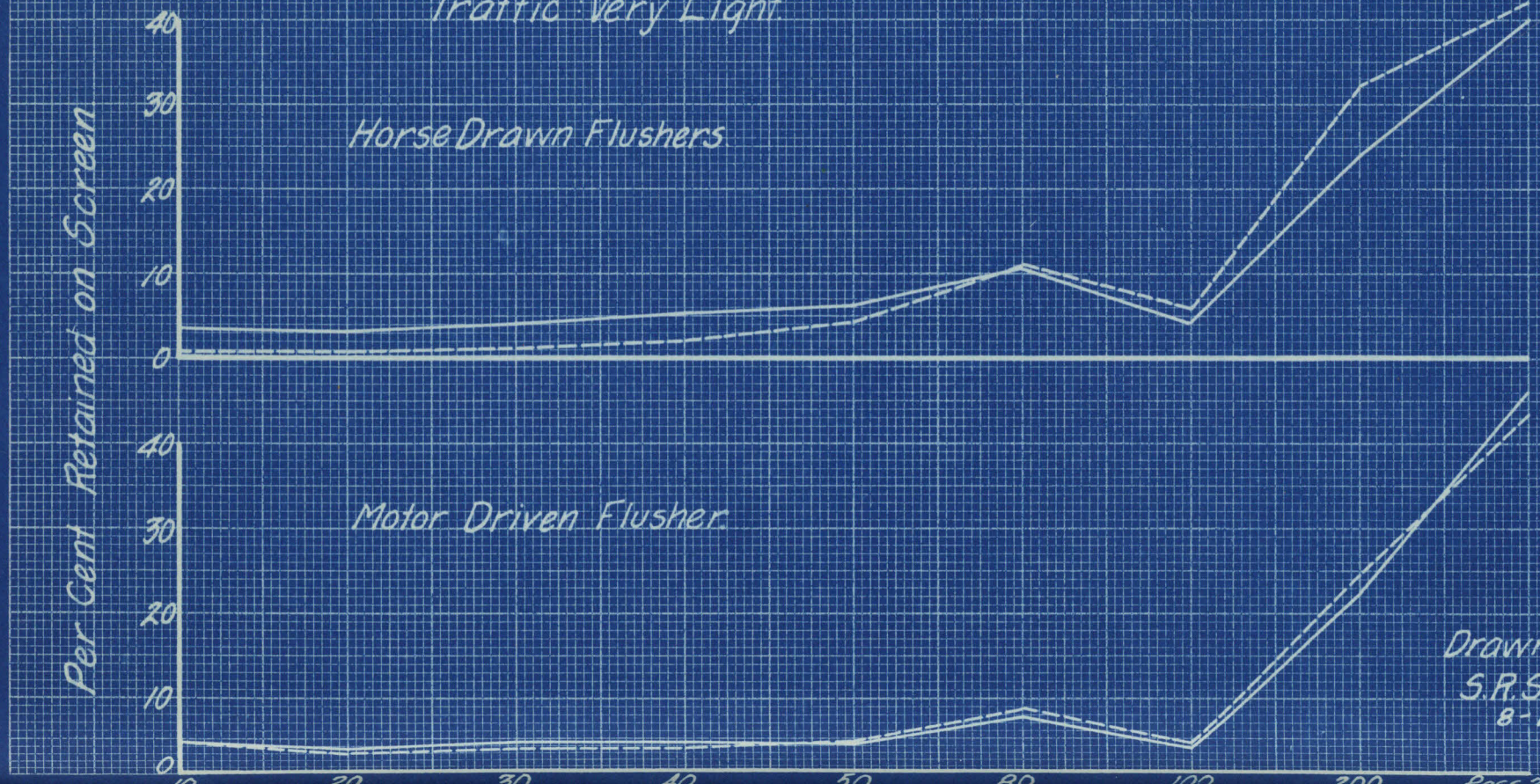
Screening Test of Dust on Paved Streets

Before and After Flushing
(Gutters Excluded)

Hayden Street - North of Ave. 21

Pavement: Asphalt-Concrete.
Condition: Good.
Width of Flusher Swath: 17 ft.
Traffic: Very Light.

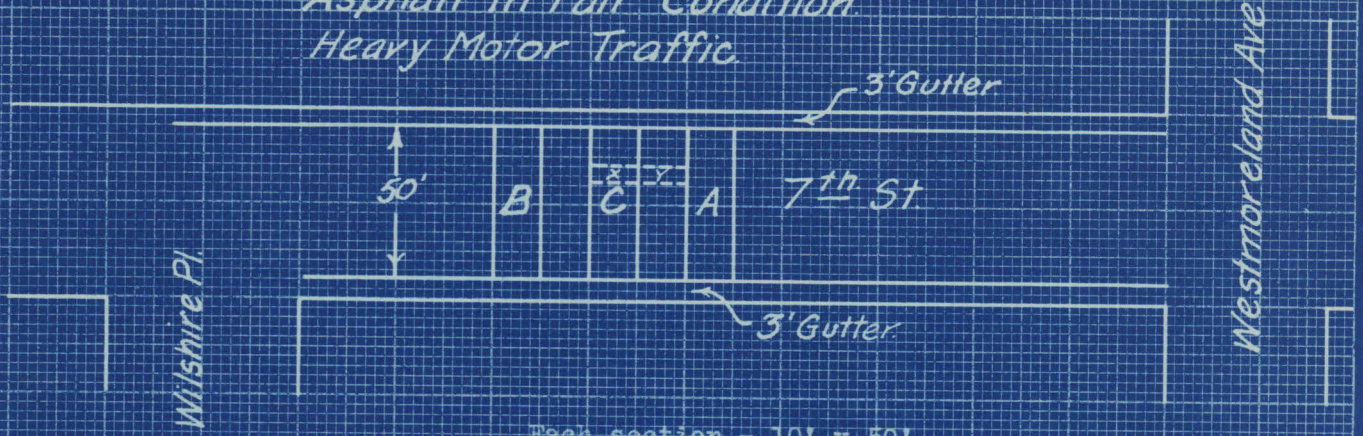
——— Before Flushing.
- - - - - After Flushing.



Drawn by -
S.R. Searl
8-18-16.

DUST TESTS ON SEVENTH STREET

Asphalt in Fair Condition. Heavy Motor Traffic.



Each section - 10' x 50'

August 7 - Sections A and B swept before horse-drawn flushing.

A - 62.20 gr.
B - 59.35 gr.

August 8 - Section C swept after horse-drawn flushing. (One week since previous flushing.)

C - 29.95 gr.

August 21 - Sections A and B swept before motor-driven flushing.

A - 60.10 gr.
B - 49.30 gr.

August 22 - Section C swept after motor-driven flushing. Because of manure, Section Y was swept in place of X. Two weeks since previous flushing.

C - 31.90 gr.

% Dust Remaining after Motor-Driven Flushing - 58.3%

% " " " Horse-Drawn " - 49.2%

Chart No. 21.

Chart No. 22

Amount of Dust Removed from Test Area on Seventh Street by Motor-Driven Flusher and Battery of Horse-Drawn Flushers

Chart No. 22 shows the total weight of the dust on the test area before flushing and after flushing by each type of flusher; also the same quantities in per cent, using the weight of the dust on the test area before flushing as 100%. The total weight of dust on the test area before flushing was approximately the same for each type of flusher. The horse-drawn battery removed approximately 51% of the dust; the motor-driven flusher removed approximately 42% of the dust.

It is interesting to note here that the test area when flushed by horse-drawn flushers had been flushed one week before, but when flushed by motor-driven flushers it had not been flushed for two weeks before. In spite of this difference in cleaning interval, the street showed less dust after the long interval than after the short.

Chart No. 23

Dust Composition Before and After Flushing

Chart No. 23 shows the results of screening tests.

After flushing by a battery of horse-drawn flushers, the dust remaining showed a slightly decreased percentage of material retained on screens No. 10, No. 20, No. 30, No. 40, and No. 50. There was a slight increase in the percentage of material retained on No. 200 and passing No. 200. The percentage of material retained on No. 80 and No. 100 was the same before and after flushing.

After motor-driven flushing, the dust remaining contained a slightly decreased percentage of material retained on screens No. 10, No. 20, No. 30, No. 40, No. 50, and No. 80, and a slightly increased percentage of material retained on No. 100, No. 200, and passing No. 200.

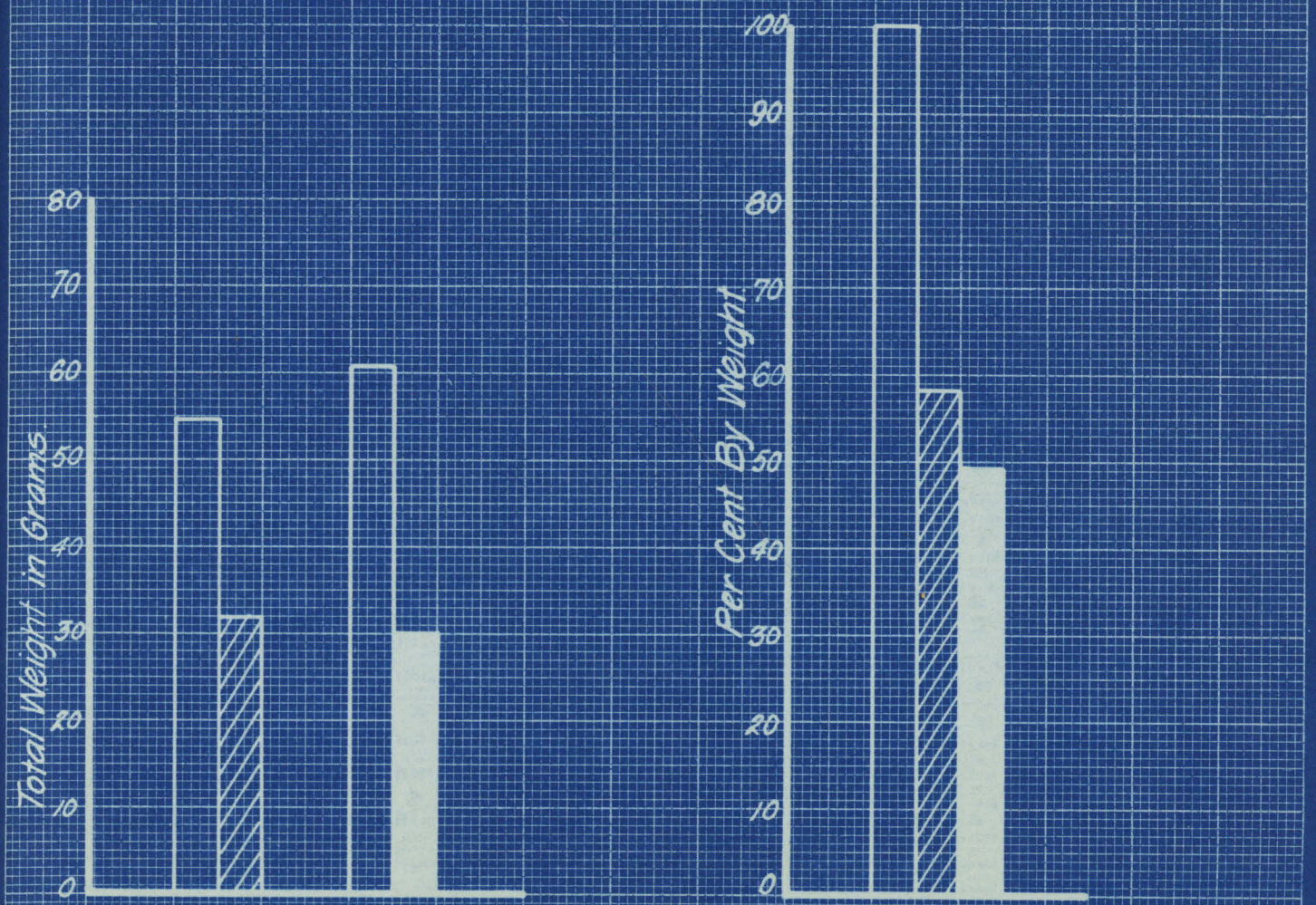
Considering the liability of its being driven into the air by traffic, the dust was of practically the same composition before and after flushing by either type of flusher.

Flushing on Paved Streets.

Amount of Dust Removed.
(Gutters Excluded).

7th. Street - East of Westmorland Ave.

Dust on Area Before Flushing.
" " " After Motor Flushing.
" " " " Horse Drawn" .



Drawn by-
S. R Searl
8-21-16.

Chart No. 22.

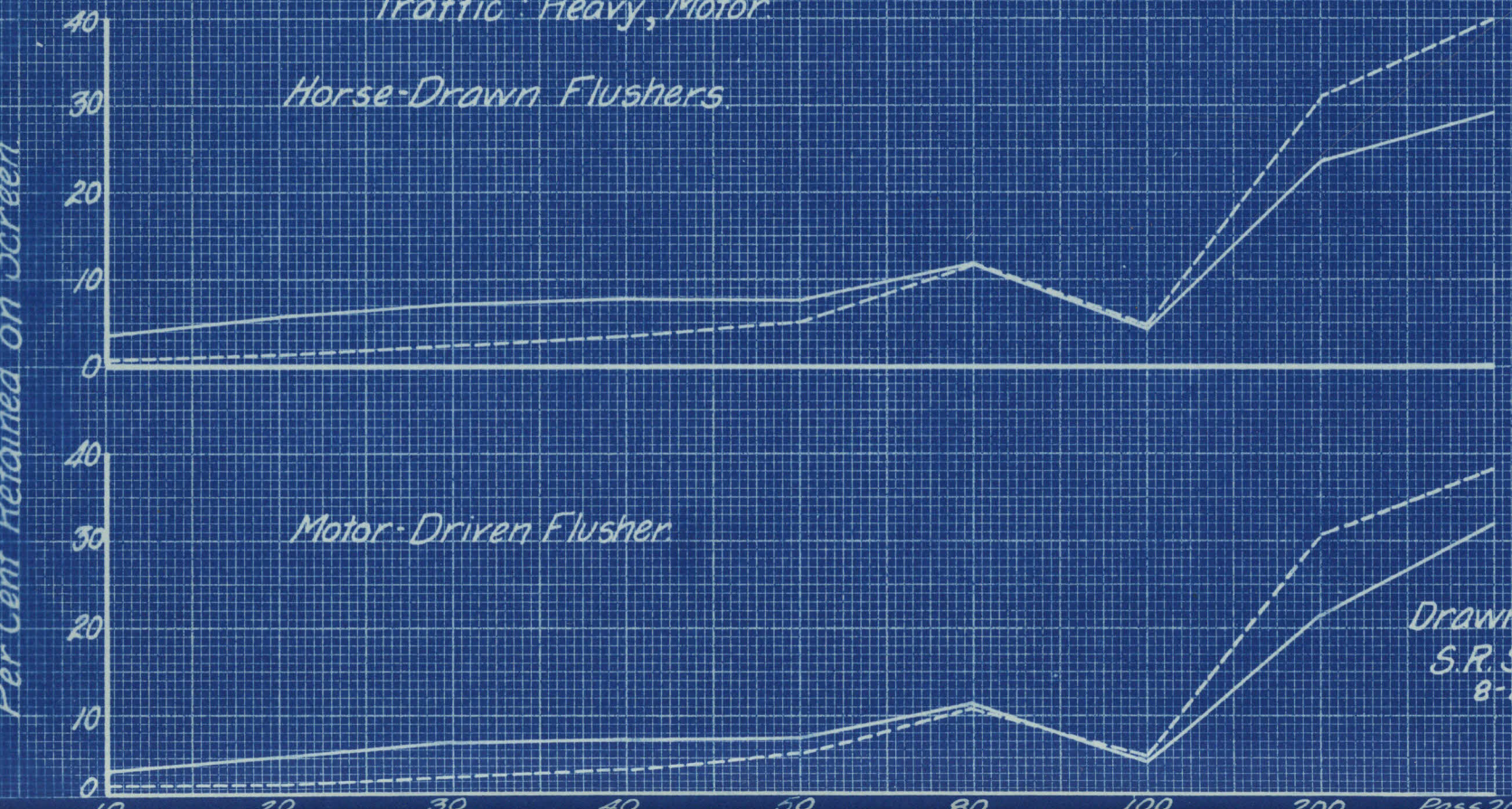
Screening Test of Dust on Paved Streets

Before and After Flushing.
(Gutters Excluded)

7th Street - East of Westmorland Ave.

Pavement : Asphalt.
Condition : Fair.
Width of Flusher Swath : 25ft.
Traffic : Heavy, Motor.

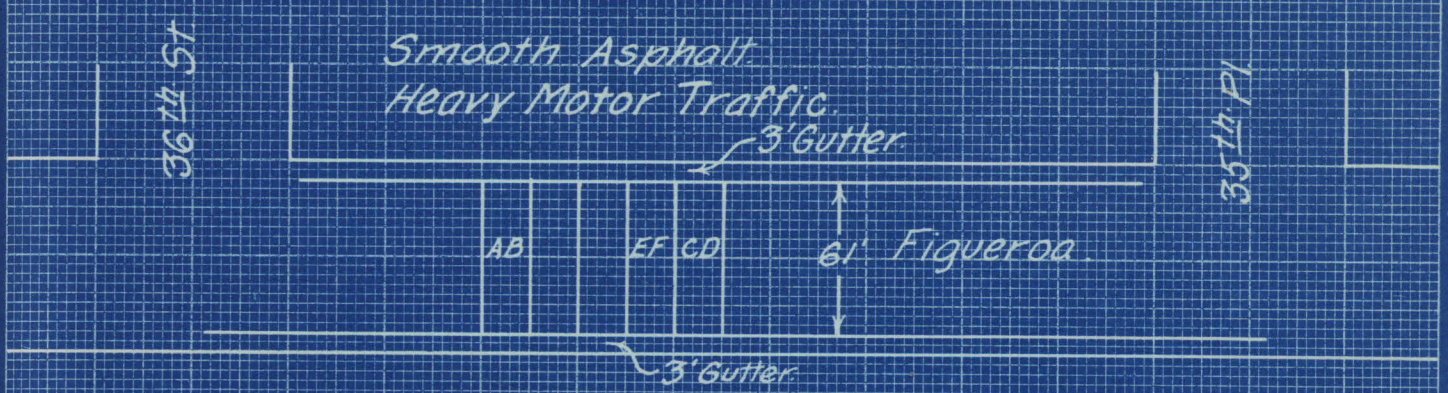
——— Before Flushing
----- After Flushing



Drawn by-
S.R. Searl
8-18-16

Chart No 23.

DUST TESTS FOR MOTOR-DRIVEN FLUSHING ONLY



Each section - 10' x 61'

August 2 - Sections AB and CD swept before flushing by motor-driven flusher.

AB - 132.30 gr.

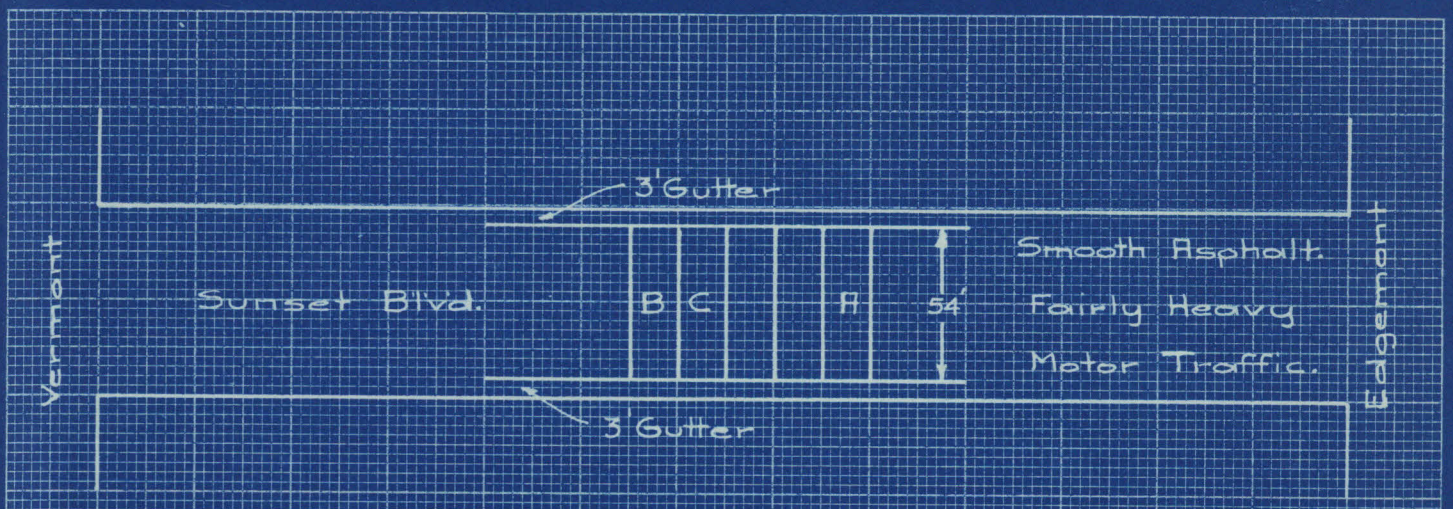
CD - 183.05 gr.

August 3 - Mid-section had fresh manure on it. Therefore Section EF was swept, after flushing by motor.

EF - 131.55 gr.

% Dust Remaining after Motor-Driven Flushing - 83.4%

Chart No. 25.



Each section - 10' x 54'

August 5 - Sections A and B were swept before motor-driven flushing.

A - 49.80 gr.

B - 46.65 gr.

August 6 - Section C was swept after motor-driven flushing.

C - 42.30 gr.

% Dust Remaining on Pavement after Motor-Flushing - 87.7%

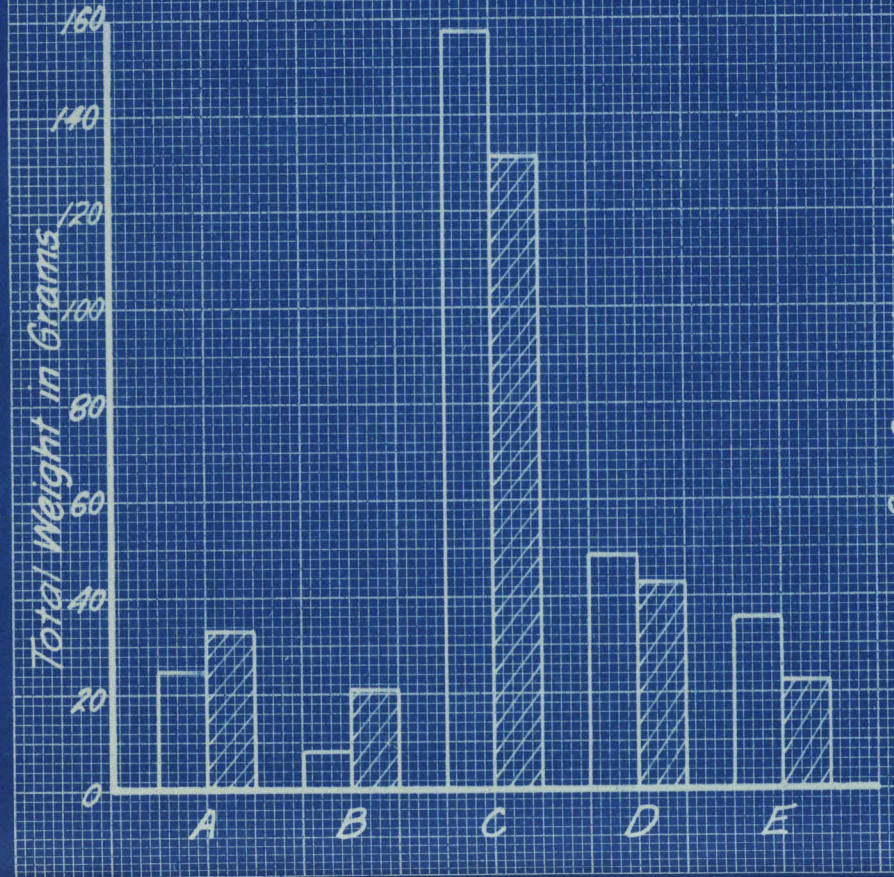
Chart No. 26

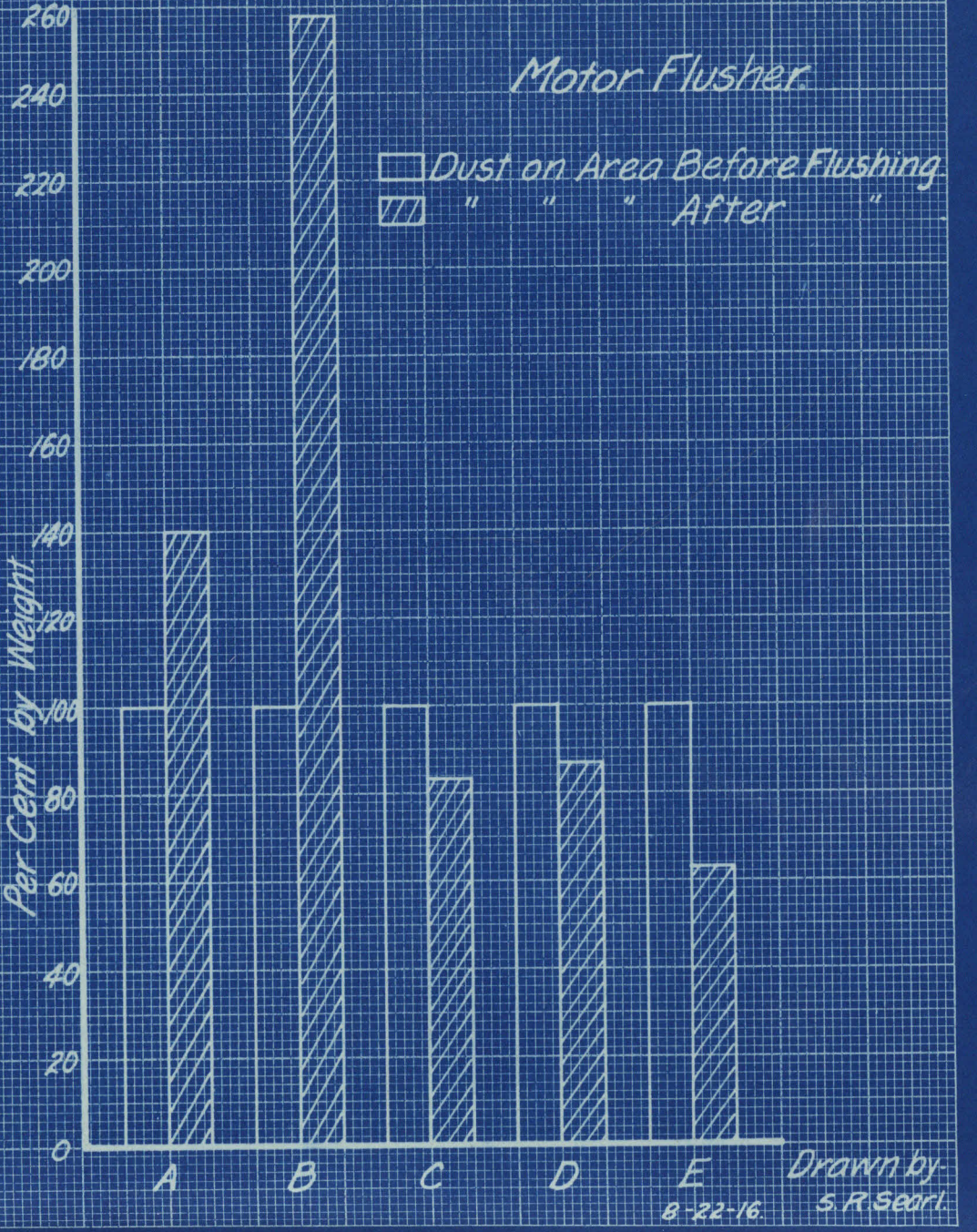
Flushing on Paved Streets.

Amount of Dust Removed.

(Gutters Excluded).

A- E. First St, east of Breed St. (South Side)
B- " " " " " " " (North ")
C- Figueroa St, south of 35th Place.
D- Sunset Blvd, east of Edgemont.
E- Western Ave, near 4th St.





Motor Flusher.

Dust on Area Before Flushing.
" " " After "

Drawn by-
S. R. Searl.
8-22-16.

CHART NO. 27

Motor Flushers on East 1st St., Figueroa St., Sunset Blvd., and Western Ave. near 4th. (Sections 1, 2, and 3.)

Chart No. 27 shows the total weight in grams of dust on the test areas before and after flushing by motor-driven flusher, and also the percent by weight. In each case the dust indicated on the area before flushing is taken as 100%. It will be noted that on East 1st St. the test showed more dust on the areas after flushing than before flushing. This was probably due to the very unfavorable conditions surrounding the test, namely: high wind, heavy traffic, and very light dust content of the pavement. In considering the performance of the motor-driven flusher, this test on East 1st St. was eliminated.

The tests on Figueroa St., Sunset Blvd., and Western Ave. show consistent results. It is interesting to note that flushing seems to remove a definite percentage of the dust regardless of the total amount of dust on the pavement. On Figueroa St. the test section contained over three times the amount of dust contained by the test section on Sunset Blvd., and yet the percentage of dust remaining after flushing is practically the same for the two areas.

CHARTS NO. 28 AND NO. 29

Effect of Flushing on Dust Composition

Charts Nos. 28 and 29 give the results of screening tests.

On Sunset Blvd., after flushing by motor-driven flusher, the dust remaining contained a slightly lower percentage of material remaining on screens No. 10, No. 20, No. 30, No. 40, No. 50, No. 80, and No. 100; it contained a slightly higher percentage of material retained on screen No. 200 and passing No. 200.

On Western Ave. near 4th, the dust remaining after flushing contained a slightly lower percentage of material retained on screens No. 20, No. 30, No. 40, and No. 50, and a slightly higher percentage of material retained on screens No. 80, No. 100, No. 200, and passing No. 200.

On Figueroa St., after motor-flushing the dust remaining contained a slightly lower percentage of material retained on screens No. 10, No. 20, No. 30, and No. 40. It showed a slightly higher percentage retained on No. 80, No. 100, and No. 200. The percentage of dust passing No. 200 was practically the same before and after flushing.

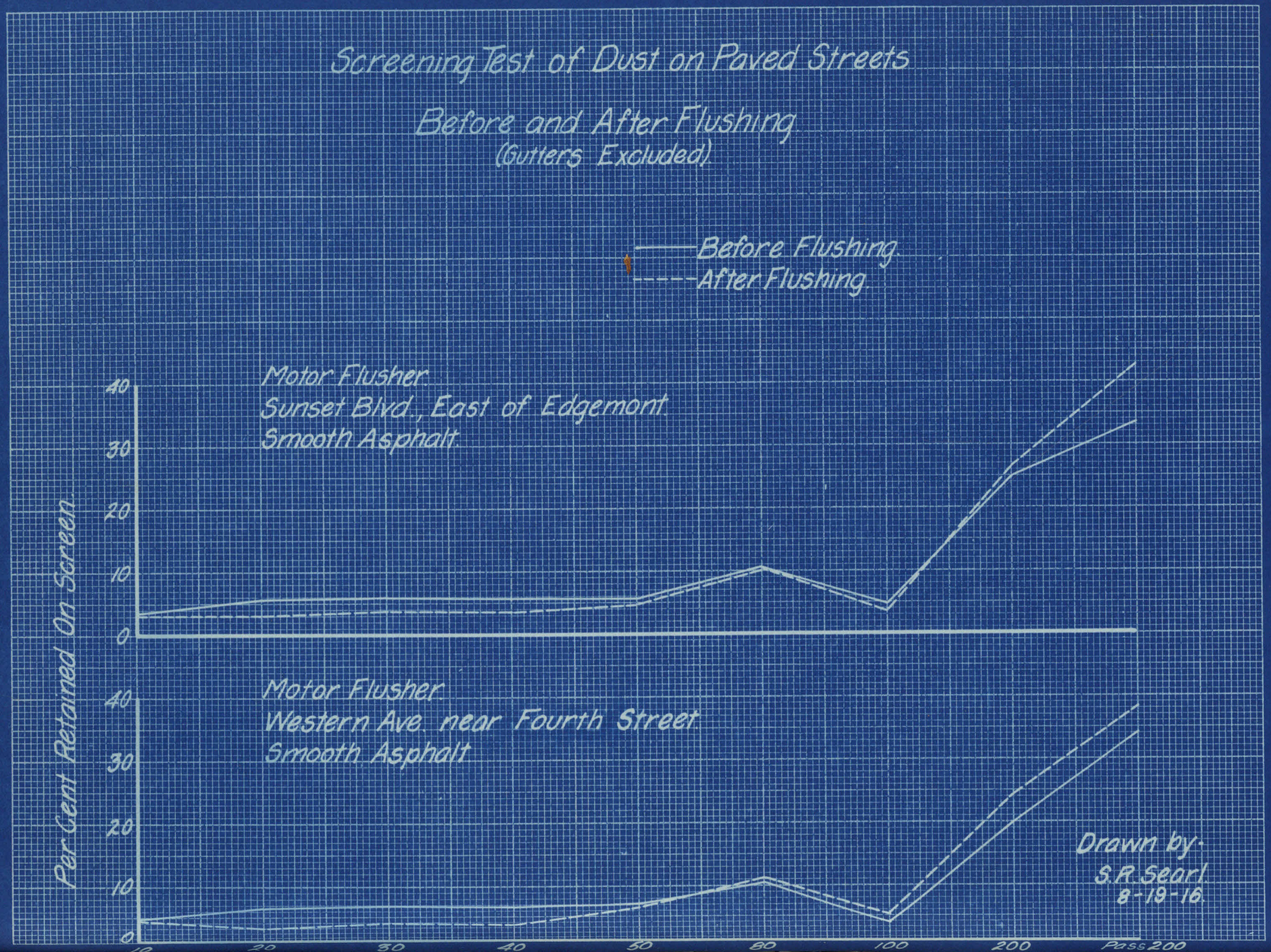
The tests on East 1st St. are not here considered because of reasons discussed above.

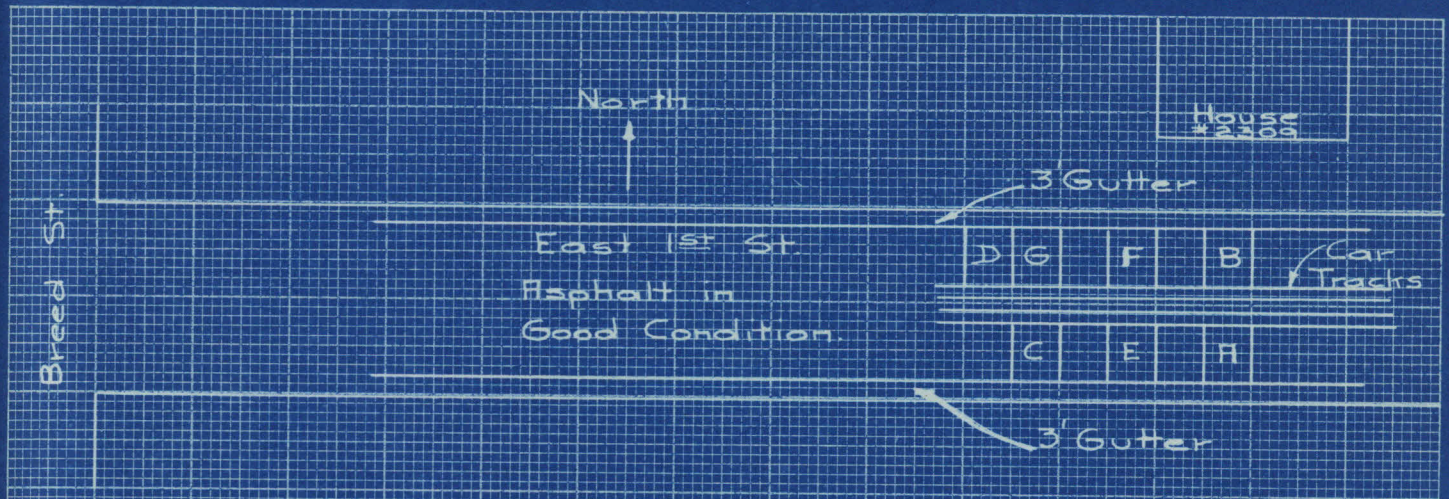
Considering the liability of its being driven into the air by traffic, the dust after flushing by motor-driven flusher was practically of the same composition as the dust on the street before flushing.

Screening Test of Dust on Paved Streets

Before and After Flushing

(Gutters Excluded)





Each section - 10' x 17.5'

August 3 - Sections A, B, C, and D were swept before motor-flushing. G was not swept because during sweeping of A and B fresh manure was deposited on G.

A - 21.95 gr.
B - 10.40 gr.
C - 26.45 gr.
D - 5.55 gr.

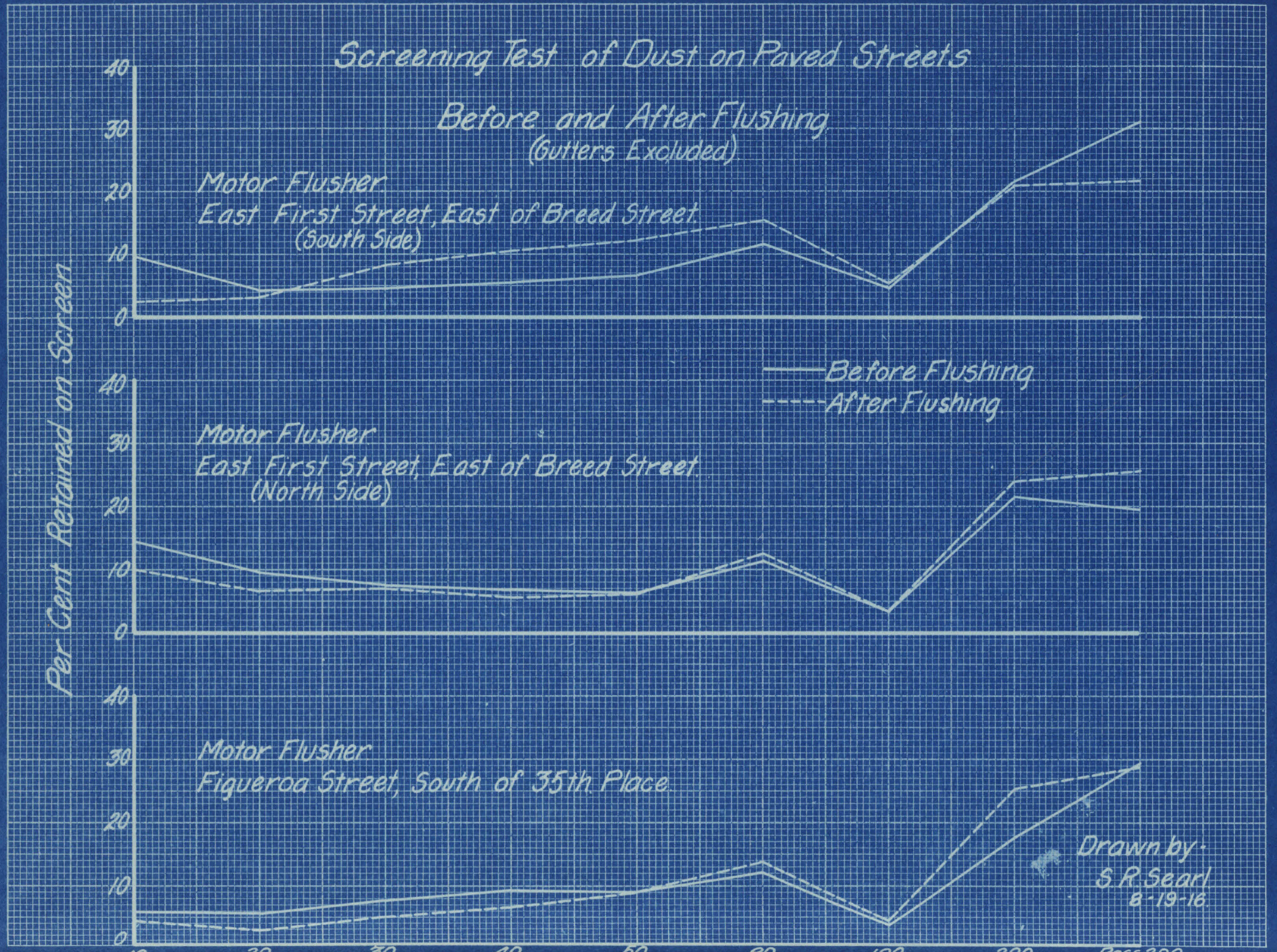
August 4 - Sections E, F, and A were swept after motor-flushing.

E - 33.85 gr.
F - 20.60 gr.
A - 28.55 gr.

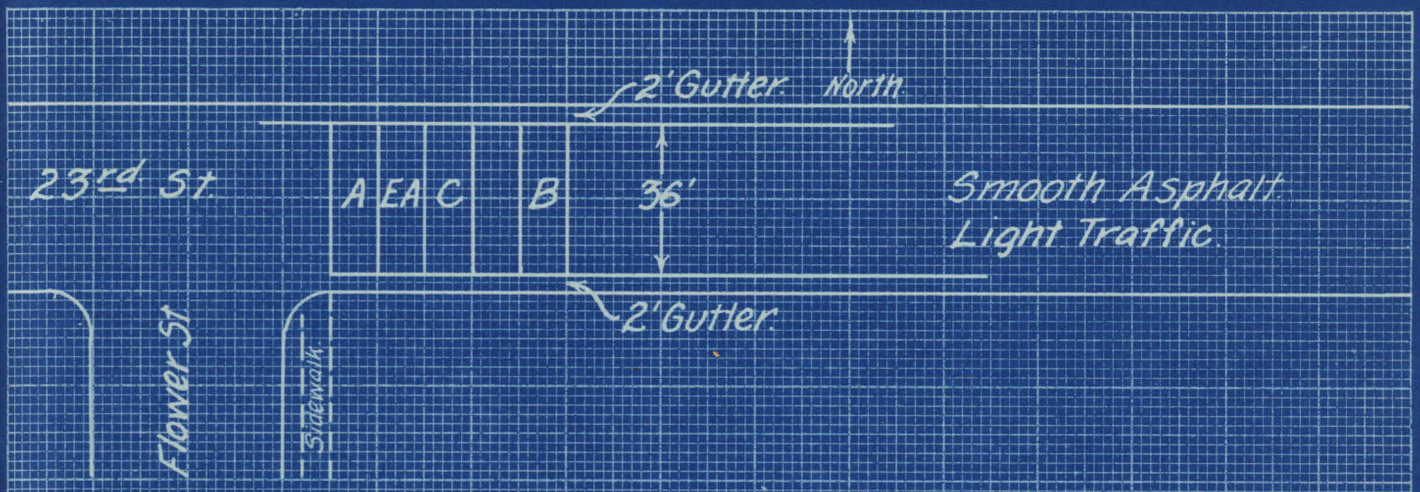
(Note - Very high wind during sweeping on August 3rd. Heavy horse-drawn and motor-driven traffic on street. Very little dust on street.)

% Dust on Pavement after Motor-Driven Flushing - 140% and 258%

Chart No. 24


Screening Test of Dust on Paved Streets
Before and After Flushing
(Gutters Excluded)
Motor Flusher
East First Street, East of Breed Street
(South Side)
Motor Flusher
East First Street, East of Breed Street
(North Side)
Motor Flusher
Figueroa Street, South of 35th Place
Before Flushing
After Flushing
Per Cent Retained on Screen
40
30
20
10
0
10
20
30
40
50
80
100
200
Pass200
Drawn by
S R Searl
8-19-16

DUST TESTS FOR HORSE-DRAWN FLUSHING ONLY



Each section - 10' x 36'

July 31 - Sections A and B swept before horse-drawn flushing.

A - 71.20 gr.
B - 67.45 gr.

August 1 - Section C swept after horse-drawn flushing (by usual method).

C - 23.20 gr.

August 13 - Sections EA and B swept before horse-drawn flushing.

EA - 158.60
B - 132.70

August 14 - Sections A and C swept after horse-drawn flushing (flusher used one cut only).

A - 58.80 gr.
C - 60.30 gr.

% Dust Remaining after Usual Horse-Drawn Flushing - 33.5%

% " " " " one flushing by H.D. Flusher- 41.0%

Chart No. 30.

Chart No. 31

Amount of Dust Removed from Test Area on 23rd Street by Horse-Drawn Flushers

Comparison of the Usual Method with an Experimental Method

Chart No. 31 shows the total weight of dust on the test area before and after flushing; also the same quantities in per cent, using the amount of dust on the area before flushing as 100%. The usual method of horse-drawn flushing is for the street to be covered twice by the flushing stream, one flusher following the other, each half of the street being covered separately in this manner. The second method, tried experimentally here, was to still cover each side of the street separately, but to cover it once only by one flusher wagon. One side of the street was flushed with the nozzle in the usual position, and the other side was flushed with the nozzle turned up so that the street received a "washing" spray instead of a "cutting" spray. The object in varying the method of flushing on the two sides of the street was to compare one side against the other. However, the observers who had secured the dust samples from the street were unaware of this intention on the part of the man directing the flushing and had not segregated the dust samples from the two sides of the street. Therefore, the only comparison that can be made is between the usual method of flushing with two flushers and the method of going once over, as described above.

It is interesting to note that, although the street contained more than twice as much dust in the test when flushed only once as when flushed twice, the percentage of dust removed by going over only once is but slightly less than that removed by the usual method of flushing. The usual method removed approximately 66% of the dust, while the "once over" method removed approximately 59% of the dust. It is well to note here that 23rd St. at the point tested is 36 feet from curb to curb and the asphalt is very smooth.

Chart No. 32

Effect of Flushing on Dust Composition

Chart No. 32 gives the results of screening tests.

Screening tests of the dust on the street before and after flushing show that after flushing in the usual manner the dust remaining had a slightly smaller percentage by weight of material retained on screens No. 20, No. 30, No. 40, and passing No. 200. There was a slightly increased percentage of material retained on screens No. 80, No. 100, and No. 200. After the "experimental" method of flushing, covering the street only once, the dust remaining had a slightly lower percentage, by weight, of material retained on screens No. 10, No. 20, No. 30, No. 40, and No. 50, and a slightly higher percentage retained on No. 100, No. 200, and passing No. 200.

Considering the liability of its being thrown into the air by traffic, the dust after flushing was of practically the same composition as before flushing.

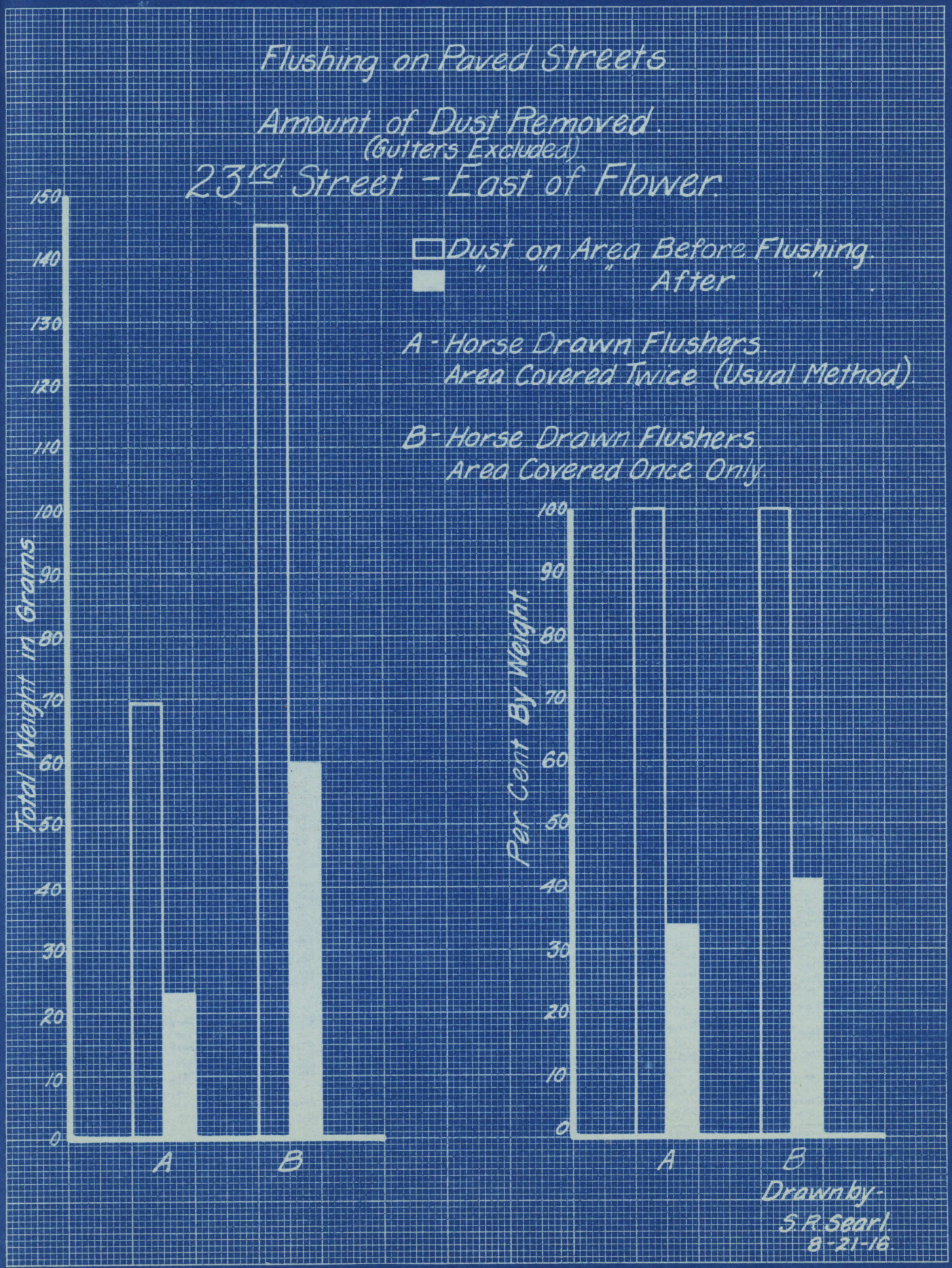

Flushing on Paved Streets
Amount of Dust Removed.
(Gutters Excluded)
23rd Street - East of Flower.
Dust on Area Before Flushing.
" " " After "
A - Horse Drawn Flushers.
Area Covered Twice. (Usual Method)
B - Horse Drawn Flushers.
Area Covered Once Only.
Total Weight in Grams
Per Cent By Weight.
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
A
B
Drawn by-
S. R. Searl
8-21-16

Chart No. 31.

Chart 32

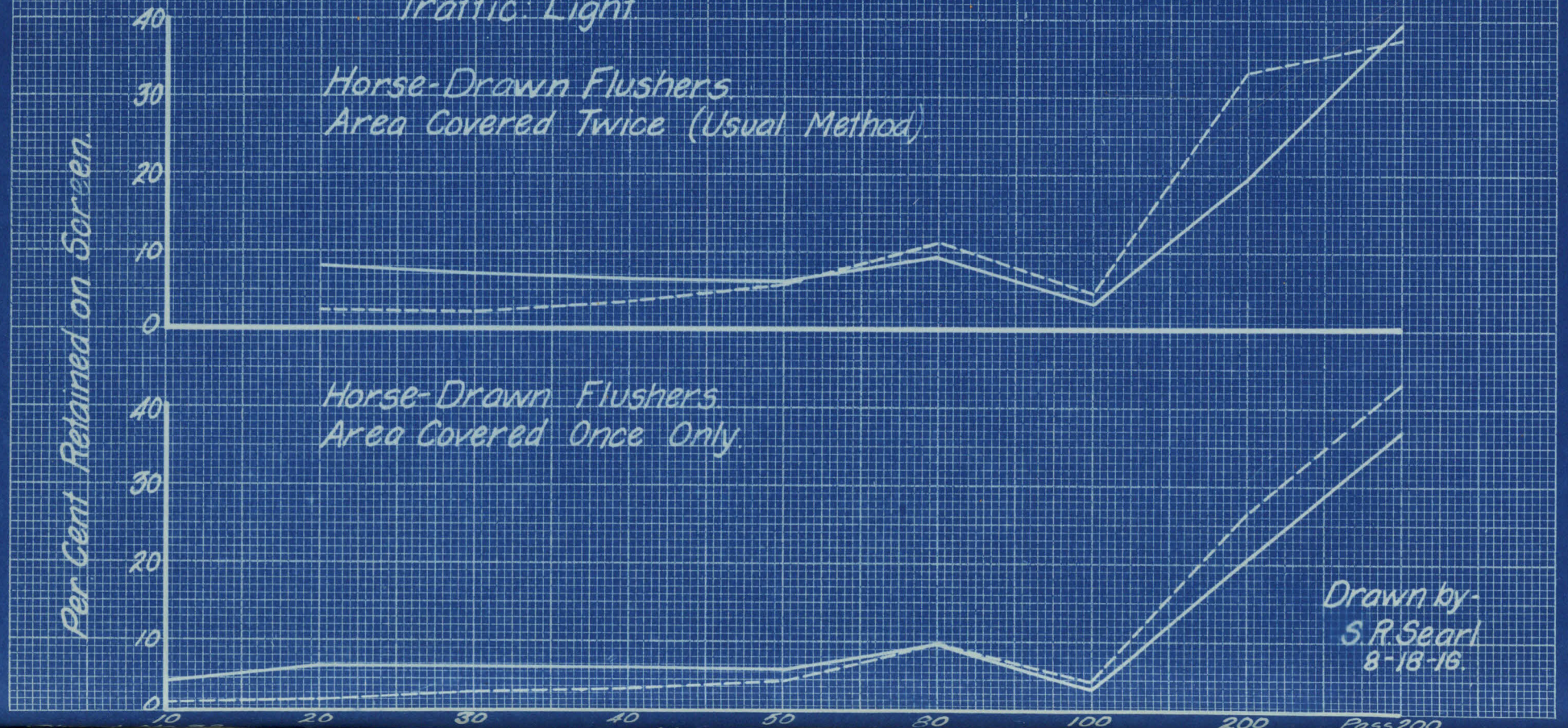
Screening Test of Dust on Paved Streets

Before and After Flushing
(Gutters Excluded)

23rd Street - East of Flower.

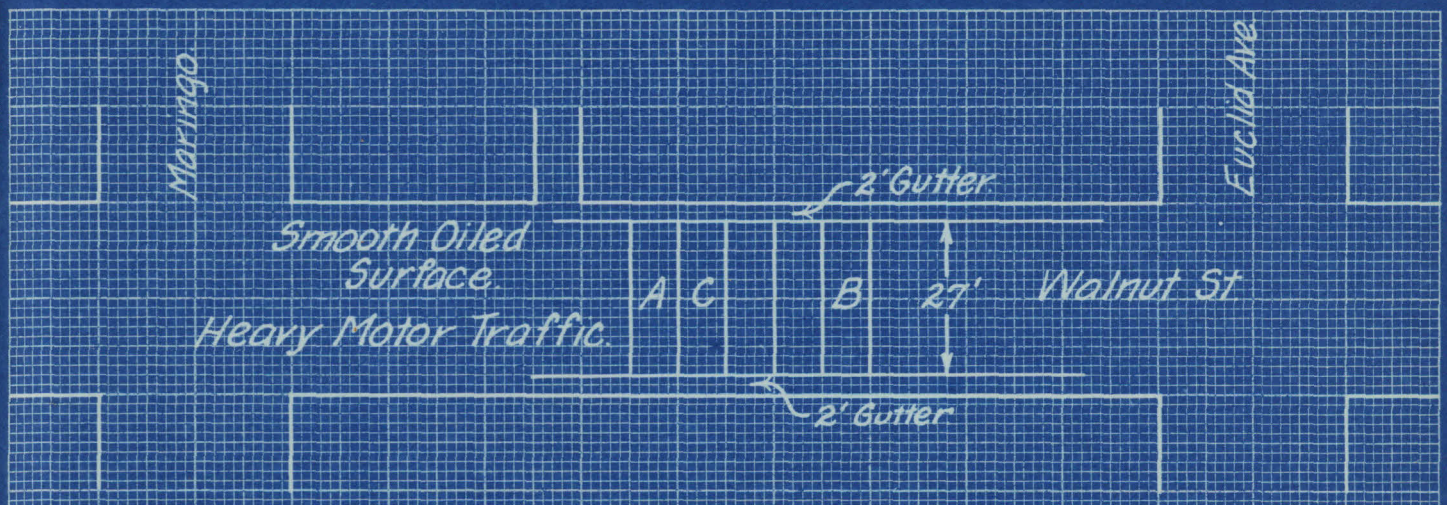
Pavement: Asphalt.
Condition: Very Smooth.
Width of Flusher Swath: 18 ft.
Traffic: Light.

—— Before Flushing.
----- After Flushing.



Drawn by-
S. R. Searl
8-18-16.

DUST TESTS FOR VACUUM CLEANING IN PASADENA



PASADENA

Each section - 27' x 10'

August 8 - Sections A and B swept before vacuum cleaning.

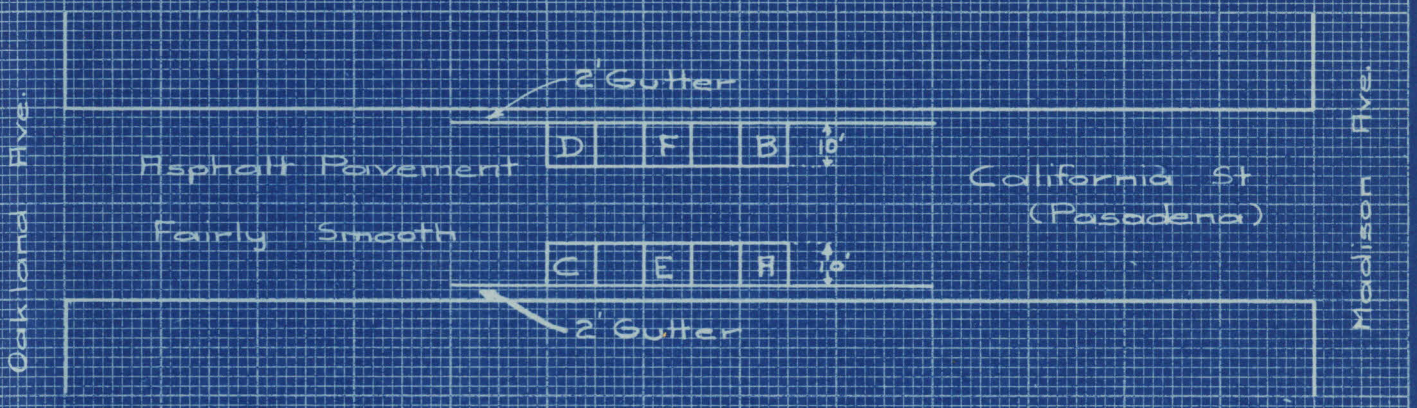
A - 42.95 gr.
B - 34.95 gr.

August 9 - Section C swept after vacuum cleaning. Mid-section was not swept because of fresh manure deposited thereon.

C - 14.15 gr.

% Dust Remaining on Surface after Vacuum Cleaning - 36.3%

Chart No. 33.



Each section - 10' x 10'

August 10 - Sections A, B, C, and D swept before vacuum cleaning.

A - 87.10 gr.
C - 89.65 gr.
B - 34.70 gr.
D - 36.00 gr.

August 11 - Sections E and F swept after vacuum cleaning.

E - 56.15 gr.
F - 17.05 gr.

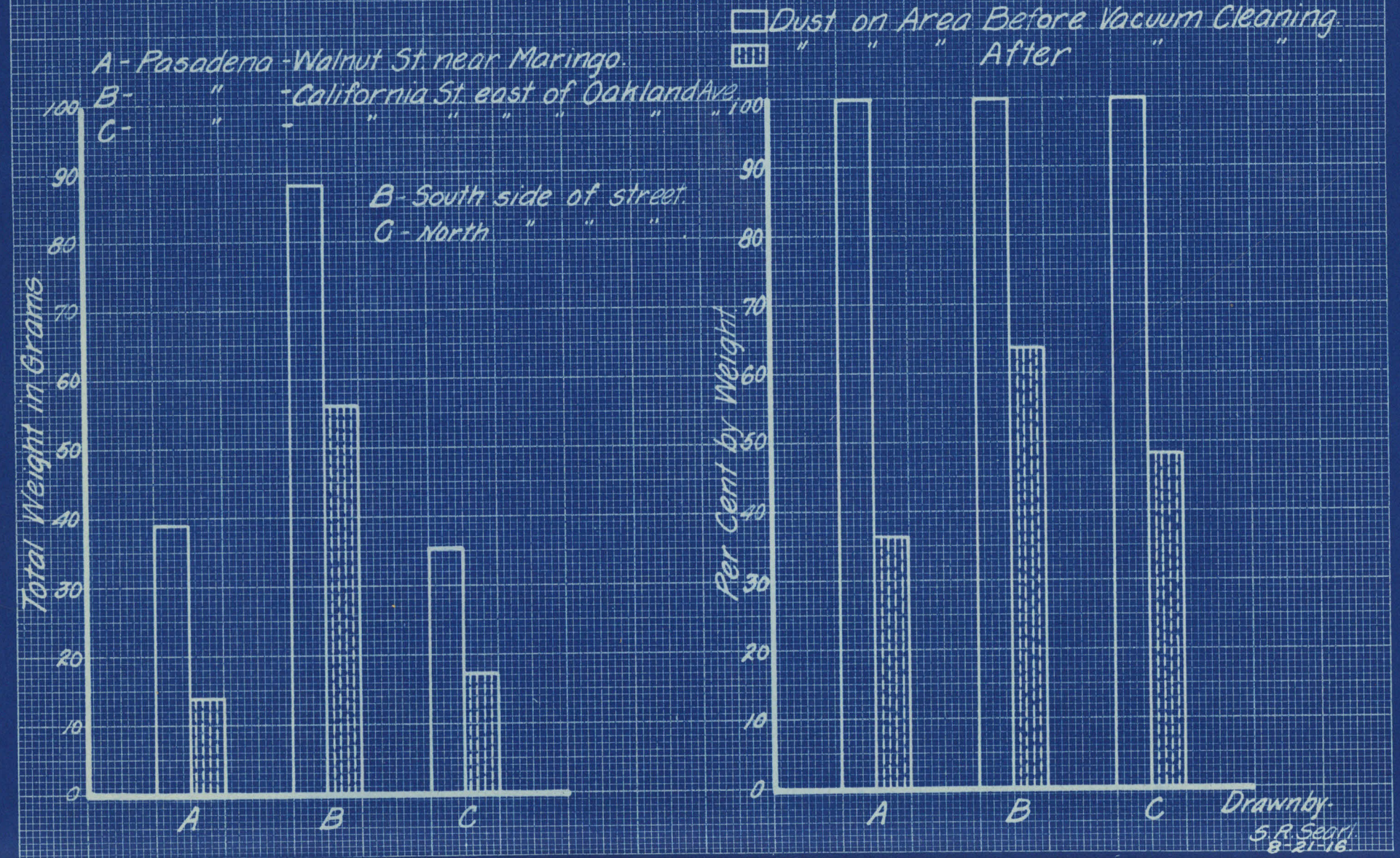
(Note - The vacuum cleaner usually covers the strip of gutter and pavement within 12 feet of the curb. On this night at the above point, only about 1 foot of the gutter was covered, which made the gutter test on this section worthless.)

% Dust Remaining on Pavement after Vacuum Cleaning - 63.6% and 48.2%

Chart No. 34

Vacuum Cleaning on Paved Streets.

Amount of Dust Removed
(Gutters Excluded).



Drawn by.
S.R. Segerl
8-27-16

Screening Test of Dust on Paved Streets

Before and After Vacuum Cleaning.

(Gutters Excluded)

——Before Cleaning.

- - - -After Cleaning.

Pasadena - Walnut St. near Maringo.

Oiled Surface in Good Condition.

Pasadena - California St. East of Oakland Ave.
(South Side)

Asphalt in Fair Condition.

Pasadena - California St. East of Oakland Ave.
(North Side)

Asphalt in Fair Condition.

Per Cent Retained on Screen.

40
30
20
10
0

10 20 30 40 50 80 100 200 Pass 200

Number of Screen

Drawn by-
S.R. Searl
8-18-16.

Chart No. 36.

CHART NO. 35

Amount of Dust Removed from Surface of Streets in Pasadena (Gutters Excluded)

By the Vacuum Cleaning Process

Chart No. 35 shows for three different test areas the total weight of dust on the area before and after vacuum cleaning; also the same quantities in per cent, using the amount of dust on the area before cleaning as 100%. Because of the small number of these tests, and because they were made in Pasadena and not in Los Angeles, the results here shown should be used with caution.

The tests show that the vacuum cleaner does not remove all dust, and indicate that in dust-removing ability it is about on a par with the horse-drawn flushers. The test on Walnut street was over a smoother surface than those on California street. As would be expected from the type of cleaner, the percentage of dust removed from the smoother surface was the greater.

CHART NO. 36

The Effect of Vacuum Cleaning on Dust Composition

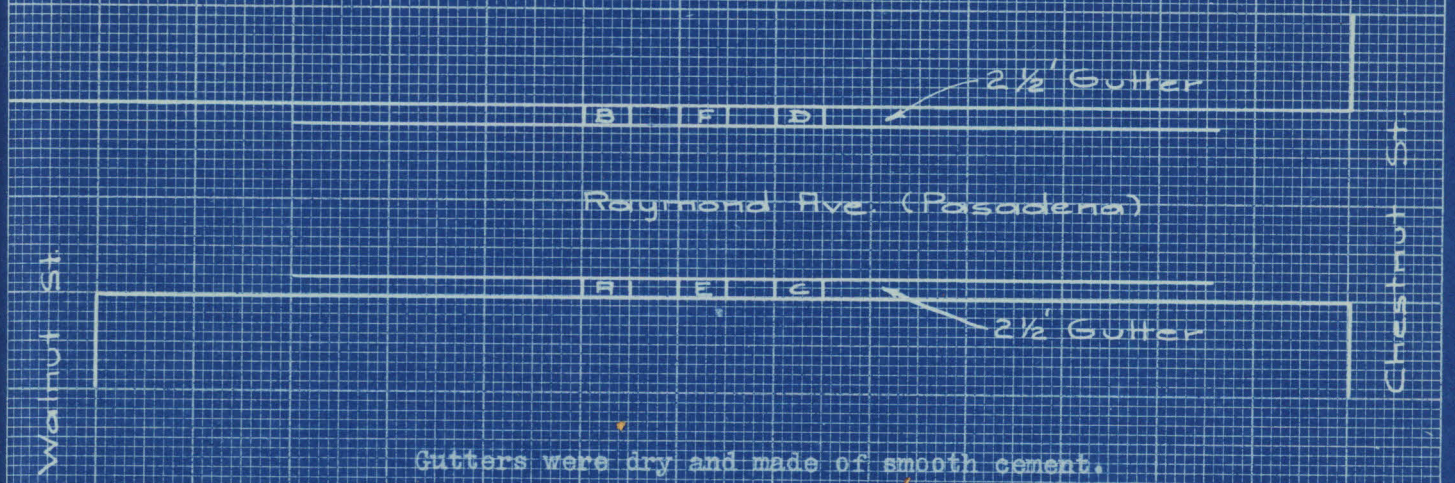
Chart No. 36 gives the results of screening tests.

On Walnut street the dust remaining after vacuum cleaning showed a slightly increased percentage of material remaining on screens No. 10, No. 50, and No. 80. There was a slight decrease in the percentage of material retained on No. 20, No. 30, No. 40, and passing No. 200. The percentage of material remaining on No. 100 and No. 200 was the same before and after vacuum cleaning.

On the south side of California street, after vacuum cleaning, the dust remaining had almost exactly the same percentages retained on all screens, there being a noticeable difference only in the dust passing No. 200, which showed a slight increase in percentage after vacuum cleaning.

On the north side of California street, after vacuum cleaning there was a slight increase in the percentage of dust retained on screens No. 10, No. 200, and passing No. 200. There was a slight decrease in the percentage of material retained on No. 20, No. 30, No. 40, No. 50, No. 80, and No. 100.

Considering the liability of its being driven into the air by traffic, the dust remaining on the street after vacuum cleaning was practically of the same composition as it was before cleaning.



Gutters were dry and made of smooth cement.

Each gutter section - 2.5' x 10'

(Note - The surface of Raymond Ave. at this point was very oily - except in the gutters - and unsuitable for a vacuum-cleaner test. This condition, however, was not apparent until actual sweeping had begun and it was too late to select another section. Therefore, only gutter tests were made.)

August 9 - Sections A, B, C, and D were swept before vacuum cleaning. (Just as the sweeping was completed the vacuum cleaner came by, going over Sections B, F, and D. The driver was unaware that tests were being made on these sections.)

A - 75.80 gr.
B - 15.30 gr.
C - 20.45 gr.
D - 13.40 gr.

August 9 - Section F was swept immediately after vacuum cleaning.

F - 6.30 gr.

August 10 - Section E was swept after vacuum cleaning.

E - 16.55 gr.

% Dust Remaining in Gutter after Vacuum Cleaning - 38% approximately.

Chart No. 37

Chart No. 38

Amount of Dust Removed from Gutters by the Vacuum Cleaner in Pasadena

Chart No. 38 shows the total weights of dust on the area before and after cleaning, and the same quantities expressed in terms of per cent; the weight on the area before cleaning being taken as 100%. Although the amounts of dirt originally on the two areas were widely different, the percentage remaining after cleaning were much more nearly of the same value.

The gutters selected for the test were cement, very smooth, and perfectly dry. The exact location of the dust in the gutters will greatly affect tests of this character. If a large percentage of the dust is very close to the curb, the suction effect of the vacuum cleaner does not have opportunity to exert its full force upon it, and a larger amount of dust will remain than if the dust is evenly deposited over the gutter. In this test the dust was lying just as it had been deposited by the traffic and, judging from appearances, quite a large proportion of it was very close to the curb.

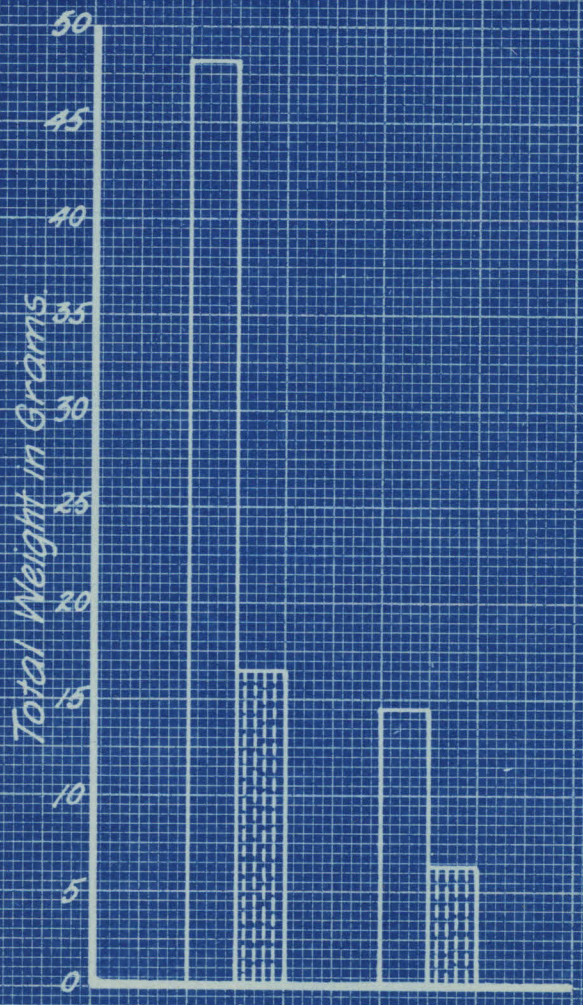
Vacuum Cleaning on Paved Streets.

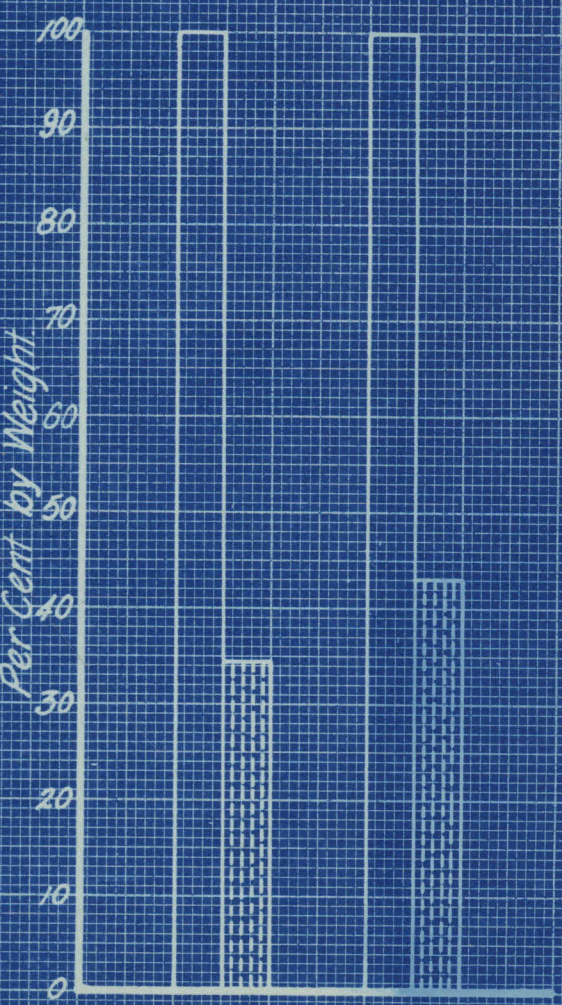
Amount of Dust Removed in Gutters.

□ Dust on Area Before Vacuum Cleaning.
▨ " " " After " " "

A - Pasadena, Raymond Ave., south of Chestnut Street.
East Side of Street.

B- Pasadena, Raymond Ave., south of Chestnut Street.
West Side of Street.





Drawn by:
S R Seard
8-22-16.

Chart No. 38.

VIII. CALCULATIONS AND BASIC DATA

METHOD OF OBTAINING FIGURES USED

Time Data

All time data was obtained by direct observation.

On Central Ave., Route II, because the motor-driven flusher started at Central and Jefferson, the horse-drawn battery was started there also. Since the nearest point to the corral on this route is Central and Washington, ordinarily the horse-drawn battery would start at Washington instead of at Jefferson. The time "going from corral" was corrected by subtracting from the actual time the time spent in going from Washington to Jefferson before flushing began.

Another correction was made for Route II because of the time spent by the battery of horse-drawn flushers in going from Jefferson and Central to 38th and Central after Central had been flushed. This correction was made because ordinarily the battery would flush the route in such sequence as to eliminate this dead-heading time.

Square Yards Flushed

The observer took notes concerning the areas flushed by the motor-driven flusher. When the same route was covered by the battery of horse-drawn flushers, the drivers were instructed to flush the same areas. (Note.- Through a misunderstanding, on Route I the horse-drawn battery flushed all aprons on Western Avenue, although the motor-driven flusher had not flushed them. On the other hand, the motor-driven flushed flushed one block of Serrano and one block of Oxford which were not flushed by the horse-drawn battery. The total number of square yards flushed on Route I was almost identical for each type of flusher.)

All areas flushed by the motor-driven flusher were calculated from the official profile maps.

All areas flushed by the battery of horse-drawn flushers, except part of Route I, were calculated from the official profile maps. The area of Western Ave. (including aprons) from Adams St. to Temple St. were obtained from the official unit area maps.

(For detailed dimensions of areas flushed, see pages 152-155)

Gallons of Water Used

Motor-driven Flusher

During the motor-driven flushing, the observer recorded at the beginning of each filling whether or not the tank was empty. He also recorded the time during the flow of water into the tank and the location of the hydrant.

Out of 161 motor-driven flusher loads, all except 23 were full loads. Of these 23 short loads 10 were made at hydrants previously used to obtain a full load. The amount of water used in these 10 loads was calculated according to the proportion of time during water inflow of the two fillings at the same hydrant.

Sample Calculation

Route III

Motor-flusher filled at Avenue 20 and Broadway 1200 gals. in 152 sec. (Time during inflow of water).

Flusher later filled at same hydrant, beginning to fill before the tank was completely empty and taking 128 sec. (time during inflow of water).

$$\text{Amount of water loaded at second filling} = \frac{128}{152} \times 1200 = 1010 \text{ gals.}$$

Estimates for water used in the remaining 13 short loads were based on rates of inflow from the nearest hydrant at which 1200 gals. were obtained, or upon the relative discharge time of the nearest full load and the short load.

Battery of Horse-drawn Flushers

The pressure in the flusher tank at each filling was read at the beginning and end of filling. From curves (obtained experimentally), between pressure in flusher and gallons of water in flusher for various initial charging pressures, it was possible, by means of the pressures recorded for each filling, to arrive at a close approximation of the amount of water put into the flusher at each filling. (These curves are given on page 139.)

Sample Calculation

Route II

At Central and 20th St.

"Charge" pressure = 48 lbs. per square inch

Press in tank at begin of fill = 11 lbs. per square inch
" " " " end of fill = 59 lbs. " " "

From the curve sheet,

Water in flusher at 48 lbs. initial charge and 59 lbs. press in tank = 515 gals.

Water in flusher at 48 lbs. initial charge and 11 lbs. press in tank = 25 gals.

Net gallons of water put into flusher = 490 gals.

(Note.- The initial "charge" pressure is first determined by observation at the time of "charging" the flusher air tank. Later any escape of air is evidenced by a lower pressure in the tank at the beginning of filling than zero water contents would give. From the curves can be obtained the "initial charge" pressure corresponding to this lower pressure at zero water contents of the flusher. This "initial charge" pressure is then usdd in the estimates until again the pressure in the tank indicates a new "charge" pressure.)

For the battery of two horse-drawn flushers, the total water used by one flusher on each route was estimated as described above, and that amount doubled as an estimate of the water used by the entire battery. The pressure gauges used in these observations and calculations were calibrated by the Water Department.

(The detailed data concerning water will be found on pages 137-145.)

Cost Calculations

Detailed cost calculations follow. They are based on data observed in this test (see page 136) and upon figures collected by the Board of Public Works on horse-drawn flushing costs in February, 1916. Each of the cost items is there fully discussed.

Detailed Cost Figures

Costs of Motor Flushing

During Test Period

(Motors Start and Finish on Their Routes)

Covering 4 routes which were covered by wagon-flushers in the same manner.

30.47 hours worked, or 5.81 days - Area Flushed (actual) 409,385 square yards.

	Total Costs	Costs per 1000 yds. flushed (cents)	Units per motor per 8-hr. day
Time Costs			
Motor (1 - $14.71 per day) (Contract price)	$56.05	13.69¢	$ 14.71
Foreman ($125 - 5 motors - 26 days - $.962 per motor day)	$ 3.67	.90¢	$ .96
Maintenance of Equipment) Depreciation and interest) Contractor's expense			
Workmen's Compensation Insurance - 1.857% on city labor - foreman - $3.67	$ .07	.02¢	$ .02
Administration - 4% on all time expense items - motors, foreman, Workmen's Comp. Ins. - total $59.79	$ 2.39	.58¢	$ .63
Water Costs			
Water: First Cost - 185,155 gal. (Calculated at $.0421 per M gal. - cost of production)	$ 7.80	1.90¢	$ 2.05
" Administration (4% of first cost)	$ .31	.08¢	$ .08
Yardage Costs			
Culvert and Catch Basin Cleaning - E D Feb. costs $.0124 per M yds. flushed (used for wagons and motor alike)	$ 5.08	1.24¢	$ 1.33
Sweeping Gutter Deposits - E D Feb. costs - $.0203 per M yds. flushed (used for wagons and motor alike)	$ 8.31	2.03¢	$ 2.18
Totals	$83.68	20.44¢	$ 21.96

Area flushed per motor per 8-hour day 107,450 square yards.

Costs of Wagon Flushing

During Test Period

(Exclusive of Traveling Time to and from Corral)

Covering 4 motor-flusher routes in the same manner as routes were covered by motor-flushers.

26.66 hours worked, or 3.33 days - Area flushed (actual) 436,659 square yards.

	Total Costs	Costs per 1000 sq. yds. flushed (cents)	Costs per 2-wagon battery per 8-hr. day
Time Costs			
Teams (2 - $10.00 per day) (Rate paid for drivers and teams)	$33.33	7.63¢	$10.00
Foreman ($110 - 23 teams - 26 days - $.184 per team day)	$ 1.23	.28¢	$ .37
Maintenance of Equipment (B.P.W.Feb. costs - $.178 per flusher-day)	$ 1.20	.27¢	$ .36
Depreciation and interest (E D Feb. costs - $.170 per flusher-day)	$ 1.13	.26¢	$ .34
Workmen's Compensation Insurance 1.057% on all labor - on 1/2 team cost, on foreman, on 80% of maintenance cost - total $18.85	$ .35	.08¢	$ .11
Administration - 4% on all time expense items - teams, foreman, maintenance, Workmen's Comp. Ins. - total $36.10	$ 1.44	.33¢	$ .43
Water Costs			
Water: First cost - 158,420 gal. at .0421 (cost of production)	$ 6.67	1.53¢	$ 2.00
" Administration (4% of first cost)	$ .27	.06¢	$ .08
Yardage Costs			
Culvert and Catch Basin Cleaning - E D Feb. costs of $.0124 per M sq.yds. flushed (used for wagons and motors alike)	$ 5.41	1.24¢	$ 1.63
Sweeping of gutter deposits - E D Feb. costs of $.0203 per M sq.yds flushed (used for wagons and motors alike)	$ 8.86	2.03¢	$ 2.66
Totals	$59.89	13.71¢	$17.98

Area flushed per battery per 8-hour day 131,129 square yards.

Costs of Wagon Flushing

During Test Period

(Inclusive of Traveling Time to and from Corral)

Covering 4 motor-flusher routes in the same manner as routes were covered by motor-flushers.

31.14 hours worked, or 3.89 days - Area flushed (actual) 436,659 square yards.

	Total Costs	Costs per 1000 sq.yds. flushed (cents)	Units per 2-wagon battery per 8-hour day
Time Costs			
Teams (2 - $10.00 per day)	$38.90	8.91¢	$10.00
Foreman ($110 - 25 teams - 26 days - $.184 per team day)	$ 1.44	.33¢	$ .37
Maintenance of Equipment (B.P.W. Feb. costs $.176 per flusher day)	$ 1.40	.32¢	$ .36
Depreciation and Interest (E D Feb. costs $.170 per flusher-day)	$ 1.32	.30¢	$ .34
Workmen's Compensation Insurance - 1.857% on all labor - on 1/2 team cost, on foreman, on 80% of maintenance cost - total $22.01	$ .41	.09¢	$ .11
Administration - 4% on all time expense items - teams, foremen, maintenance, and Workmen's Comp. Ins. - total $42.15	$ 1.68	.39¢	$ .43
Water Costs			
Water: First Cost - 158,420 gal. (calculated at cost of production, $.0421)	$ 6.67	1.53¢	$ 1.71
" Administration (4% of First Cost)	$ .27	.06¢	$ .07
Yardage Costs			
Culvert and Catch Basin Cleaning - E D Feb. costs $.0124 per M sq.yds. (used for wagons and motor alike)	$ 5.41	1.24¢	$ 1.39
Sweeping of Gutter Deposits - E D Feb. costs - $.0203 per M sq.yds. flushed (used for wagon and motor alike)	$ 8.86	2.03¢	$ 2.28
Totals	$66.36	15.20¢	$17.06

Area flushed per battery per 8-hour day 112,226 square yards.

THEORETICAL COSTS OF VACUUM CLEANING

Assuming Machines to be Owned and Operated by the

City of Los Angeles.

Assumptions:

1. Minimum of 1,200,000 yards to be cleaned daily. (Minimum specified in contract; provided also that machines furnished shall be worked to their normal capacity.)

2. 175,000 yards - estimated average 8-hour performance of one machine. Based on 125,637, actual performance in heavy district; 211,000, theoretical maximum performance in normal light districts. Overlap calculated at 10% (February performance)*; yardage equivalent to 27-1/3 miles run per 8 hours.

3. 26 working days per month.

4. Driver, $85.00 per month; helper, $2.50 per day.

5. The cost of removal of material collected by a vacuum cleaner will be comparable with the cost of removal of material deposited in gutters by flushers (not including cost of piling such deposits) and therefore, for a comparative basis, should not be included, as this cost for flushing cannot be ascertained.

6. Truck repairs, $.0413 per mile (Efficiency Department haulage cost data).

7. Repairs to cleaning apparatus, $.055 per mile (based on data furnished by agent of machine)

8. Gas and Lubricants - $.10 per mile (based on data furnished by agent of machine).

9. Tires - $.0136 per mile - based on city prices, 8000-mile life.

10. Foreman - $110 per month for each four machines, or for each 8-hour shift.

11. Administration - 4% on all items of current expense.

12. Depreciation - $.0807 per mile, as follows -

Bins and Fan Engine - Cost, $628 - Life, 3 years (agent)

Truck and All Other - Cost, $3364 - 60,000 mile life.

13. Interest - $.3205 per working day - based on average value of $2000.00 at 5%.

14. Workmen's Compensation Insurance Cost - $1.857 per $100 of Pay Roll - based on State Labor Bureau rate ($2.70) at actual cost.

15. Fire Insurance - $.202 per day - based on average annual premium of $63.

16. Property Damage Insurance - $.045 per day - based on standard class-of-machine rate, $14 per year.

17. Collision Insurance - $.308 per day - based on standard annual premium of 2.4% of machine's first cost ($96 per year).

18. Public Liability Insurance - $.160 per day, based on standard class-of-machine rate of $50.00 per year.

19. Garage or Yard Rental - $.769 per day, based on Efficiency Department haulage cost data, showing an average annual rate of $240.

20. State Taxes - $.099 per day, based on rate of $.40 per H. P. (40), plus a lump sum of $15.00 on account of weight.

An equipment of 4 machines would be needed. It is assumed, on the basis of 175,000 yards per machine per 8 hours, that 1,225,000 yards would be swept by 3 machines working 2 shifts and 1 machine working single shift. It is further assumed that this extra machine would be worked only one shift and held as a reserve-equipment unit.

* (Note - Assumption 2) - Tests made by the Board of Public Works, City of Los Angeles, during the month of February, 1916.

PERFORMANCE

1,225,000 yards (net) per day, for 26 working days per month, or 31,850,000 yards per month.

27.33 miles run per machine per 8-hour day - 7 machines, 26 8-hour shifts - 4974 miles per month.

Costs of Vacuum Cleaning (by Contract)

Entire Month of February, 1916, in a Downtown District.

Machine Started and Finished on Route.

(Note - This work was experimental and temporary. A nominal rental of $500. per month was agreed upon, because of the shortness of the period of work. For this statement, the figure of $.105 per 1000 yards cleaned is used, this being the price fixed by a contract recently signed for a period of three years.)

Gross Areas Swept, 3,179,505 yards; Net Allowed, 3,025,802 yards.

District was in the center of the city and included certain congested-district streets; was difficult to clean.

Time Worked - 192.67 hours during 26 days - an average of 7.41 hours per day.

Maximum Normal Working Time During Period - 27 8-hour days - 216 hours.

	Total Cost	Cost per 1000 yards cleaned (cents)	Costs per machine per 8-hour day
Contract Price - 3,025.8 M. yds. @ $.105	$317.71	10.50¢	$13.19
Foreman (Inspector) - ($110 - assumed 4 machines	$ 27.50	.91¢	$ 1.06 (26 days)
Maintenance of Equipment - (Contractor)	-	-	-
Depreciation and Interest - (Contractor)	-	-	-
Water - None used	-	-	-
Workmen's Compensation Insurance (on foreman)	.51	.02	$ .02 (26 days)
Administration - 4% (on $345.72)	$13.83	.46¢	$ .57
Culvert and Catch Basin Cleaning - none	-	-	-
Sweeping Gutter Deposits - none	-	-	$ -
Total	$359.55	11.89¢	$14.84

(Note - The above is the only actual cost data obtainable on the Vacuum Cleaner from tests made in Los Angeles.)

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TOTAL AND UNIT COSTS

	Total Costs	Costs per 1000 yards cleaned (cents)	Costs per vacuum-cleaner per 8-hour day
Drivers (7 at $85. per month) $595 Helpers (7 at $2.50 per day) $455 Operating Labor Costs	$1050.00	3.30¢	$ 5.77
Foreman (2 at $110 per month)	$ 220.00	.69¢	$ 1.21
Maintenance of Equipment Truck - $.0413 per mile Cl. App. - .055 " " 4974 mi. @ $.0963 " "	$ 479.00	1.50¢	$ 2.63
Depreciation (4974 mi. @ .0807	$ 401.30	1.26¢	$ 2.21
Interest - 4 machines, each $.3205 per day	$ 33.33	.10¢	$ .18
Supplies and Materials: Gas, Oil, etc. - $.10 per mile Tires - $.0136 " " 4974 miles at - $.1136 " "	$ 565.05	1.77¢	$ 3.10
Workmen's Compensation Insurance: On drivers, helpers, foreman, and an estimated 50% of maintenance of equipment - .01857% on $1509.50	$ 28.00	.88¢	$ .15
Insurance and Taxes (shown but not incl.)* Fire $.202 per day Property Damage .045 " " Collision .308 " " Publ. Liability .160 " " State Tax .099 " " 4 machines, each $.814 " "	$(3.26)*	(.01¢)*	$(.02)*
Garage or Yard Rental (shown but not incl.)* 4 machines, each $.769 per day	$(3.08)*	(.01¢)*	$(.02)*
Administration: 4% on current expense items - labor, foremen, maintenance of equipment, supplies and workmen's compensation insurance - total $2342.05	$ 93.68	.29¢	$ .52
Culvert and Catch Basin Cleaning (none)	-	-	-
Sweeping Gutter Deposits (none)	-	-	-
T O T A L S	$2370.36	9.79¢	$15.77

Costs of Vacuum Cleaning by Contract

Based on contract, recently signed, for a minimum of 1,200,000 square yards daily, at a rate of $.105 per 1000 square yards, with the specification that each machine furnished shall be worked up to its normal capacity.

Assumptions

1. 175,000 square yards, normal 8-hour capacity of 1 machine.
2. Four machines will be required, three of which will be worked 16 hours, and one for 8 hours - the latter to be used as a "reserve" unit.
3. 26 working days per month.
4. 31,850,000 square yards cleaned per month.
5. One foreman in charge of all machines working during an 8-hour shift - salary $110 per month.
6. Workmen's Compensation Insurance - 1.857% (actual cost) per $100 of payroll, on city employees only.
7. Administration - 4% on all items of current expense.

Total and Unit Costs

	Total Cost per month	Cost per 1000 sq.yds. cleaned (cents)	Cost per Vacuum-cleaner per 8-hour day
rdage Costs			
Contract - 31,850,000 sq.yds. at $.105 per M	$3344.25	10.50¢	$18.38
ne Costs			
Foremen - 2 at $110.00 (See "5" above)	$ 220.00	.69¢	$ 1.21
Workmen's Compensation Insurance $.01857 on $220.00	$ 4.09	.01¢	$ .02
Administration - 4% on $3,568.34	$ 142.73	.45¢	$ .78
T O T A L S	$3711.07	11.65¢	$20.39

Note - Maintenance of Equipment, Depreciation and Interest are items of expense that are borne by the contractor, and are included in the contract price.

The items of water, culvert and catch basin cleaning, and sweeping of gutter deposits (included in flushing costs) are not shown here, there being no cost for these items for vacuum-cleaning.

Other Derived Figures

Figures in Table 1, page 45:

Area flushed per 8-hour day is derived from total area flushed and time to flush same. (For basic data, see Table 16, page 136)

Gallons of water per 1000 square yards flushed is derived from total water used and total area flushed. (For basic data, see Table 16, page 136)

Flushing time per 1000 square yards was derived from observed time data (Tables 25 and 26, pages 146-147) and observed yardage data (Table 16, page 136)

Total cost per 8-hour day was calculated as shown on pages 124-127.

Figures in Table 3, page 52, were obtained by grouping the detail costs calculated on pages 124-127.

Table 4, page 55, was obtained as follows:

Time observations as given in Tables 25 and 26, pages 146-147, were reduced to terms of per cent, taking time in the route as 100%. This gives us the first and third columns of figures in Table 4.

Next we obtained the fourth and sixth columns by dividing the average total number of seconds per 1000 square yards into its constituent parts according to the percentages shown in columns one and three. In these calculations the results only to the nearest second were used. Next, column five was obtained by using the identical figures in column four except for the last item. Finally, column two was figured from column five.

The origin of all other tables and figures used is shown as they occur in the report.

BASIC DATA

TABLE NO. 16

SUMMARY OF FLUSHING DATA

Vehicle	Route No.	Linear Distance of flushed Area (feet)	Square Yards Flushed	Gallons of Water Used	Working Time on Route (hours)	Total Time Including To and From Corral (hours)
One Motor-Flusher	I	22,185	126,190	52,800	8.22	-
"	II	12,260	56,040	35,960	6.68	-
"	III	21,790	109,284	49,525	7.75	-
"	IV	20,010	117,871	46,870	7.82	-
		76,245	409,385	185,155	30.47	-
Battery of Two Horse-drawn Flushers	I	21,005	126,047	38,340	6.51	8.35
"	II	23,600	83,457	32,190	5.30	6.01
"	III	21,790	109,284	49,400	7.50	8.30
"	IV	20,010	117,871	58,490	7.35	8.48
		86,405	436,659	158,420	26.66	31.14

Details of Above Table

Linear Distance of Flushed Area)
) See pages 123, 152-155
Square Yards Flushed)

Gallons of Water Used . . . . . See pages 123, 137-145

Time Data . . . . . See pages 123, 146-147

WATER USED

Table No. 17

ROUTE NO. ONE - WESTERN AVENUE, ETC.

Motor Flusher #5 - 52,800 gallons

(No check valve)

Location of Hydrant	Time During Inflow of Water Min.Sec.	Gallons of Water
Western & Adams	1-15	1200
" & 22nd	1-55	1200
" & 20th	1-25	1200
" & 18th	1-25	1200
" & Dorchester	1-40	1200
" Country Club Dr.	1-55	1200
" & 11th	1-20	1200
" & San Marino	1-34	1200
" & 9th	1-26	1200
" & 7th	1-34	1200
" & Ingraham	1-23	1200
" & 6th	3-30	1200
" & 4th	2-12	1200
" & 3rd	1-19	1200
" betw. 1st & 2nd	1-27	1200
" & Temple	1-31	1200
" & Oakwood	1-28	1200
" & Melrose	1-27	1200
" & Melrose	1-30	1200
" & Romaine	1-34	1200
" & Santa Monica	3-20	1200
" & Romaine	1-32	1200
" & Lemon Grove	1-22	1200
" & Melrose	1-10	1200
" & Maplewood	1-20	1200
" & Temple	1-22	1200
" & 1st	1-42	1200
" & 3rd	1-26	1200
" & 3rd	1-8	1200
" & 5th	2-16	1200
" & 6th	2-54	1200
Serrano & 5th	2-29	1200
" & 6th	3-54	1200
Western & Ingraham	1-28	1200
" & 8th	1-25	1200
" & 9th	1-11	1200
" & San Marino	1-18	1200
" & 11th	1-22	1200
" Country Club Dr.	1-20	1200
" & Roxbury	1-38	1200
" & 18th	1-30	1200
" & 20th	1-29	1200
" & 22nd	1-36	1200
" & 24th	1-41	1200

Table No. 18

ROUTE NO. TWO - CENTRAL AVENUE, ETC.

Motor Flusher #4 - 35,960 gallons

(Check Valve)

Location of Hydrant	Time During Inflow of Water Min.Sec.	Gallons of Water
Central & Jefferson	1-47	1200
" & 38th	1-5	1200
" & 40th	1-18	1200
" betw. 42nd & 43rd	1-23	1200
" & 45th	1-14	1200
" & 47th	1-20	1200
" & 49th Place	1-58	1200
" & 52nd	1-10	1200
" & 54th	50	1200
" & 55th	30	720
" & 57th	1-29	1200
" & 58th	1-32	1200
" & 55th	1-13	1200
" & 52nd	1-14	1200
" & 51st	1-32	1200
" & 49th Place	1-8	1200
" & 47th	2-20	1200
" & 45th	2-0	1200
" betw. 42nd & 43rd	1-7	1200
" & 40th	1-36	1200
" & 36th	5-4	1200
" & 34th	1-18	1200
" & 31st	1-42	1200
" & 27th	1-46	1200
" & 25th	2-8	1200
" & 22nd	3-24	1200
" & 20th	56	1200
" & Washington	1-0	440
" & 22nd	1-17	1200
" & 24th	1-22	1200
" & 27th	1-14	1200

Note: The method of obtaining the above tables is explained on page 123.

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WATER USED

Table No. 19
ROUTE NO. THREE - NORTH BROADWAY

Motor Flusher #3 - 49,525 gallons
(No check valve)

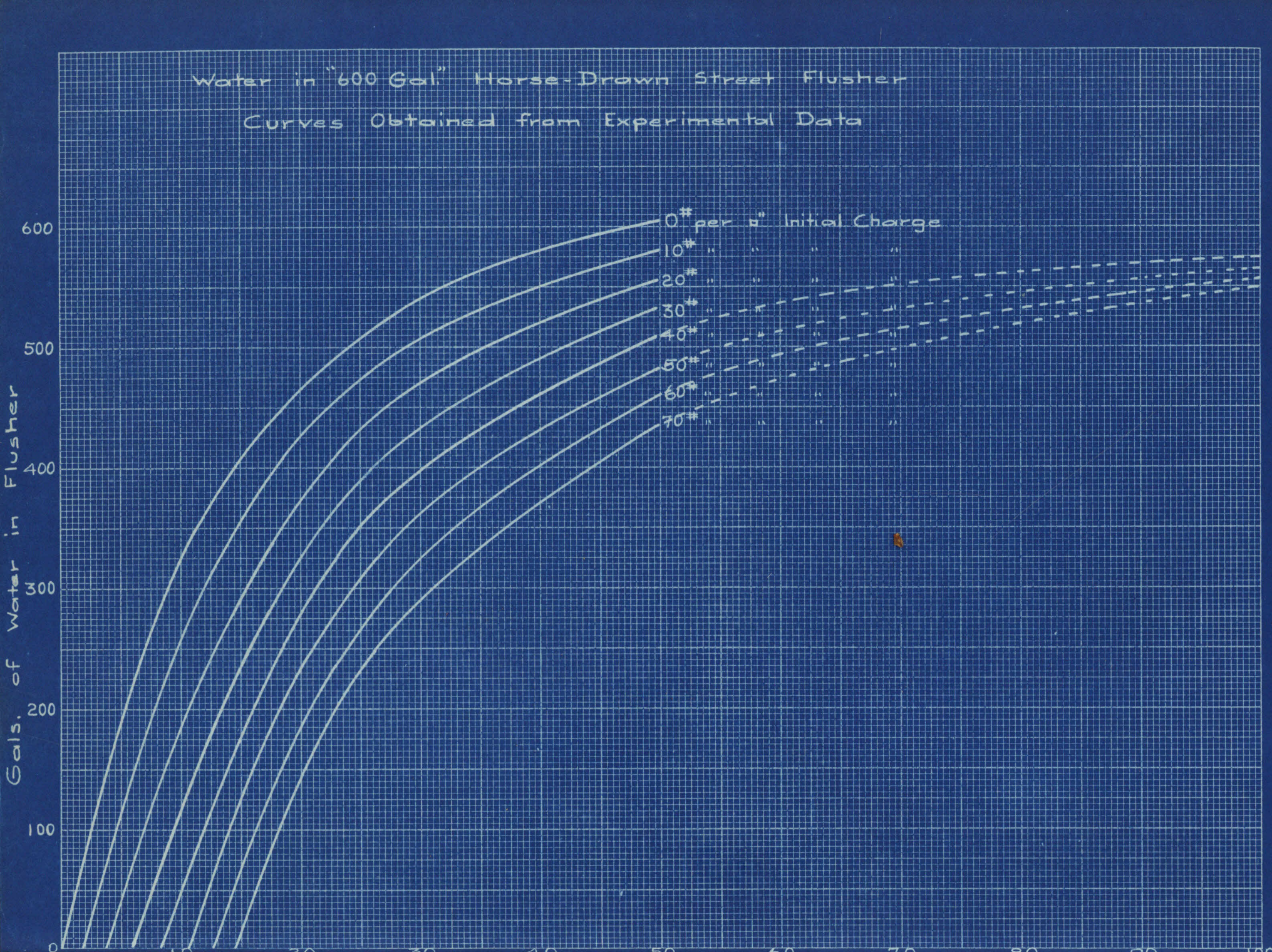
Location of Hydrant	Time During Inflow of Water Min.Sec.	Gallons of Water
Downey & Ave. 18	2-25	1200
Ave. 20 & Broadway	2-6	1200
" 20 & Albion	4-0	1050
" 20 & Darwin	2-9	1200
Main & Moulton	2-8	1000
Ave. 20 & Mozart	3-43	1200
" 20 & Albion	3-32	930
Broadway betw. Ave. 21 & 22	2-18	1200
" & Ave. 24	2-15	775
" & Workman	2-24	830
" & Griffin	2-34	885
" & Hancock	3-47	1200
" & Thomas	1-28	1200
" & Prichard	1-34	1200
Prichard & Manitou	1-38	1200
" & Barbee	2-6	1200
" & Barbee	1-44	800
" & Manitou	1-28	1200
Broadway & Prichard	1-15	960
" & Thomas	1-[illegible]	860
" & Eastlake	1-7	915
" & Johnson	4-15	1200
" & Workman	2-22	1200
" & Workman	2-13	1200
Workman betw.Ave.26 & Bdwy.	3-10	1200
" & Ave. 26	2-30	1200
" & Ave. 26	1-15	1200
Pasadena & Ave. 28	3-0	1200
Workman betw.Pas. & Ave.26	3-38	1200
Pasadena & Ave. 26	3-30	1200
Daly betw.Bdwy.& Ave. 26	1-50	630
Broadway & Workman	1-38	565
" & 24	2-20	805
" & 20	2-32	1200
Ave. 20 & Pasadena	1-44	920
" 20 & Humboldt	2-22	1200
" 20 & Salt Lake R.R.	1-30	760
" 20 & Dayton	2-16	1200
" 20 & Dayton	2-28	1200
" 20 betw. Salt Lake & S.F. R.R.	2-42	1200
" 20 & Humboldt	2-35	1200
Hayden & 22	2-35	1200
Ave. 20 & Humboldt	2-14	1200
" 20 & Pasadena	1-57	1030
" 20 & Broadway	2-8	1010
" 20 & Pasadena	2-16	1200

Table No. 20
ROUTE NO. FOUR - 7th and 9th Sts.

Motor Flusher #1 - 46,870 gallons
(No check valve)

Location of Hydrant	Time During Inflow of Water Min.Sec.	Gallons of Water
Ninth & Vermont	2-3	1200
" betw. Westmoreland & Hoover	2-17	910
" & Carondalet	1-51	1200
" & Alvarado	1-46	1200
" & Burlington	1-55	1200
" & Valencia	1-52	1200
" & Denver	1-55	1200
" & Figueroa	1-28	700
7th betw. Kip & Bixel	2-18	1200
7th & Witmer	1-55	1200
" & Union	2-50	1200
" & Alvarado	1-17	1000
" & Lake	1-56	1200
" & Park View	1-45	1200
" & Carondalet	2-33	1200
" & Rampart	1-47	1200
" & Wilshire Place	2-15	1200
" & Westmoreland	2-22	1200
" & Vermont	2-20	1200
" & Westmoreland	2-6	1200
" & Wilshore Place	2-35	1200
" & Hoover	1-38	1200
" & Coronado	2-34	1200
" & Park View	2-0	1200
" & Lake	2-0	1200
" & Westlake	2-37	1200
" & Bonnie Brae	2-2	1200
" & Beacon	2-40	1200
" & Valencia	3-18	1200
" & Witmer	2-3	1200
" & Garland	3-45	1200
" betw. Kip & Bixel	2-33	1200
9th & Figueroa	3-31	1200
" & Denver	2-17	1200
" & Albany	1-48	1200
" & Beacon	2-35	1200
" & Westlake	3-10	1200
" & Grand View	2-13	1200
" & Hoover	1-52	1060
" betw. Westmoreland & Hoover	3-1	1200

Note: The method of obtaining the above tables is explained on page 123.


Water in "600 Gal" Horse-Drown Street Flusher
Curves Obtained from Experimental Data
0# per ▫" Initial Charge
10# " " " "
20# " " " "
30# " " " "
40# " " " "
50# " " " "
60# " " " "
70# " " " "
Gals. of Water in Flusher
600
500
400
300
200
100
0

The curves shown in Chart No. 39 were used in estimating the amount of water used by the battery of horse-drawn flushers. The method of using them in this test is described on page

Method of Obtaining Curves on Chart No. 39

A "600-gallon" flusher was weighed empty and with atmospheric pressure in the tank. Then water was allowed to flow into it until water began to go over into the air chamber, i.e., until the water chamber was entirely full. The pressure in the flusher was then noted, and the full flusher weighed. Next, water was discharged from the flushing nozzles until the pressure gauge showed a 5-lb. drop in pressure. At this point the flusher was again weighed. This cycle of operations was repeated until a record had been obtained of the weight of the flusher and its contents at pressures in the flusher tank varying from zero lb. per square inch (atmospheric pressure) to the maximum pressure obtained when the water chamber was full. From this data a curve was drawn between water in flusher and pressure in flusher at zero initial charge.

The above process was repeated for each of the following initial charges in the air chamber - 10 lbs., 20 lbs., 30 lbs., 40 lbs., and 50 lbs. The test was stopped at 50 lbs. initial charge because the hydrants near the only scales available gave a pressure of only a little above 50 lbs.

The curves shown in Chart No. 39 are curves derived from the original data obtained. They are not the direct plotting of this data, because the initial charging pressures actually obtained in the experiment were not exactly 10 lbs., 20 lbs., 30 lbs., etc.; and, furthermore, the experimental data of course did not give perfectly smooth curves. To obtain the smooth curves shown, supplementary curves were drawn between water in flusher and initial charging pressure, a separate curve being drawn for 5-lb. pressure in flusher, 10-lb. pressure in flusher, etc. Since these last are straight line "curves," the experimental data could be more accurately averaged by their use, and from them were drawn the smooth curves given in Chart No. 39.

Table No. 21

WATER USED

Route Number One -- Western Avenue, etc.

Horse-Drawn Flusher #29 -- Total Gallons - 19,170.

Location of Hydrant	Pounds Pressure in Tank At begin. of fill	At end of fill	Estimated Water in Tank At begin. of fill	At end of fill	Net in tank		
Washington & Harvard	0	62	0	600	600	Charge - 62 lbs.	
24th & Western	0	60	0	490	490	"	"
22nd & "	17	61	110	495	385	"	"
20th & "	16	63	85	500	415	"	"
18th & "	16	66	85	505	420	"	"
Dorchester & Western	11	66	0	520	520	"	51 lbs.
Country Club Drive	11	78	0	540	540	"	"
11th	15	81	120	545	425	"	"
10th	19	73	210	535	325	"	"
9th	13	81	60	545	485	"	"
8th	17	73	165	535	370	"	51 lbs.
7th	19	66	210	525	315	"	"
6th	10	87	0	560	560	"	47 lbs.
5th	19	92	250	560	310	"	"
4th	19	92	250	560	310	"	"
3rd	19	92	250	560	310	"	47 lbs.
Fire House	15	82	145	555	410	"	"
Temple	9	94	0	565	565	"	42 lbs.
Maplewood	12	87	90	565	475	"	"
Melrose	17	83	215	560	345	"	"
Lemon Grove	10	74	35	550	515	"	42 lbs.
Sierra Vista	15	72	165	550	385	"	"
Santa Monica	14	71	140	550	410	"	"
Santa Monica	0	71	0	490	490	"	71 lbs.
Romaine	21	76	160	500	340	"	"
Marathon	14	84	0	525	525	"	71 lbs.
Clinton	22	87	185	530	345	"	"
Temple	17	97	70	545	475	"	"
Fire House	14	82	0	525	525	"	"
3rd	15	102	10	550	540	"	"
4th	24	92	215	535	320	"	71 lbs.
5th	24	95	215	540	325	"	"
6th	20	97	140	545	405	"	"
Ingraham	19	72	120	505	385	"	"
7th	25	70	230	500	270	"	"
9th	13	82	0	535	535	"	60 lbs.
10th	13	77	0	525	525	"	"
11th	19	82	170	535	365	"	"
Country Club Drive	19	82	170	535	365	"	"
Pico	17	73	120	520	400	"	"
Cambridge	16	72	95	520	425	"	60 lbs.
18th	17	72	120	520	400	"	"
20th	14	70	40	515	475	"	"
22nd	13	70	0	515	515	"	"
24th	19	66	170	505	385	"	"

Note: The method of obtaining the above table is explained on page 124.

Table No. 22

W A T E R U S E D

Route Number Two - Central Avenue, etc.

Horse-Drawn Flusher #29 -- Total Gallons - 16,095

Location of Hydrant	Pounds Pressure in Tank At begin. of fill	At end of fill	Estimated Water in Tank At begin. of fill	At end of fill	Net in tank		
Washington & Griffin	0	56	0	600	600	Charge - 56 lbs.	
Central & Jefferson	0	61	0	505	505	"	"
" & 38th	13	64	30	510	470	"	"
" & Vernon	12	70	5	520	515	"	"
" & 47th	10	71	0	535	535	"	48 lbs.
Central & 50th	13	74	90	540	450	"	48 lbs.
" & 54th	10	76	0	545	545	"	"
" & 57th	19	76	225	545	320	"	"
" & 57th	16	81	165	550	385	"	"
" & 54th	19	78	225	545	320	"	"
Central & 51st	14	79	110	550	440	"	48 lbs.
" & 49th	16	73	165	540	375	"	"
" & 45th	15	72	140	540	400	"	"
" near 43rd	17	70	185	535	350	"	"
" & 39th	13	72	90	540	450	"	"
Central & Jefferson	13	71	90	535	445	"	48 lbs.
" & 31st	14	64	110	525	415	"	"
" & 27th	13	65	90	525	435	"	"
" & 24th	13	62	90	520	430	"	"
" & 20th	11	59	25	515	490	"	"
Central & 20th	12	58	50	510	460	"	48 lbs.
" & 23rd	9	61	0	520	520	"	"
" & 27th	9	63	0	525	525	"	"
" & 31st	12	65	50	525	475	"	"
" & 36th	11	71	25	535	510	"	"
Central & 38th	0	72	0	535	535	"	72 lbs.
Hooper & 38th	17	71	70	500	430	"	"
Ascot & 39th	15	70	10	500	490	"	"
Ascot & 42nd	16	72	40	505	465	"	"
Ascot & 39th	15	67	10	490	480	"	"
Compton & 38th	14	71	0	505	505	"	68 lbs.
38th near Long Beach	16	71	60	505	445	"	"
" & Compton	14	71	0	505	505	"	"
" & Hooper	14	70	0	500	500	"	"
" near Naomi	19	71	130	505	375	"	"

Note: The method of obtaining the above table is explained on page 124.

Table No. 23

WATER USED

Route Number Three - North Broadway, etc.

Horse-Drawn Flusher #7 --- Total Gallons - 24,700.

Location of Hydrant	Pounds Pressure in Tank At begin. of fill	At end of fill	Estimated Water in Tank At begin. of fill	At end of fill	Net in tank		
Alpine & Broadway	0	45	0	595	595	Charge - 45 lbs.	
Broadway & Ave. 18	0	41	0	450	450	"	"
" & Ave. 19	13	41	100	450	350	"	"
" & Ave. 20	13	38	100	435	335	"	"
Albion & Ave. 20	9	40	0	445	445	"	"
Mozart & Ave. 20	9	46	0	475	475	"	45 lbs.
Darwin & Ave. 20	10	41	20	450	430	"	"
" & Ave. 20	7	45	0	505	505	"	32 lbs.
Mozart & Ave. 20	8	45	50	505	455	"	"
Albion & Ave. 20	9	40	75	480	405	"	"
Broadway & Ave. 20	8	39	50	475	425	"	32 lbs.
" & Ave. 22	7	31	0	425	425	"	"
" & Ave. 24	11	34	125	450	325	"	"
" & Workman	7	32	0	440	440	"	"
" & Sichel	9	33	75	445	370	"	"
Broadway & Griffin	10	32	100	440	340	"	32 lbs.
" & Johnson	10	30	100	425	325	"	"
" & Hancock	10	29	100	415	315	"	"
" & Eastlake	9	70 (Approx)	75	560	485	"	"
" & Thomas	8	70 "	50	560	510	"	"
Broadway & Prichard	10	70 "	100	560	460	"	32 lbs.
Prichard & Manitou	12	70 "	155	560	405	"	"
Prichard & Barbee	8	70 "	50	560	510	"	"
Prichard & Manitou	7	70 "	0	560	560	"	"
Prichard & Broadway	11	70 "	130	560	430	"	"
Broadway & Thomas	10	70 "	100	560	460	"	32 lbs.
" & Eastlake	9	70 "	75	560	485	"	70
" & Eastlake	0	70 "	0	500	500	"	"
" & Johnston	14	30	0	290	290	"	"
" & Griffin	14	33	0	320	320	"	"
Broadway & Sichel	14	33	0	320	320	"	70 lbs.
" & Workman	14	34	0	325	325	"	"
Workman & Manitou	13	37	0	380	380	"	60
" & Broadway	14	33	40	350	310	"	"
" near Broadway	11	31	0	370	370	"	50
Workman & Ave. 26	11	28	0	340	340	"	50 lbs.
Pasadena Ave. & Ave.28	11	28	0	340	340	"	"
" " & Ave.28	11	23	0	280	280	"	"
Workman near Ave. 28	11	25	0	305	305	"	"
" & Ave. 26	11	28	0	340	340	"	"

Flusher #7 (Continued)

Location of Hydrant	Pounds Pressure in Tank At begin. of fill	At end of fill	Estimated Water in Tank At begin. of fill	At end of fill	Net in tank		
Workman near Broadway	11	31	0	370	370	Charge	50 lbs.
" " "	10	31	0	385	385	"	45
Ave. 26 & Griffin	11	70	50	540	490	"	"
Ave. 26 & Pasadena Ave.	11	28	50	360	310	"	"
Ave. 26 & Workman	11	26	50	340	290	"	"
Daly & Broadway	9	30	0	395	395	"	40 lbs.
" & "	9	30	0	395	395	"	"
" & "	9	30	0	395	395	"	"
Broadway & Ave. 22	11	32	75	410	335	"	"
" & Ave. 20	9	39	0	455	455	"	"
Ave. 20 & Barranca	9	38	0	450	450	"	40 lbs.
" 20 & Santa Fe R.R.	9	35	0	430	430	"	"
" 20 & Dayton	9	35	0	430	430	"	"
" 20 & Dayton	9	35	0	430	430	"	"
" 20 near Dayton	9	35	0	430	430	"	"
Ave. 20 & Salt Lake R.R.	9	35	0	430	430	"	40 lbs.
" 22 & Hayden	9	35	0	430	430	"	"
" 22 & Hayden	9	35	0	430	430	"	"
" 20 & Pasadena	8	38	0	450	450	"	"
" 20 & Broadway	8	36	0	450	450	"	"
Pasadena & Ave. 18	11	40	75	460	385	"	"

Note: The method of obtaining the above table is explained on page 124.

Table No. 24

W A T E R U S E D

Route Number Four - Seventh and Ninth Streets

Horse-Drawn Flusher #5 -- Total Gallons - 19,245.

Location of Hydrant	Pounds Pressure in Tank At begin. of fill	At end of fill	Estimated Water in Tank At begin of fill	At end of fill	Net in tank		
15th & Los Angeles	0	39	0	510	510	Charge - 39 lbs.	
9th & Figueroa	0	40	0	510	510	"	"
" & Georgia	10	42	50	470	420	"	"
" & Garland	10	42	50	470	420	"	"
" & Grattan	9	35	35	435	400	"	"
9th & Beacon	11	29	75	390	315	"	"
" & Bonnie Brae	9	28	35	380	345	"	"
" & Alvarado	9	29	35	390	355	"	"
" & Grand View	9	31	35	405	370	"	"
" & Hoover	9	44	35	480	445	"	"
9th & Wilshire Place	10	51	50	510	460	"	"
" & Westmoreland	10	54	50	520	470	"	"
" & Hoover	10	46	50	490	440	"	"
" & Grand View	10	31	50	405	355	"	"
" & Alvarado	10	31	50	405	355	"	"
" & Bonnie Brae	10	28	50	380	330	"	"
9th & Beacon	7	31	0	405	405	"	35 lbs.
" & Grattan	8	35	25	450	425	"	"
" & Albany	10	39	85	470	385	"	"
" & Sunbury	8	44	25	495	470	"	"
" & Georgia	13	45	165	500	335	"	"
" & Figueroa	10	43	85	490	405	"	"
7th & Figueroa	0	34	0	415	415	"	43 lbs.
" & Bixel	10	44	30	470	440	"	"
" & Bixel	15	44	160	470	310	"	"
" & Witmer	10	56	30	520	490	"	"
" & Valencia	12	47	85	485	400	"	"
7th & Union	10	51	30	500	470	"	"
" & Burlington	11	54	55	510	455	"	"
" & Alvarado	10	75	30	555	525	"	"
" & Alvarado	16	75	185	555	370	"	"
" & Park View	11	35	55	425	370	"	"
7th & Coronado	10	34	30	415	385	"	"
" & Hoover	10	41	30	455	425	"	"
" & Wilshire Place	10	43	30	465	435	"	"
" & Vermont	10	52	30	505	475	"	"
" & Wilshire Place	10	42	30	460	430	"	"
7th & Lake	9	41	10	455	345	"	"
" & Westlake	9	37	10	435	425	"	"
" & Beacon	7	22	0	335	335	"	35 lbs.
" & Hoover	10	41	85	480	395	"	"
" & Coronado	11	33	110	435	325	"	"
7th & Carondalet	11	33	110	435	325	"	"
" & Union	9	45	85	500	415	"	"
" & Witmer	8	51	30	520	490	"	"
" & Bixel	7	45	0	500	500	"	"
" & Bixel	12	47	140	510	370	"	"

TIME DATA

Operation	Sum of the Seconds Consumed by Each of Two Horse-drawn Flushers				
	Route I	Route II	Route III	Route IV	All Routes
Going to Hydrants:					
Turning 180°	1448	1058	860	1186	4552
Moving forward	2423	1186	2158	2443	3210
Waiting for other team	590	469	1516	527	2902
Standing at Hydrants:					
Before water inflow	4637	3102	4069	4604	16412
After water inflow	5459	4091	4350	4449	18349
During water inflow	11805	10000	18718	14953	55476
Going from Hydrants:					
Turning 180°	972	799	1453	979	4203
Moving forward	2516	1542	2403	2281	8742
Flushing	15985	14016	16597	18802	65200
Traveling (to and from corral)	13194	5207	5651	8062	32114
Other traveling	---	---	329	690	1019
Repairing	---	273	25	145	443
Charging air tanks	1111	1131	1684	1072	4998
Traffic delays	197	426	122	655	1400
Other delays	---	17	---	160	177
Total	60137	43317	59735	61008	224197
Summary of above					
Total Working Time on Route	46943	33110	54084	52946	192083
Traveling Time to and from corral	13194	5207	5651	8062	32114

Table No. 25

(The above quantities were obtained by direct observation)

TIME DATA

Operation	Total Seconds Consumed by One Motor-driven Flusher				
	Route I	Route II	Route III	Route IV	All Routes
Going to Hydrants:					
Turning 180°	----	60	60	50	170
Moving backwards	1244	862	522	1030	3658
Moving forward	762	890	1308	992	3952
Standing at Hydrants:					
Before water inflow	3022	1984	1825	2825	9656
After water inflow	2445	1592	2025	2636	8698
During water inflow	4538	2937	6464	5414	19353
Going from Hydrants:					
Turning 180°	----	173	309	----	482
Moving backward	2092	1847	2385	1854	8178
Moving forward	808	341	794	600	2543
Flushing	12283	12738	12001	11632	48654
Repairing	2172	166	75	1144	3557
Traffic delays	81	460	102	18	661
Other delays	78	30	45	----	153
Total	29525	24080	27915	28195	109715

Table No. 26

(The above quantities were obtained by direct observation)

Table No. 27

QUANTITATIVE DUST TESTS

Street & Section		Grams of Dust	When Taken	Type of St.Cleaner	% of Dust by wt.	% (by weight) of sweepings retained on screen								% passing #200
						#10	#20	#30	#40	#50	#80	#100	#200	
23rd (2 cuts)	A	71.20	Before	H.Flusher		--	8.2	6.5	6.1	6.4	9.1	3.2	20.3	40.2
" " "	B	67.45	"	" "		--	8.1	7.5	7.0	6.1	10.1	3.2	18.9	39.1
" " " Avg.	A&B	69.33	"	" "	100%	--	8.15	7.0	6.55	6.25	9.6	3.2	19.6	39.65
" " "	C	23.20	After	" "	33.5	--	2.2	2.1	3.4	5.8	11.1	4.8	33.0	37.6
23rd (1 cut)	EA	158.60	Before	H.Flusher		5.8	8.5	7.0	6.8	5.8	9.5	2.7	17.9	36.0
" " "	B	132.70	"	" "		2.9	4.5	5.9	5.9	6.4	9.4	4.1	22.8	38.1
" " "Avg B &	EA	145.65	"	" "	100%	4.35	6.5	6.45	6.35	6.1	9.45	3.4	20.35	37.05
" " "	C	60.30	After	" "	41	1.7	1.8	2.8	3.5	4.7	9.4	4.9	25.7	45.5
Western Ave.,	A	28.75	Before	H.Flusher		8.0	5.3	5.7	7.2	8.3	13.2	5.4	21.4	25.5
" "	C	25.05	"	" "		3.8	4.9	4.8	6.0	6.6	11.9	3.6	22.9	35.5
" " Avg.	A&C	26.9	"	" "	100%	5.9	5.1	5.25	6.6	7.45	12.6	4.5	22.15	30.5
" ""	E	6.6	After	" "	24.5	3.8	2.7	5.1	5.7	8.0	15.2	4.5	32.4	22.6
Western Ave.	B	11.35	Before	H.Flusher		9.9	10.7	6.5	4.6	4.7	8.1	3.2	24.5	27.8
" "	D	9.40	"	" "		2.8	5.3	4.4	4.5	4.8	9.3	2.8	24.1	42.0
" " Avg.	B&D	10.37	"	" "	100%	6.35	8.5	5.45	4.55	4.75	8.7	3.0	24.3	34.8
" "	F	3.2	After	" "	30.8	0.	1.3	1.7	2.7	4.7	10.7	2.7	35.4	40.8
Western Ave.	AB & CD	37.13	Before	H.Flusher	100%	6.1	6.8	5.35	5.58	6.1	10.65	3.75	23.23	32.15
" "	EF	9.80	After	" "	26.4	1.9	2.0	3.4	4.2	6.35	12.95	3.6	33.9	31.7
" "	AB	35.60	Before	M.Flusher		3.1	6.7	9.5	9.7	9.0	11.7	7.6	20.4	22.3
" "	CD	33.70	"	" "		8.5	10.9	7.8	7.0	7.0	11.9	3.3	20.4	23.2
" " Avg.	above	34.65	"	" "	100%	5.8	8.8	8.65	8.35	8.0	11.8	5.45	20.4	22.8
" "	EF	19.75	After	" "	57	3.8	2.7	4.1	4.6	7.0	11.8	5.3	26.6	34.1

Table No. 27 (continued)

Street & Section	Grams of Dust	When Taken	Type of St. Cleaner	% of Dust by wt.	% (by weight) of sweepings retained on screen								% passing #200
					#10	#20	#30	#40	#50	#80	#100	#200	
Central Ave., A	80.60	Before	H.Flusher		3.2	3.2	6.1	8.0	11.0	14.9	4.5	22.4	26.7
" " C	50.77	"	" "		8.3	3.4	4.6	5.0	7.0	11.4	3.9	24.8	31.6
" " Avg. A&C	65.69	"	" "	100%	5.75	3.3	5.35	6.5	9.0	13.15	4.2	23.6	29.15
" " E	36.25	After	" "	55.2	4.1	2.8	4.6	5.0	6.6	11.5	3.4	26.0	36.0
Central Ave., #2	48.65	Before	M.Flusher		5.7	3.7	3.6	4.1	5.5	11.0	4.7	22.4	39.3
" " #4	53.45	"	" "		5.2	3.9	4.7	4.9	6.5	11.5	4.9	23.6	34.8
" " Avg. #2&#4	51.05	"	" "	100%	5.45	3.8	4.15	4.5	6.0	11.25	4.8	23.0	37.05
" " #6	82.35	After	" "	161	9.2	4.5	5.2	5.3	6.8	12.2	5.2	23.4	28.2
Central Ave., B	57.90	Before	H.Flusher		10.1	4.0	4.2	4.6	5.2	9.9	3.2	18.8	40.0
" " D	47.52	"	" "		11.5	4.2	3.9	4.7	5.5	10.9	3.3	19.6	36.4
" " Avg. B&D	52.71	"	" "	100%	10.8	4.1	4.05	4.65	5.35	10.4	3.25	19.2	38.2
" " F	57.00	After	" "	108	5.3	3.4	3.4	4.0	4.9	10.6	3.1	22.4	42.9
Central Ave., #1	55.70	Before	M.Flusher		9.5	5.6	4.5	4.3	4.7	9.8	3.1	18.1	40.4
" " #3	63.25	"	" "		7.6	4.9	4.4	5.1	6.0	12.0	3.6	20.2	36.2
" " Avg. #1 & 3	59.48	"	" "	100%	8.55	5.25	4.45	4.7	5.55	10.9	3.35	19.15	38.3
" " #5	57.30	After	" "	96.4	8.4	4.5	4.7	5.3	6.3	12.4	3.6	21.2	33.6
Hayden, A	172.47	Before	H.Flusher		3.8	3.2	3.9	5.2	5.8	10.4	3.4	22.8	41.5
" B	163.10	"	" "		3.1	2.6	4.0	5.1	6.5	10.5	4.7	24.8	38.7
" Avg. A & B	167.79	"	" "	100%	3.45	2.9	3.95	5.15	6.15	10.45	4.05	23.8	40.1
" C	86.25	After	" "	51.5	0.8	0.6	1.1	2.0	4.2	10.9	5.9	32.3	42.2
Hayden, #1	128.70	Before	M.Flusher		4.0	3.2	4.6	4.1	4.3	7.5	3.9	23.5	44.8
" #2	152.30	"	" "		5.3	3.5	4.1	4.3	3.9	8.1	2.9	20.7	47.2
" Avg. #1 & 2	140.50	"	" "	100%	4.65	3.35	4.35	4.2	4.1	7.8	3.4	22.1	46.0
" #3	119.20	After	" "	85	4.6	3.0	3.5	3.4	4.5	8.8	4.4	24.3	43.5

Table No. 27 (continued)

Street & Section		Grams of Dust	When Taken	Type of St. Cleaner	% of Dust by wt.	% (by weight) of sweepings retained on screen								% passing #200
						#10	#20	#30	#40	#50	#80	#100	#200	
7th St.,	A	62.20	Before	H.Flusher		5.35	6.32	6.65	6.97	6.50	12.3	3.4	23.33	29.18
" "	B	59.35	"	" "		1.53	4.93	7.48	8.5	8.5	11.4	4.94	23.62	29.1
" " Avg	A & B	60.78	"	" "	100%	3.44	5.63	7.07	7.74	7.5	11.85	4.17	23.48	29.14
" "	C	29.95	After	" "	49.2	.67	1.34	2.35	3.36	5.03	11.75	4.7	30.9	39.9
7th St.,	A	60.10	Before	M.Flusher		3.9	4.8	6.0	6.5	6.5	10.9	3.9	21.1	36.4
" "	B	49.30	"	" "		3.0	5.4	8.3	8.3	8.0	12.2	4.9	22.3	27.6
" " Avg	A &B	54.70	"	" "	100%	3.45	5.1	7.15	7.4	7.25	11.55	4.4	21.7	32.0
" "	C	31.90	After	" "	58.3	1.6	1.7	2.8	3.8	5.5	10.8	5.2	30.5	38.1
Figueroa,	AB	132.30	Before	M.Flusher		6.8	6.2	7.7	9.4	8.1	11.4	3.1	16.1	31.2
"	CD	183.05	"	" "		5.1	4.8	7.9	9.1	9.9	12.8	3.7	19.2	27.5
" Avg	above	157.68	"	" "	100%	5.95	5.5	7.8	9.25	9.0	12.1	3.4	17.65	29.35
"	EF	131.55	After	" "	83.4	4.3	2.9	5.0	6.7	8.9	13.8	4.3	25.2	28.9
East 1st	A	21.95	Before	M.Flusher		8.1	4.5	4.2	5.1	5.6	10.8	3.5	20.5	37.7
" "	C	26.45	"	" "		11.4	4.2	5.5	6.1	7.8	12.3	5.3	22.8	24.6
" "Avg	A & C	24.20	"	" "	100%	9.75	4.35	4.85	5.6	6.7	11.55	4.4	21.65	31.15
" "	E	33.85	After	" "	140	2.5	3.0	8.2	10.6	12.2	15.2	5.5	21.1	21.7
East 1st	B	10.40	Before	M.Flusher		12.5	8.4	6.6	6.2	6.3	10.4	3.5	21.2	24.9
" "	D	5.55	"	" "		16.1	10.5	8.4	6.9	6.3	12.6	2.9	21.9	14.4
" "Avg	B & D	7.98	"	" "	100%	14.3	9.45	7.5	6.55	6.3	11.5	3.2	21.55	19.65
" "	F	20.60	After	" "	258	9.9	6.5	7.0	5.5	5.9	12.3	3.4	23.9	25.6
Sunset,	A	49.80	Before	M.Flusher		3.2	5.2	5.5	5.7	5.2	10.5	4.6	25.6	34.5
"	B	46.65	"	" "		3.67	6.06	6.5	5.85	6.06	10.4	4.76	24.5	32.2
" Avg.	A & B	48.23	"	" "	100%	3.44	5.63	6.0	5.78	5.63	10.45	4.68	25.05	33.35
"	C	42.3	After	" "	87.7	2.9	2.9	3.6	3.4	4.8	10.1	3.4	26.3	42.6

Table No. 27 (concluded)

Street & Section	Grams of Dust	When Taken	Type of St. Cleaner	% of Dust by wt.	% (by weight) of sweepings retained on screen								% passing #200
					#10	#20	#30	#40	#50	#80	#100	#200	
Western, #1	38.05	Before	M. Flusher		5.8	6.9	7.2	7.2	6.9	10.6	3.2	18.9	33.3
" #2	32.85	"	" "		3.9	5.7	6.3	6.3	7.0	10.1	4.5	21.2	35.0
" Avg. #1 & #2	35.45	"	" "	100%	4.85	6.3	6.75	6.75	6.95	10.35	3.85	20.05	34.15
" #3	22.30	After	" "	62.9	4.3	2.9	3.9	3.7	6.4	11.2	5.2	24.3	38.1
Walnut (Pasadena) A	42.95	Before	Vac. Clnr.		2.8	9.9	14.7	13.5	12.3	13.9	4.8	17.1	11.0
" " B	34.95	"	" "		5.1	11.8	12.5	13.5	8.0	14.9	3.8	19.0	11.4
" "Avg. A&B	38.95	"	" "	100%	3.95	10.85	13.6	13.5	10.15	14.4	4.3	18.05	11.2
" " C	14.15	After	" "	36.3	5.3	9.8	12.2	12.1	11.6	16.7	4.4	18.8	9.1
California St. (Pasadena) A	87.10	Before	Vac. Clnr.		3.1	8.1	8.9	10.0	9.8	16.7	4.5	21.1	17.8
" " C	89.65	"	" "		4.7	7.8	9.6	10.0	10.6	15.6	6.0	21.4	14.3
" " Avg. A & C	88.38	"	" "	100%	3.9	7.95	9.25	10.0	10.2	16.15	5.25	21.25	16.05
" " E	56.15	After	" "	63.6	2.1	7.6	8.3	9.2	9.3	16.7	4.5	21.7	20.6
California St. (Pasadena) B	34.70	Before	Vac. Clnr.		4.1	5.2	7.0	9.7	9.8	16.3	4.4	21.8	21.7
" " D	36.00	"	" "		2.0	6.3	9.3	10.4	11.2	15.5	5.6	22.2	17.5
" " Avg. B & D	35.35	"	" "	100%	3.05	5.75	8.15	10.05	10.5	15.9	5.0	22.0	19.6
" " F	17.05	After	" "	48.2	4.2	4.3	5.7	6.5	7.9	14.6	4.2	23.0	29.6
(Gutters Only) Pasadena													
Raymond Ave. A	75.80	Before	Vac. Clnr.										
" " C	20.45	"	" "										
" " Avg. A&C	48.13	"	" "	100%									
" " E	16.55	After	" "	34.4									
Raymond Ave. B	15.80	Before	Vac. Clnr.										
" " D	13.40	"	" "										
" " Avg. B&D	14.60	"	" "	100%									
" " F	6.30	After	" "	43.1									

DETAILS OF AREAS FLUSHED

Route No. 1

Motor-Driven Flusher

All of Western Ave. except the aprons between Adams St. and Temple St.

Between Temple St. and Melrose Ave., all of Western except the street car right-of-way.

From Melrose to Santa Monica, on Western Ave., the entire area of the street except the aprons.

All of Oxford St. from curb to curb, between the south property line of 5th St. and the north property line of 6th St.

All of Serrano from curb line to curb line, between the south property line of 5th St. and the north property line of 6th St.

Battery of Two Horse-Drawn Flushers

The horse-drawn flushers flushed the same area on Western as that given above for the motor-driven flusher except that all aprons were flushed by the horse-drawn flushers. Serrano and Oxford were not flushed.

Route No. 2

Motor-Driven Flusher

On Central, between Jefferson and Slauson, the area on the west side of Central between the outer car rail and the curb, with the exception of the aprons.

The area between the outer car rail and the curb, on the east side of Central, from Slauson to Washington, except the aprons.

On the west side of Central, the area between the outer car rail and the curb, between Washington and 28th St., except the aprons.

Battery of Two Horse-Drawn Flushers

Starting at Central and Jefferson, the horse-drawn flushers flushed all of the area on Central given above for the motor-driven flushers, and in addition flushed the following:

Central Ave., from 28th to Jefferson, between outer car rail and curb, except the aprons.

All of 38th St., from Central to end of pavement near Long Beach Ave., except the aprons.

All of Ascot from 38th St. to 43rd, except the aprons.

Route No. 3

Motor-Driven Flusher

N. Broadway from Ave. 18 to Prichard St., except the aprons and the area between the outer rails of the car tracks.

Prichard St. from N. Broadway to Mission Road, except the aprons and the

area between the two innermost rails of each car track.

Ave. 20 from N. Main St. to Pasadena Ave., except the aprons.

Ave. 20 from Pasadena Ave. to Dayton, with the exception of the aprons and the area between the two innermost rails of the car tracks.

Ave. 20 from Dayton to San Fernando, with the exception of the aprons.

All of Ave. 26 between Griffin and Daly Sts., with the exception of the aprons.

All of Daly St. between Pasadena Ave. and N. Broadway, with the exception of the aprons.

The east side of Pasadena Ave., between Ave. 18 and Ave. 20, from the outer car rail to the curb, except the aprons.

Battery of Two Horse-Drawn Flushers

The same areas given above were flushed by the horse-drawn flushers.

(Note:- In calculating areas flushed, the following intersections were considered as being flushed once only - Workman and Ave. 26, Workman and North Broadway, Ave. 20 and North Broadway.)

Route No. 4

Motor-Driven Flusher

All of 9th and 7th Sts., between Figueroa and Vermont, with the exception of the aprons.

Battery of Two Horse-Drawn Flushers

The area given above was flushed by the horse-drawn flushers.

Dimensions Used in Deducting Areas Within Car Tracks

Los Angeles Railway Tracks

Outer rail of outbound track to outer rail of inbound track = 15 feet

Inner rail of outbound track to inner rail of inbound track = 7.5 feet

Width of entire right-of-way, two tracks = 19 feet

" " " " single track = 7.9 feet

Pacific Electric Railway Tracks

Outer rail of outbound track to outer rail of inbound track = 18 feet.

Table No. 28

Data for Area Flushed

Route I - Motor flusher flushed all of below except aprons
Horse-drawn battery flushed all of below including aprons, except no flushing was done on Serrano and Oxford.

Section	Length (feet)	Width (feet)	Width not flushed
Western Avenue			
N.P.L. of Wilshire to S.P.L. of Temple	5216	56	--
" " " to " " Wilshire	100	56	--
S.P.L. " " to N.P.L. " Pico	5185	56	--
N.P.L. " Pico to S.P.L. " Pico	70	48	--
S.P.L. " Pico to N.P.L. " Washington	2550	40	--
N.P.L. " Wash. to S.P.L. " Washington	70	48	--
S.P.L. " Wash. to S.P.L. " 24th	1868	56	--
Next 82 feet	82	48	--
Next 590 ft. to N.P.L. of Adams	590	40	--
S.P.L. of Temple north 1381 feet	1381	56	19
Next 314 feet	314	58 (avg.)	19
Next 725 feet	725	60	19
Next 90 feet	90	60	13.5 (avg.)
Next 135 feet	135	60	7.9
Next 1210 feet	1210	60	--
Next 210 feet	210	50	--
Next 1209 feet to S.P.L. of Santa Monica Blvd.	1209	60	--
Oxford St.			
S.P.L. of 5th to N.P.L. of 6th	590	40	--
Serrano			
S.P.L. of 5th to N.P.L. of 6th	590	40	--

(Above data was obtained from profile maps)

For Horse-drawn Flushing

Area of Western, including aprons, from Adams to S.S. of Temple = 95,869 sq.yds. (From unit area maps)

Area of Western, exclusive of aprons, from Temple to Santa Monica = 28,870 sq.yds. (From profile maps)

Area of aproms on Western from Temple to Santa Monica = 1308 sq. yds.

Total area flushed by horse-drawn battery = 126,047 sq. yds.

Total area flushed by motor flusher = 126,190 sq. yds.

Table No. 29

Data for Area Flushed

Section	Length (feet)	Width (feet)	Width not flushed
Route II			
Central Avenue			
S.P.L. of Wash. to N.P.L. of Slauson	13,217	56	15
S.P.L. of Wash. to S. P. L. of 28th	3,280	56	15
S.P.L. of 28th to S.P.L. of Jefferson	1,915	56	15
58th Street			
E.P.L. of Central to near Long Beach Avenue	3,770	40	--
Ascot Street			
S.P.L. of 38th to S.P.L. of 42rd	1,418	40	--
Route III			
Hayden, Ave. 23 to Ave. 20	1,115	40	--
Pasadena, Ave. 18 to Ave. 20	1,110	56	37
Daly, N. Broadway to Pasadena Ave.	958	40	--
Ave. 26, Griffin Ave. to Pasadena Ave. (excluding Workman intersection)	1,037	40	--
Ave. 20, Pasadena Ave. to N. Main (excluding Broadway intersection)	3,015	40	--
Ave. 20, San Fernando Rd. to Dayton	500	56	--
Ave. 20, Dayton to Pasadena Ave.	2,867	56	7.5
Prichard, N. Broadway to Mission Road	2,100	52	7.5
N. Broadway, Ave. 18 to Prichard	6,228	70	15
Workman, Manitou to Pasadena Ave. (excluding Broadway intersection)	2,860	40	--
Route IV			
9th Street			
W.P.L. Union to E.P.L. Coronado	3,720	50	--
E.P.L. Coronado west 140 feet	140	50	--
Next 2120 ft. to E.P.L. Vermont	2,120	40	--
W.P.L. Figueroa to W.P.L. Union	3,531	50	--
7th Street			
W.P.L. Figueroa to E.P.L. Alvarado	5,712	56	--
E.P.L. Alvarado to E. curb L. Park View	1,069	70	--
Next 201 feet west	201	72	--
Next 78 feet west	78	58 (avg.)	
Next 1269 ft. west to W.P.L. Hoover	1,269	56	--
W.P.L. Hoover to E.P.L. Vermont	2,170	56	--