A REPORT

ON

SOME OF THE FOREST PLANTATIONS OF MASSACHUSETTS.

BY

ARTHUR HERBERT RICHARDSON.

CONTENTS.

1. INTRODUCTION.

INTRODUCTION.

The subject of forest plantations is one which is becoming increasingly important as time goes on. The fast disappearing forests of the United States and Canada make it necessary that some attempt be made to replenish the timber supply of both countries. Both state and private companies are cognizant of this fact, and both have made more or less sporadic attempts to supplement the depleted areas by planting. Particularly is this the case in the older states of the Union, notably Massachusetts, and one may find scattered within its boundaries forest plantations ranging from the age of one year to sixty. Consequently, because of this, the Bay State is probably the best in which to observe the results of forest planting after a long period of years.

The purpose of this study has been to bring together certain facts which may be deduced from the study of a number of plantations of different species, grown on different sites.

The work was carried on chiefly with the Harvard Forest as a centre and embraced, besides the plantations at the Forest, all those which are within reasonable access therefrom.

The writer is indebted to Professor R. T. Fisher of the Harvard Forest School for assistance in securing the following data, and also to the State Department of Forestry for Massachusetts as well as private owners of plantations.

2. NOTES ON PLANTATIONS.

Notes on the Plantations Visited.

Harvard Forest Plantations.

The plantations at the Harvard Forest School have not the advantage of age which many other plantations in the state possess. The oldest at the time of writing would not exceed twelve years. Neither in size are the individual plantations as large as one might wish. The chief value, however, of these plantations is the admirable system of records which has been kept of each. After all, the investigator , ten, twenty or fifty years hence can draw few accurate conclusions if no records have been kept. The necessity of this cannot be stressed too strongly as the value of a plantation as an experiment is depreciated a great deal by such a lack, and the period of time which elapses between planting and harvesting is such that records must be put in a permanent form. In the case of the Harvard Forest School plantations, the record begins with the origin of the seed, mentions the nursery, describes fully the conditions of the site at the time of planting, gives the planting method used and notes on local factors.

Private plantations.

A great deal of private planting has been done in Massachusetts, and much credit and encouragement is due those who have been pioneers in this work. This has been carried on chiefly by those who are interested in replenishing land which otherwise would become eroded beyond recovery as well as utilizing better sites.

Also, the woodworking industries of the state, which are very numerous, have done considerable planting from an economic point of view, because they realize that if the supply of timber is to be maintained, some one must supplement the native stands by planting.

Wachusett Plantations.

The plantations at Clinton, forming a protection for the margins of the Wachusett Reservoir, are perhaps the most creditable piece of reforesting on the continent. The purpose here, primarily, has been to control the water runoff, of the adjoining slopes and the water courses entering the reservoir.

The lake which forms this magnificent reservoir, is about four miles long by two miles wide. It is situated in a natural basin formed by surrounding low hills. The area now occupied by the water has been appropriated largely from what, at one time, was productive farm land. Consequently, with a better quality of soil than that which plantations usually occupy, and with such excellent drainage which the sloping shores provide, the site is an ideal one for tree growth. Due to these factors, and partly also to the close proximity of a large body of water, the trees have made phenomenal growth.

The first planting at Wachusett was done in 1902 on lots 106 B; 107 F and 126 A, section G. This would make the oldest plantations, at the time the study was made (spring of 1920) eighteen years of age. Previous to two years ago, complete records of the work were to be had, but owing to the bursting of a large water conduit, which flooded and cleaned out part of the office building, these have since been destroyed.

State Plantations.

A number of State plantations were included in the report, but these were mostly young plantations, and no attempt was made to keep them separate from the privately owned plantations of the same age.

Older Plantations.

In 1915, the State Department of Forestry published a bulletin entitled "The Older Forest Plantations of Massachusetts, Conifers." It is not intended to trespass on the purpose of this publication, but simply to mention it here, because plantations which it includes must needs form an important part of such a study as this. The purpose was to show by illustration and measurement, what might be expected in a few years, if the land owners of the state would plant trees. The introduction of the bulletin gives some interesting glimpses into the origin of some of these older plantations.

" The period between 1820 and 1880 was one of enthusiastic planting of pine in New England. The lumberman foresaw the time when natural white pine as a marketable commodity would be gone, and the rise in prices would make planted timber of economic importance. Large plantations were made by private owners, and a few by corporations. Seedlings were usually dug up from the fields lying around old seed pines, and planted either at random or in rows, and spaced at distances varying from 4 to 15 feet. Seed plots were attempted by some, and others even tried out broadcast sowing. At the end of this period there were in Massachusetts alone forest plantations of white pine to the extent of 10,000 acres.

Typical of the forest planters of this time, was Mr. Augustus Pratt, a former member of the State Board of Agriculture, who, when nineteen years old, planted pine seed on an old pasture belonging to his father. The wood lot which thus developed has been recently cut, and was between forty and fifty years old.

After 1880 interest began to decline, chiefly because of the immense supply of lumber brought from the region of the Great Lakes at a low rate of transportation and the inadequate methods of combating forest fires; these conditions tended to gradually dampen the enthusiasm of the forest planter."

Most of the plantations mentioned in the publication were visited by the writer, and the results of the visits recorded, as well as it is possible to record such things, in the subjoined tables. But in viewing stands of timber such as these, there come thoughts and conclusions which cannot be reduced to writing, as well as a deep sense of satisfaction. It is as if the results which you have been striving for, the work which you have been advocating and which cannot be realized more than once in a life time were by one pass of the magician's hands revealed before your eyes.

Cape Cod Plantations.

A study of the plantations of Massachusets would not be complete without mentioning the work done in connection with the reclaiming of the sand dunes at Cape Cod. A visit was made to this area in the spring of 1919 and the plantations were examined to the extent that a part of a day would allow. The work at the Cape, however, is primarily to retard the encroachment of the sand dunes.

In connection with this, the use of trees is being largely supplanted by beach grass and bayberry. The plantations examined, where exposed to the sweep of the Atlantic wind, were a failure, and it would seem that without first stabilizing the sand by some binding growth that such species as Pitch and Jack pine even, could not withstand the punishment which the force of the ocean winds inflict.

A study of this work was made a few years ago by the United States Department of Agriculture, the results of which have been embodied in Bulletin $ 65 entitled "Reclaiming of Cape Cod Sand Dunes."

3. DESCRIPTIVE TABLES.

WHITE PINE

Site Quality I.

No.	Name	Size In Acres	Blanks	Cause of Blanks	Competing Growth	Recent Weeviled	Spacing	Planting Method	Age	Height
1.	N.Ashburnham 21	8					8x8		5	3
2.	Waterville 19	25					6x6		6	5
3.	Wachusett 5	4					6x6		8	6
4.	Royalston 10	5	1/10				6x6		10	7
5.	Wachusett 1	10					6x6		14	17
6.	Wachusett 21	4					8x8		15	15
7.	Wachusett 3	8					6x6		15	24
8.	Wachusett 11	1					10x12		16	25
9.	Wachusett 2	8					6x6		16	18
10.	Wachusett 12	3					12x12		17	24
11.	Wachusett 4	8					6x6		17	25
12.	N. Andover	4					6x5		17	18
13.	Wachusett 17	4					6x6		17	25
14.	Wachusett 18	3					12x15		17	20

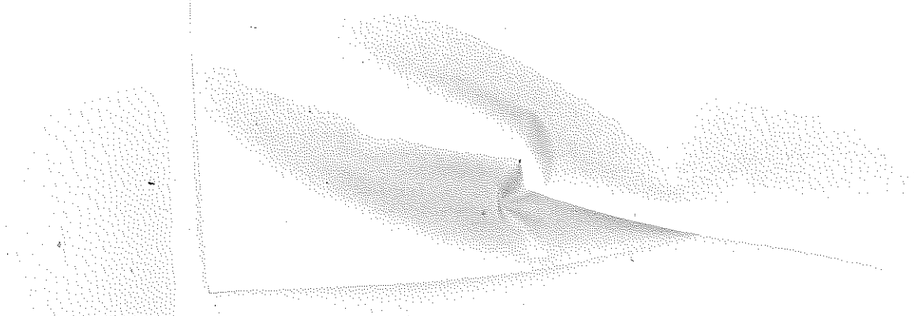
Site Quality II.

No.	Name	Size In Acres	Blanks	Cause of Blanks	Competing Growth	Percent Weeviled	Spacing	Planting Method	Age	Height
1.	P.H.,C3-30	½	2/3	competing herbaceous and woody growth		5	6x6	slit sod on	4	3
2.	P.H.,C3-29	1				5	3x3 to 6x6	3 different	4	1.5
3.	P.H.,C6-16W	4	1/5	competing herbaceous and woody growth		15	6x6	side hole	5	3
4.	P.H.,C6-16E	4	1/5	competing herbaceous and woody growth		5	6x6	side hole	5	3.5
5.	P.H.,C8-21	1	1/5	competing woody growth		5	6x6	mattock hole	7	5
6.	Ashburnham 1	1		competing woody growth			8x8		8	3
7.	P.H.,C1-25	1.5	1/5	competing herbaceous & woody growth	sweetfern hardwoods	25	6x6	mattock hole	9	6
8.	P.H.,C3-1	1	1/4	ant hill and shade		35	6x6	mattock hole	9	5.5
9.	P.H.,C1-25	1.5	2/3	competing growth		15	6x6	mattock hole	9	6.5
10.	New Boston 16	10	1/10				6x6		9	6
11.	P.H.,C4-13	7.5	9/10	competing woody growth	sweetfern blueberry tussock	5	6x6	mattock hole	10	5.5
12.	P.H.,C2-10	1	2/3	competing woody growth & shade	sweetfern blueberry tussock		5x5		11	5
13.	P.H.,C2-3	3				5	6x6	mattock hole	11	8
14.	Bullardsville 8	2	1/10				6x6		11	8
15.	Bullardsville 9	1	2/3	wind			6x6		11	7
16.	Wachusett 10	1					6x6		13	12

WHITE PINE

Site Quality III.

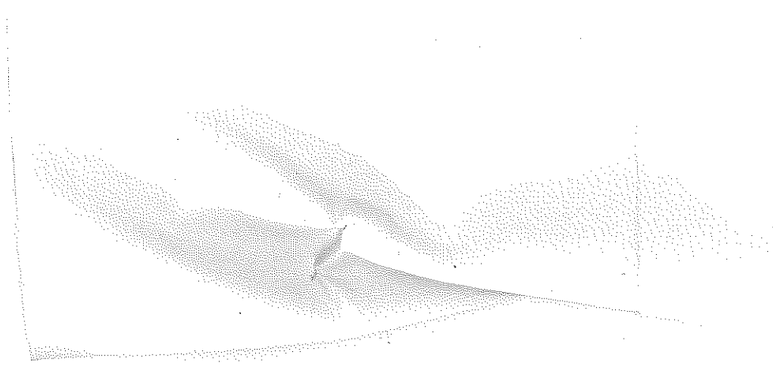
No.	Name	Size In Acres	Blanks	Cause of Blanks	Competing Growth	Percent Weeviled	Spacing	Planting Method	Age	Height
1.	Bullardsville 7	2	1/10	competing growth, marshy	young hardwoods		6x6		10	7
2.	Wachusett 10	½	¼	sour soil			6x6		13	6



SCOTCH PINE

Site Quality I.

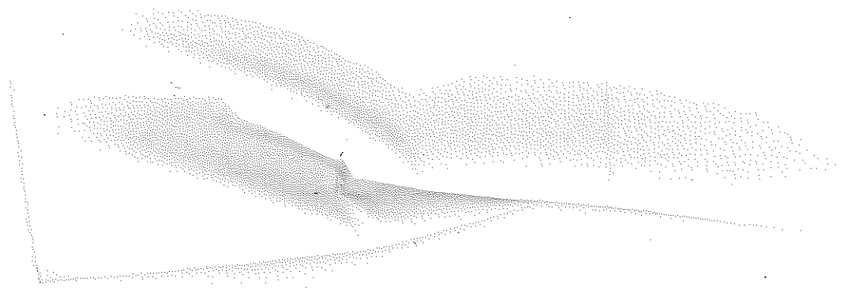
No.	Name In Notes	Size In Acres	Blanks	Cause of Blanks	Competing Growth	Planting Method	Spacing	Age	Height	Additional Notes
1.	P.H.,C6-16	¼				side hole	6x6	5	5.5	
2.	P.H.,C3-3	½	1/3	mice		mattock hole	6x6	6	6	
3.	P.H.,C7-18	½			blueberry	slit sod off	6x6	6	6	
4.	Ashburnham 2	5	1/3	poor stock		mattock hole	6x6	6	4	
5.	P.H.,C3-3	½	4/5	mice		" "	6x6	7	9	thick grass beneath trees
6.	Race course 18	10					6x6	7	6	trees on actual course average 3' & sickly due to compact soil
7.	P.H.,C3-3	½	1/3	mice			6x6	8	6	
8.	Winchendon 3	40	1/10	mice			6x6	8	7	thick grass beneath trees
9.	New Boston 12	2	1/20	mice			6x6	10	8	
10.	Whitney 17	4					6x6	10	12	
11.	N.Ashburnham 20	8	1/20	mice			6x6	10	11	thick grass beneath trees



SCOTCH PINE

Site Quality II.

No.	Name	Size In Acres	Blanks	Cause of Blanks	Competing Growth	Planting Method	Spacing	Age	Height	Additional Notes
1.	New Boston 14	1					6x6	5	2.5	
2.	New Boston 15	1					6x6	5	2.5	
3.	Whitney 13	100					6x6	6	3	flat sand plain
4.	Whitney 11	5					6x6	7	3	
5.	Bullardsville	5	1/15				6x6	7	4	flat sand plain



LARCH

Site Quality I.

No.	Name In Notes	Size In Acres	Blanks	Cause of Blanks	Competing Growth	Planting Method	Spacing	Age	Average Height	Additional Notes
1.	P.H.,C1-26	1/8			heavy grass,aspen root suckers	slit sod off	6x6	6	8	Larix leptolepsis
2.	P.H.,C7-9	1/2				variety	8x8	6	10	Larix larix
3.	P.H.,C1-24	1/8			witch grass	mattock hole	6x6	7	11	Larix europeae

LARCH

Site Quality II.

No.	Name In Notes	Size In Acres	Blanks	Cause of Blanks	Competing Growth	Planting Method	Spacing	Age	Average Height	Additional Notes
1.	P.H.,C5-17	1½	½		mixed woody growth	slit sod off	7x7	5	9	Larix larix
2.	P.H.,C5,P.17	3 1/3	½		" " "	" " "	7x7	5	8.5	" "
3.	Wachusett 14	2					6x6	15	27	
4.	Wachusett 16	4					6x6	16	25	

LARCH

Site Quality III.

No.	Name In Notes	Size In Acres	Blanks	Cause of Blanks	Competing Growth	Planting Method	Spacing	Age	Average Height	Additional Notes
1.	P.H.,C5-17	$2\frac{1}{2}$	$\frac{3}{4}$	Rigorous site	mixed woody growth	slit sod off	7x7	5	4	Larix larix
2.	P.H.,C5-17	4 1/3	$\frac{3}{4}$	" "	" " "	" " "	7x7	5	5.5	" "

4. QUESTIONS TO BE ANSWERED.

QUESTIONS TO BE ANSWERED.

I. How much and to what extent did the various accepted site classes affect the height growth? (height, volume or both).

To answer this question adequately the reader is referred to the subjoined tables.

II. Yield?

To answer this question adequately, the reader is referred to the subjoined tables.

III. What per cent of the total areas examined for each site class was failed?

White Pine

Site Quality		I.	0.52
"	"	II.	29.0
"	"	III.	(12.8) not sufficient number examined.

Scotch Pine

Site Quality		I.	9.4 (mice responsible for most of this.)
"	"	II.	0.3

Larch

Site Quality		I.	0.0
"	"	II.	22.7
"	"	III.	75.0

IV. What are some of the causes of failure in a forest plantation?

Many questions arise as to what may increase or retard the success of a forest plantation. A long list might be drawn up, but after visiting the hundred odd plantations upon which this study is based, the most important may be gathered under the following headings:-

(a) Nursery and Planting.

It is not intended here to go into the practice of forest nursery work. That is a field which this treatise does not discuss. But let it be said that unless great care is taken at the time the plants are leaving the nursery and being planted, no amount of care and natural favorable conditions will atone for the neglect. There are a number of little things each in themselves of small account, yet taken together in their accumulative effect which go far to destroy the success of the plantation. From the nursery until the plants are in the ground in their permanent site, is a critical stage and demands the greatest possible care from injury and dying out.

Of many plantations visited where the percentage of failures was high, after considering such factors as soil site and location, no other reason could be given for their condition than that of poor stock and neglect.

(b) Other things being equal, does the choice of site within a species botanical range account for many failures?

This is one of the fundamentals of sylvics. Briefly let it be said that a slight difference in site, such as a location which subjected the trees to slightly more shade or moisture

and particularly, wind, accounted for many failures. A good example of the effect of wind on the percentage of failure is shown by the larch plantations at Havard on the slopes of Prospect Hill. Where the trees have a moderate amount of protection, they have done well, but as they ascend the hill and are subjected to the sweep of the winds the plantation is a failure.

(c) Does the planting method account for much loss in the plantation?

The influences of the planting method cannot be traced beyond the end of the first year. But during that first year, the plantation may be greatly diminished, if the choice of planting method has not been a wise one. From observations of plantations where records have been kept, the planting method to be recommended is one which allows the roots to hang perpendicular in the hole and which also minimizes the amount of competing growth for the first year.

(d) What effect if any, did the competing vegetation if any, have on the survival of the plantation?

This in the opinion of the writer is the most important cause of failure in forest plantations; and especially so where the tree is a light demanding species. Where the planting is done on thick sod or in long grass, with the commonly used species of pine, and at least eighteen inches is not removed from around the plant the loss is ninety per cent. Other woody growth varies with the species as does also the species of tree planted with different species of competing growth.

(e) To what extent may sour soil be accounted for in the percentage of failures?

By sour soil is meant alkaline soil or stagnant areas of a plantation caused by saucer shaped depressions in the site. This condition has been referred to as "frost pockets". Frost is not to blame here, but the inability of the plants to receive proper nourishment from the soil.

This condition is very noticeable where planting has been done on blow sand where craters have been left by the fancy of the wind. Trees planted in such areas invariably die, not even the tenacious poplar and willow have survived under such conditions when the alkaline condition was severe.

(f) Are trespassing animals responsible for much loss?

The greatest loss of this kind is attributed to mice where long matted grass covers the floor of the plantation, this injury is most imminent. The mice apparently use the tender bark of the young trees for food. Feeding of this kind is done under the snow and in most cases the trees are completely girdled.

During the severe winter of 1918 a number of plantations were injured by this means.

5. THE RELATION OF PLANTING METHOD TO HEIGHTH GROWTH.

THE RELATION OF PLANTING METHOD

TO HEIGHT GROWTH.

In the spring of 1913, Mr. E.H.Carter, then Assistant Professor of Forestry in Harvard University, conducted a number of experiments with forest plantations in order to determine if possible, the relation of planting methods to survival. A description of these experiments and the results obtained were published as an article in the Proceedings of the Society of American Foresters, Volume X, Number 1, Page 9.

In setting out to determine this relationship, Mr. Carter chose for his site a medium to low quality I for white pine, on the basis of Frothingham's yield table. The species he used were; White Pine, Scotch Pine, Douglas Fir, Norway Spruce and Western Yellow Pine. The three planting methods employed are known at the Harvard Forestry School as, the mattock hole, the slit, sod on, and the slit sod off methods.

More complete data about the site, the species used and the planting methods employed, will be found in Mr.Carter's article, but for the purpose of the present writer, it is thought well to describe more fully the planting methods used.

The mattock hole method consists of digging a hole with the mattock and removing all the earth therefrom. The seedling is then carefully planted with the hands, care being exercised in seeing that the roots are perpendicular and that the root collar is at the proper level. The earth is then swept back into the hold and tamped firmly with the hands and closed fists.

With the slit sod off method, "the first act is to cut off at least a square foot of sod, the second to drive the blade of the mattock as deeply as possible with one stroke, and to twist or pull the mattock so as to lift a mass of earth on the blade, thus leaving a hole into which the roots of the seedling are slipped, and the third is to remove the mattock and firm the earth over the roots by one or more vigorous stamps."

The slit, sod on method "is exactly like the second except that no sod is cut off, and the seedling is left with its stem in contact with the grass."

At least one row of each species, with about forty trees in each row, were planted by each of the three methods, and the rows distributed irregularly as regards both species and planting method in order to compensate for any unseen difference in site. The condition of each tree was determined about once a month for two growing seasons and the results recorded in a table which forms part of Mr.Carter's article. It was concluded that the influences of planting methods to survival,cannot be traced beyond the end of the first year.

In the fall of 1919 this plantation was measured by the writer in order to determine if possible, the relation between the height growth of the various species and the planting method employed, after a period of seven growing seasons. Each tree was measured, with a rod, to the nearest half foot and the average height obtained for each row. It

will be observed, however, when looking at the subjoined table that there is a great difference between the number of trees recorded for the different planting methods by Mr. Carter and the writer. This is due to two reasons. A certain number of trees during seven growing seasons become damaged by trespassing cattle, weevils and other causes, and secondly, a number of trees on one side of the plantation have had a hard struggle for existance with competing low woody growth. All of the first named and some of the last were omitted from the calculations because a study of the results due to such competing factors are aside from the work in hand.

The compilation of the height growth figures, shown in the accompanying tables, set forth clearly that after the first year (as concluded by Mr. Carter for survival) the method of planting has little if any relation to height growth. If there is any appreciable difference it is in favour of the mattock hole and the slit, sod off methods. It is obvious, therefore, that for successful planting the first two methods, or methods analogous to them, are to be advised in preference to the slit, sod on method, which fell below the other two, both as regards relation of survival to method, and relation of height growth to method.

SCOTCH PINE.

Planting Method	Mattock Hole				Slit Sod Off	Slit Sod On				
Row Number	4	8	21	29	27	14	22	28	31	35
Number Planted	40	41	40	23	37	40	45	39	42	41
Number Included	32	26	30	34	34	34	22	23	24	33
Average Height	6.53	6.42	6.66	7.26	7.58	5.88	6.40	6.47	6.7	5.63
Total Average Height.	6.71				7.58	6.21				

WESTERN YELLOW PINE.

Planting Method	Mattock Hole	Slit Sod Off	Slit Sod On
Row Number	15	37	17
Number Planted	40	39	39
Number Included	17	13	19
Average Height	4.70	3.92	3.68
Total Average	4.70	3.92	3.68

NORWAY SPRUCE.

Planting Method	Mattock Hole		Slit Sod Off		Slit Sod On	
Row Number	11	40	19	36	13	38
Number Planted	39	43	39	38	41	47
Number Included	23	22	26	15	17	12
Average Height	3.13	3.36	3.30	3.46	2.82	3.25
Total Average	3.24		3.38		3.03	

DOUGLAS FIR.

Planting Method	Mattock Hole		Slit Sod Off		Slit Sod On	
Row Number	18	33	10	34	9	26
Number Planted	38	42	40	41	40	41
Number Included	26	28	25	25	21	20
Average Height	3.73	4.07	3.4	3.56	3.52	3.0
Total Average Height.	3.90		3.48		3.26	

WHITE PINE.

Planting Method	Mattock Hole					Slit Sod, Off				Slit Sod On			
Row Number	1	5	12	25	41	3	7	16	20	24	30	32	39
Number Planted	40	35	38	40	43	40	41	39	20	44	46	44	41
Number Included	11	7	4	3	7	9	11	5	13	8	11	5	5
Average Height	4.45	5.0	5.0	6.6	4.57	5.11	5.81	4.8	5.53	5.25	5.63	5.8	4.2
Total Average Height		5.11					5.31				5.22		

6. YIELD TABLES.

YIELD TABLES.

The following tables were compiled in order to show the comparative yield of certain forest plantations with natural stands of the same species and age.

The abbreviations - Mass., Froth. and Margolin, refer to yield tables for White Pine compiled by the Massachusetts State Forester, Frothingham and Margolin respectively. The other names refer to plantations described in the bulletin entitled, " The Older Plantations of Massachusetts, Conifers."

YIELD PER ACRE, PURE EVEN AGED WHITE PINE

SITE QUALITY I

Plantation or table	Age	Av.ht.	d.b.h. of av. tree	No.of trees per ac.	Spacing	Cubic feet	B.M.
Sp.Pt.#I	34	50	10.5	332	10x10		29,212
Spl.pt.#4	34	60	5.	648	10x10		26,760
Mass.	35						31,150
Froth.	35	53	7.5	710		5200	
Margolin	35	48				5850	

YIELD PER ACRE PURE EVEN AGED WHITE PINE

SITE QUALITY I_I

Plantation or table	Age	Av.ht.	d.b.h. of av tree	No.of trees per ac.	Spacing	Cubic feet	B.M.
Spl.Plot 3	34	60	7	440	10x10		22,880
Mass.	35						24,400
Froth.	35	44.4	6.1	950		4180	
Margolin	35	45				4850	
Spl.Plot 1	43	55	11.5	332	10x10		37,716
Spr.Plot 4	43	65	6	648	10x10		38,680
Mass	45						40,600
Froth	45	58	8	633		6100	
Margolin	45	59				6600	

YIELD PER ACRE PURE EVEN AGED WHITE PINE

SITE QUALITY III.

Plantation or table	Age	Av.ht.	d.b.h. of av. tree	No.of trees per ac.	Spacing	Cubic feet	B.M.
Sp.Plot #2	34	50	9.5	264	10x10		19,640
Mass	35						16,950
Froth	35	36	4.7	1400		3100	
Marg.	35	42				3850	
Dean	38	50		250	10x10		29,000
East Bridge	39	50	8	452	8x10		24,428
Kilburn	41	55	9	325	6x8		25,934
Mass	40						25,200
Froth	40	42.5	5.5	1118		3780	
Margolin	40	48				4567	
Sp.Plot #2	43	55	10.5	264	10x10		26,742
Sp.Plot #3	43	65	8	440	10x10		33,080
Albea	46	42	10.4	315	10x10		31,780
Mass	45						32,100
Froth.	45	48.5	6.3	900		4500	
Marg.	45	54				5200	
Cook	50	51	10	460			34,927
Mass	50						37,550
Froth	50	54	7	764		5200	
Marg.	50	60				5833	
Douse	55	50	11	480	8x10		43,654
Fobes	56	70	11	254			38,464
Mass	55						42,100
Froth.	55	58	7.8	639		5870	
Marg.	55	66				6375	

YIELD PER ACRE PURE EVEN AGED WHITE PINE

SITE QUALITY III.

Plantation or table	Age	Av.ht.	d.b.h. of av. tree	No.of trees per ac.	Spacing	Cubic feet	B.M.
Kilburn	60	60	11	383	6x8		43,620
Dean	61	60		266	10x10		41,000
Mass	60						44,532
Froth	60	64	8.6	543		6530	
Margolin	60	71				6900	

7. PHOTOGRAPHS AND MAPS.

(Figure 1)

WACHUSETT RESERVOIR:

North slope.

(Figure 2)

WACHUSETT RESERVOIR:

Showing White Pine plantations and protected stream bed. View looking south near North Dike.

(Figure 3)

WACHUSETT RESERVOIR:

Locust and White Pine Plantations.

(Figure 4)

WACHUSETT RESERVOIR:

White Pine Plantations, interior view.
Trees 25 feet high, 17 years of age.

(Figure 5)

WACHUSETT RESERVIOR:

General view.

(Figure 6)

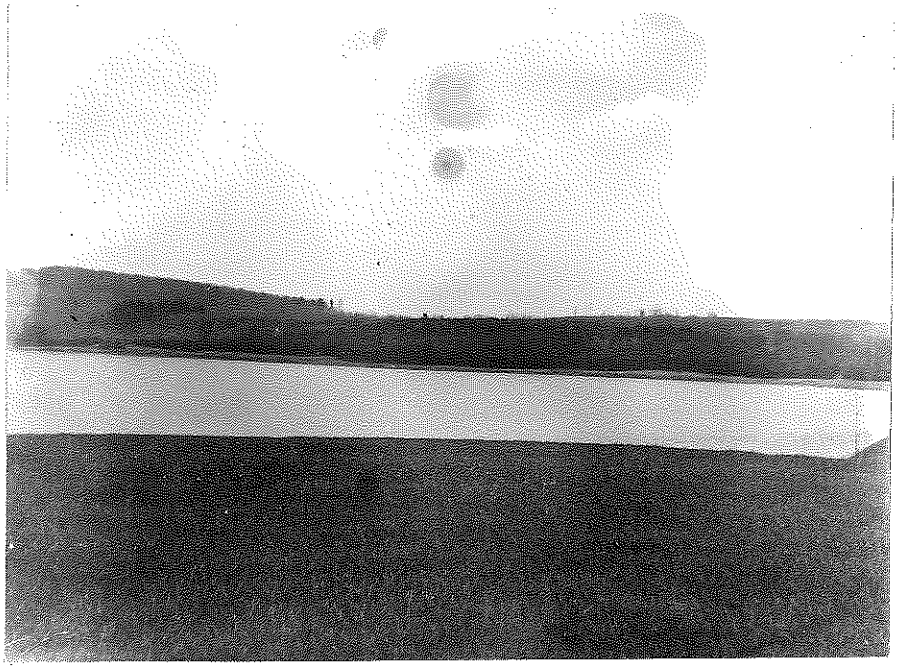
WACHUSETT RESERVOIR:

White Pine,18 years old, $5\frac{3}{4}$ inches D.B.H.

(Figure 7)

WACHUSETT RESERVOIR:

Marginal View.



(Figure 8)

WACHUSETT RESERVOIR:

Marginal View from North Dike.

(Figure 9)

WACHUSETT RESERVOIR:

Marginal View, showing protected margin,
Cedar wall and White Pine plantations.

(Figure 10)

WACHUSETT RESERVOIR:

Norway Spruce Plantations.

(Figure 11)

SHARON, MASS.

White Pine 62 years of age.

(Figure 12)

SHARON, MASS.

White Pine 62 years of age.

(Figure 13)

BRIDGEWATER, MASS.

White Pine, 50 years of age.

(Figure 14)

SOUTH LANCASTER:

White Pine 47 years old.

(Figure 15)

NORTH ANDOVER:

White Pine 17 years old.

(Figure 16)

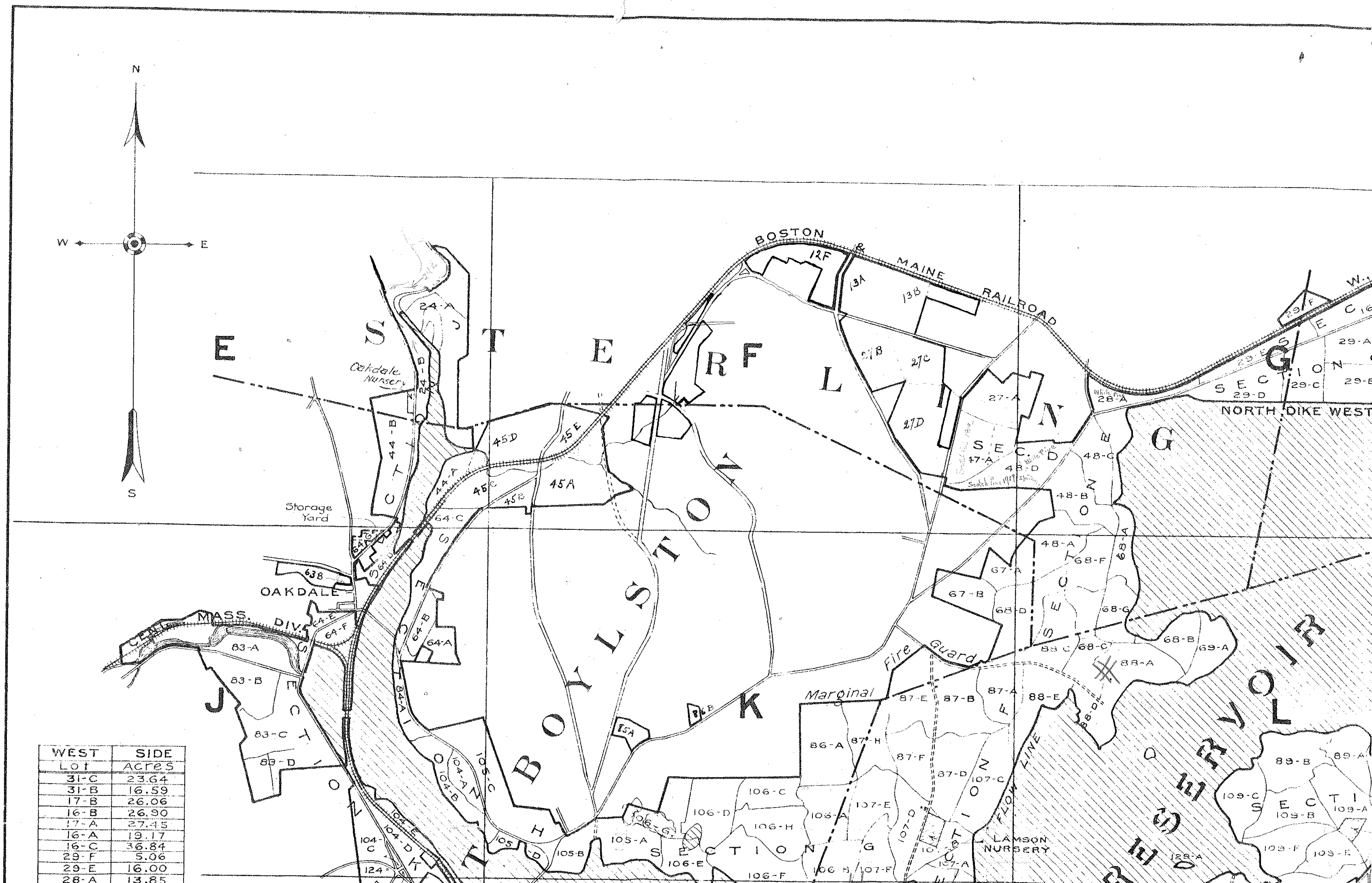
NORTH ANDOVER:

White Pine 17 years old.

(Figure 17)

WINCHENDON, MASS :

Scotch Pine 8 years old.



WEST	SIDE
Lot	Acres
31-C	23.64
31-B	16.59
17-B	26.06
16-B	26.90
17-A	27.45
16-A	19.17
16-C	36.84
29-F	5.06
29-E	16.00
28-A	13.85

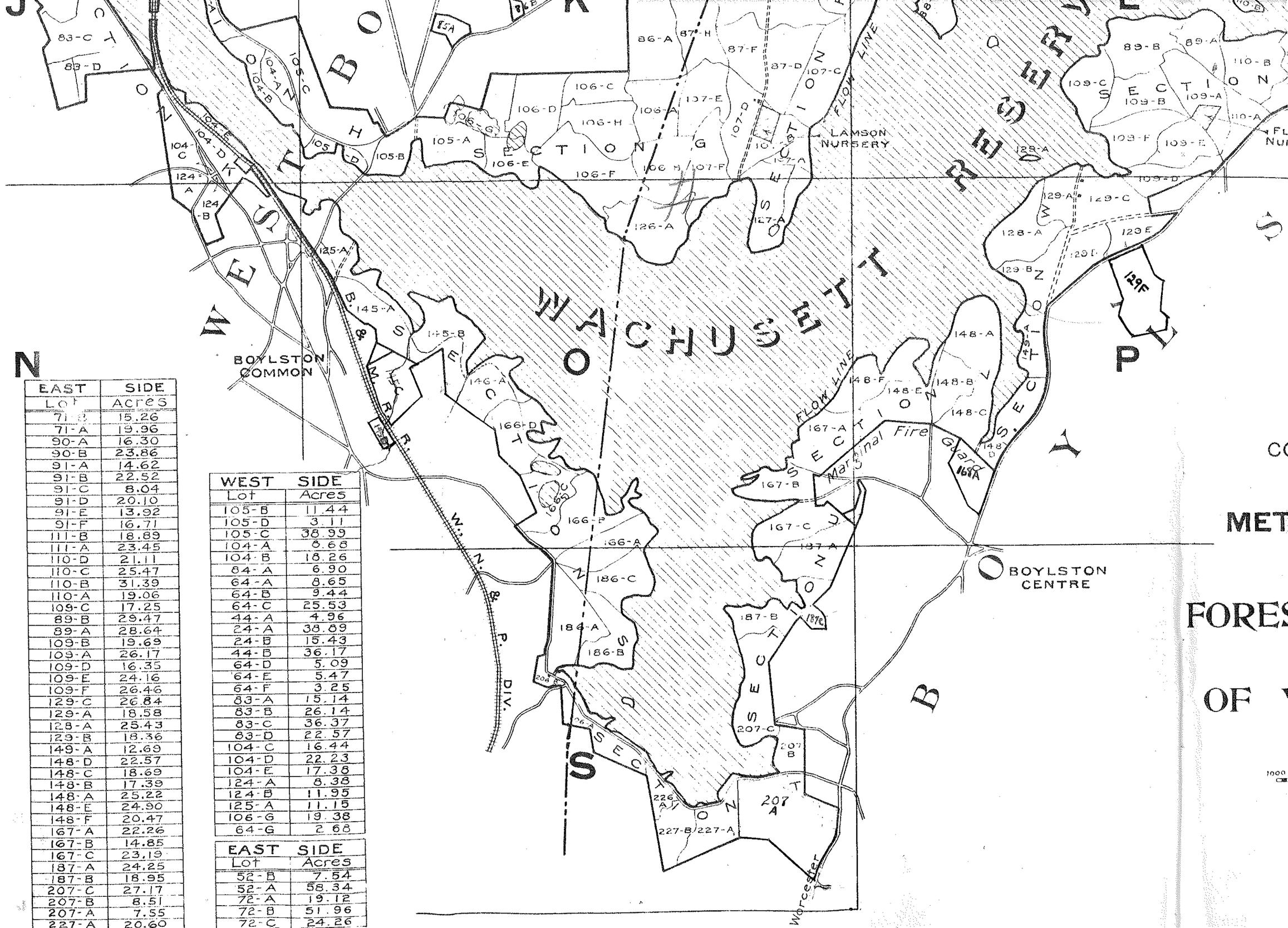
WEST SIDE Lot	Acres
31-C	23.64
31-B	16.59
17-B	26.06
16-B	26.90
17-A	27.45
16-A	19.17
16-C	36.84
29-F	5.06
29-E	16.00
28-A	13.85
30-B	23.10
30-A	29.17
29-A	25.17
29-B	29.49
29-C	25.99
29-D	27.80
27-A	31.11
47-A	30.47
48-D	29.28
67-B	20.57
48-C	31.37
48-B	30.95
48-A	25.78
68-F	22.93
68-A	14.78
67-A	19.77
69-A	16.66
68-D	28.61
68-C	25.35
88-C	29.19
68-G	18.66
88-A	21.51
68-B	21.69
127-A	24.28
88-D	9.08
88-E	28.15
87-A	27.75
87-B	27.67
87-D	20.37
107-C	30.59
107-B	22.76
107-A	13.75
87-E	24.17
87-F	18.27
87-H	27.29
107-E	24.68
107-F	27.17
86-A	28.94
106-A	29.60
107-D	31.92
106-B	31.00
126-A	26.41
106-C	24.74
106-D	26.92
106-E	16.38
106-F	30.66
106-H	25.24
105-A	21.50
145-A	28.60
145-B	29.70
186-C	20.80
166-A	28.53
166-B	30.88
166-C	22.05
166-D	25.19
146-A	16.98
186-B	23.66
186-A	25.21
206-B	3.20
206-A	16.67
226-A	11.01
227-B	14.63

N

EAST SIDE Lot	Acres
71-B	15.26
71-A	19.96
90-A	16.30
90-B	23.86
91-A	14.62
91-B	22.52
91-C	8.04
91-D	20.10
91-E	13.92
91-F	16.71
111-B	18.89
111-A	23.45
110-D	21.11
110-C	25.47
110-B	31.39
110-A	19.06
109-C	17.25
89-B	29.47
89-A	28.64
109-B	19.69
109-A	26.17
109-D	16.35
109-E	24.16
109-F	26.46
129-C	26.84
129-A	18.58
128-A	25.43
129-B	18.36
149-A	12.69
148-D	22.57
148-C	18.69
148-B	17.39
148-A	25.22
148-E	24.90
148-F	20.47
167-A	22.26
167-B	14.85
167-C	23.19
187-A	24.25
187-B	18.95
207-C	27.17
207-B	8.51
207-A	7.55
227-A	20.60

WEST SIDE Lot	Acres
105-B	11.44
105-D	3.11
105-C	38.99
104-A	8.68
104-B	18.26
84-A	6.90
64-A	8.65
64-B	9.44
64-C	25.53
44-A	4.96
24-A	38.89
24-B	15.43
44-B	36.17
64-D	5.09
64-E	5.47
64-F	3.25
83-A	15.14
83-B	26.14
83-C	36.37
83-D	22.57
104-C	16.44
104-D	22.23
104-E	17.38
124-A	8.38
124-B	11.95
125-A	11.15
106-G	19.38
64-G	2.68

EAST SIDE Lot	Acres
52-B	7.54
52-A	58.34
72-A	19.12
72-B	51.96
72-C	24.26



BOSTON & MAINE RAILROAD

N. Y., N. H. & H. R. R.

CLINTON STA.

W., N. & P. DIV.

M. R.

CENT. MASS. DIV.

NORTH DIKE EAST

NORTH DIKE WEST

SOUTH DIKE

DAM

FLOW LINE

Fire Guard

Marginal

Scotch Pine 1919 Shrubs

White Pine

Sand Pit 52-A

LAMSON NURSERY

FLAGG NURSERY

NASHUA RIVER

SECTION A

SECTION B

SECTION C

SECTION D

SECTION E

SECTION F

SECTION G

SECTION X

SECTION Y

SECTION Z

BERLIN

CLINTON

HOLDEN

LANCASTER

SHREWSBURY

WORCESTER

12F 13A 13B 16-A 16-B 16-C 17-A 27-A 27-B 27-C 27-D 28-A 29-A 29-B 29-C 29-D 29-E 29-F 30-A 30-B 31-A 31-B 31-C 32-B 47-A 48-A 48-B 48-C 48-D 67-A 67-B 68-A 68-B 68-C 68-D 68-F 69-A 71-A 71-B 72-A 72-B 86-A 86-B 87-A 87-B 87-D 87-E 87-F 87-H 88-A 88-B 88-C 88-D 88-E 89-A 89-B 90-A 91-A 91-B 91-C 91-D 91-E 91-F 93-B 106-A 106-B 106-C 106-D 106-E 106-F 106-H 107-A 107-C 107-D 107-E 107-F 109-A 109-B 109-C 109-D 109-E 109-F 110-A 110-B 110-C 110-D 111-A 129-A 129-C

COMMONWEALTH OF MASSACHUSETTS.

METROPOLITAN WATER WORKS.

FORESTAL PLAN OF MARGINS OF WACHUSETT RESERVOIR.

1000 500 0 1000 2000 3000 4000 5000 6000 7000 FEET

0 1/4 1/2 3/4 1 MILE

1903