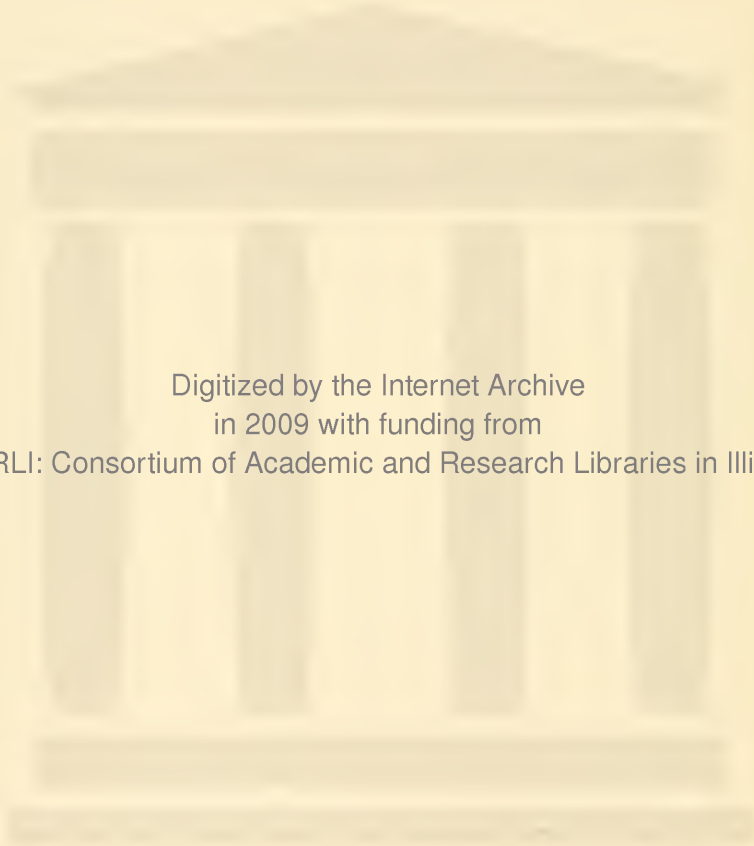
CONSTRUCTION OF SUBSTRUCTURE MAYFAIR PUMPING STATION, CHICAGO.

BY

J. T. LUCAS

ARMOUR INSTITUTE OF TECHNOLOGY

1917



CONSTRUCTION OF SUBSTRUCTURE OF MAYFAIR PUMPING STATION CITY OF CHICAGO

A THESIS

PRESENTED BY

JOHN THOMAS LUCAS

TO THE

PRESIDENT AND FACULTY

OF

ARMOUR INSTITUTE OF TECHNOLOGY

FOR THE DEGREE OF

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APPROVED:

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INDEX.

The Wilson Avenue Tunnel system, the construction of which was commenced in August, 1913, extends from the intake crib in Lake Michigan about 16,250' east of the shore shaft, located at Wilson and Clarendon Avenues, to the new Mayfair Pumping Station at Wilson and N. Lamon Avenues. This station, when completed, will supply the extreme northwest part of the city of Chicago and its adjacent suburbs with water under standard pressure, and under high pressure for high level territory.

GENERAL DESCRIPTION.

The building fronts south on Wilson Avenue with a pump room 236' x 60', the floor being at elev. - 7.15' or 38.65' below street grade. At the entrance to station, in the center of south front, there is an office section one story in height, 50' x 31'. The boiler room, 239' x 54'- 3", lies north of the pump room; its basement level is at elev. + 13.92' or 17. 58' below grade, and the main floor at elev. + 28.84'. A coal receiving room, 72'- 9" x 70'-

9" is located north of the boiler room with an 18' driveway between these two sections of the station.

A side track, turning south from the C.M.& St.P.Ry., carries coal cars into the receiving room over three receiving hoppers. The coal can be unloaded directly into the hoppers through bottom dump cars, or by means of a grab bucket from an overhead traveling crane; or the coal can be stored in bins on both sides of the track hoppers. Plate No. 1. shows a general layout of the station.

The coal after passing through a crusher under the hoppers is carried south on an apron conveyor to the main bucket conveyor, running east and west in the boiler room four feet north of the boiler fronts. This conveyor supplies a set of enclosed bunkers 175'-6" long, which have a capacity of 1,000 tons. Spouts feed the coal from the bottom of the bunkers, 22' above boiler room floor, to each stoker.

The boilers, fronting north, supply

steam at 175 lbs. pressure through a double header system to the seven pumping engines. They consist of a battery of 6 - 4 pass Edgemoor water tube boilers equipped with Taylor stokers, and have a rating of 500 H.P. each.

The smoke breeching is suspended from the main floor, and enters the central stack from the east and west. The stack is 184'-2" high above boiler room floor, the inside diameter being 8'0" at top and 14'- 5" at base, and is supported by four 5'- 0" caissons extending to solid rock at elev. - 50.00'.

The water will be pumped by seven pumping engines of a total capacity of 152.5 million gallons in 24 hours. The pumps are of the triple expansion, crank and fly wheel type with mechanically operated suction and discharge valves of Riedler design. The steam ends of both high and standard pressure pumps are alike, but the water ends of the three west pumps are smaller. The three west pumps will each deliver 17.5 million gallons per day against a 200' head,

and the four east pumps will each deliver 25 million gallons per day against a 140' head.

Each pump has two suction nozzles extending south and then down into a common suction tunnel, the flowline of which is 20'- 10" beneath pump room floor. All the water entering the pumps passes around the tubes of a surface condenser, and is discharged through four pipes from each pump into the station mains.

There are two discharge mains for the 140' head, one north and one south of the pumps at elev. + 4.00', extending the full length of the station and leaving at the west. They are supported by a series of piers adjacent to the north and south walls of pump room. The two high pressure lines start at about the center of the building, and are supported by saddles on the pipe, leaving also at the west.

Immediatedly west of the station are two pipe vaults in which the pipes rise to street grade, and change direction to conform with general layout of the water pipe system in street.

Plate No. 2. indicates the general arrangement of station.

CONSTRUCTION.

Construction work on foundations was commenced on September 16, 1915.

(A). EXCAVATION.

As a preliminary step on the arrival of forces on the ground in April, 1914, at which date work on the Mayfair shaft of the Wilson Avenue tunnel was started, a network of farm tile was laid over the entire area of the proposed station, and connected with the sewer of adjoining territory. This served to remove all surface water, and when ground was broken in the following year the upper strata was comparatively free from moisture.

(1). GENERAL EXCAVATION.

The general excavation consisted in removing the upper nineteen feet of earth from the building site by the open cut method. Starting at east end of pump room with a 3/4 yard Osgood steam shovel, a strip 30 feet in width was

opened. The shovel moved westward on a downward slope for a distance of 100 feet, until it reached bottom of pit at elev. + 12.75', the level of sub-soil for boiler room basement floor. This incline was covered with a single layer of 2" planking to afford easy passage for the dump wagons and teams passing over it to receive the excavated material. The shovel itself was provided with four timber floats, each about 8'- 0" long, 4'- 0" wide, and 3" in thickness. These floats were constructed of 3" x 10" pieces of oak bound together and the edges and sides reinforced with angle irons and steel plates. As the shovel traveled forward, its path was laid in advance, the rear float being swung to the front by fastening the attached chains of float to dipper stick of shovel. The dump wagons, of two yard capacity each, moving down runway into pit, were loaded with spoil and hauled to surface, assisted by an auxiliary snatch team of three horses. In like manner the coal receiving room and entire east half of boiler room, and pump room were stripped of the top

layers of soil.

At this stage a more permanent runway in the form of a timber trestle was constructed at the east end of boiler room, and the earth incline removed. The runway was about 25 feet in width, to provide clear passage for two wagons. On the south side a narrow guage track was laid. At the top in center of track was inserted a 24" pulley, over which was run a 3/4" wire cable to electric hoist on surface. Attached to the other end of cable was a small four wheeled truck operating on track, and serving to boost loaded wagons up the incline. The truck replaced the snatch team previously used for the work.

In laying out work for excavation, an additional strip of ten feet outside actual lines of building footings was included to act as berm, and prevent the loose ground from sloughing off, and falling into wall trenches alongside. The banks were not braced except in a few instances, in which shoring was provided to hold up tempor-

ary buildings on top at edge of pit. Care was taken throughout to keep the bottom of pit at same elevation, to insure against water accumulating in pockets. To remove drainage, steam lines were used to bring water to a central steam driven pump, which raised it to the level of surface lines leading to surrounding sewer.

A periodical progress record was kept of work accomplished by steam shovel, as is shown by Plate No. 3. The contract for disposing of spoil was assigned on the basis of loose yardage, measured in wagons. As a means of check, the percentage of swell was computed semi- monthly by measuring the yardage in place excavated and proportioning it to the corresponding loose yardage.

The accompanying photograph No. 1. shows the work in its preliminary stages. In the foreground to the right may be seen the trestle leading from headhouse over shaft and rock removed from the tunnel drift. Some difficulty was encountered in excavating coal receiving room

and northwest section of boiler room due to proximity of rock pile, and extreme precautions were taken to secure ground showing any signs of cracking.

This completed the first step by the open cut method of excavation from elev.+ 31.5' to elev.+ 12.75', a depth of 18'- 9".

(2). TRENCH EXCAVATION.

Immediatedly after the general excavation had been finished by open cut, work was started on the trench excavation for the wall footings of building, beginning in the coal receiving room and following in the wake of the shovel. In the coal receiving room the depth of footings below grade of pit was 7'- 9". These trenches were opened by hand digging and the sides lined with 3" lagging, held in place by 6" x 6" waling pieces and 6" x 6" struts. The soil encountered was very firm and free from moisture, and in no instance was it necessary to drive any lagging in advance.

In the boiler room the footing trenches

were 3'- 9" below pit level, necessitating only the ordinary precautions taken in shoring shallow trenches.

The excavated soil was disposed of as in the open cut method by shoveling on dump wagons, and boosting them up incline with truck.

In trench excavation for pump room a problem of more intricate nature presented itself. The pump room, as previously described, embraces an interior area of 236' x 60', and is bounded by four reinforced concrete walls of the counterfort type. The south, east and west walls have a footing penetration to elev.- 13.00' or 25'- 9" below grade of pit, and in each case the footings are 25' in width. The north wall has a footing penetration to elev.- 10.15' or 23'- 2" below grade of pit, and a footing width of 15'- 0".

In the south, east and west wall trenches the first five foot cut was made by steam shovel, with exception of outer six feet, which was left as a factor of safety against the banks

caving in on shovel. In the north wall trench it was found impossible to operate the shovel due to the narrowness of trench, and all material was removed by hand digging.

As practically the same methods were employed in excavating all four trenches in pump room, an explanation of the proceedure adopted in digging south wall trench will suffice. Actual hand digging was not begun until after severe cold weather had set in, and to prevent the frost from penetrating into exposed ground, as well as to facilitate construction, three eight hour shifts were organized to carry on the work.

The steam shovel being of service no longer for excavating, its dipper stick was replaced by a 30 foot boom, enabling it to be operated as a derrick. A steel swinging derrick was also placed in east end of pump room, the shovel taking care of west end of building. Beginning at grade of pit, the outer six feet of earth in trench was removed by hand, and loaded into skips of 2 yard capacity each. These skips

were constructed of 3" oak and mounted with chains, which could be fastened to boom of derrick. On being loaded with spoil they were lifted out of trench and elevated to a dumping hopper in pit, under which the wagons passed to receive the disposal. As soon as a section had been excavated to a depth of six feet, the sides were caught with 3" lagging secured with 8" x 10" wales and 8" x 8" struts. The digging was carried on until an additional six foot section was removed, and a similar six foot set of lagging placed. In this manner the excavation progressed in six foot drops, until trench bottom at elev. - 13.00' was reached. Throughout the digging it was found unnecessary to drive any lagging, the ground being of a firm texture and free from quick-sand and excessive moisture. To remove any water accumulating from underground sources or rainfall, steam siphons were extended into trenches, and connected with a steam driven pump on top. This kept the ground in trenches dry and enabled the digging to be prosccuted without interruption. Plate No. 4.

shows the typical bracing used in south wall trench.

(3). CAISSON EXCAVATION.

Referring to Plate No. 5. showing general plan and section of south wall of pump room, it will be seen that the counterforts are centered upon caissons. These caissons, which are of the open well type, extend down past suction tunnel and rest upon hard pan. The method employed in excavating wells consists as follows. A tripod and windlass arrangement was placed over each opening at elev.- 13.00', the level of bottom of wall trench. The core was removed by hand digging in five foot sections, the sides of caisson being well secured by five foot sets of 3" maple lagging held in place by steel rings 2'- 6" apart. In a few instances wet ground and soil resembling quick-sand were encountered, making it necessary to use shorter sets of lagging and also to thoroughly pack the voids behind lagging with hay. The excavated material was raised in buckets to level of trench bottom by hand and emptied into

skips, which were in turn elevated to surface by derrick and the contents dumped into receiving hopper. From this receptacle the spoil was loaded into wagons and boosted up incline to street grade. The digging for caissons was carried on in three shifts, three men working in each shaft. A daily progress of the work was kept in graphical form, indicating the nature of the ground encountered and other general information necessary in computing costs for excavation. A specimen of these charts is illustrated in Plate No. 6.

A somewhat different method was employed in excavating caissons under chimney in boiler room. The foundations for stack consist of a 19'- 0" square slab of reinforced concrete 6'- 0" in thickness, resting upon four caissons of 5'- 0" diameter penetrating to solid rock at elev.- 50.00'. The digging was started at level of pit elev.+ 12.75' and was prosecuted in five foot sections as in south wall caissons in pump room. An electric hoist was installed about 25'

east of wells and connected by cable with spools over caisson openings. In this manner it was possible to work two diagonally opposite wells at the same time, the spoil buckets being raised to surface of pit by electric power instead of by hand. Plate No. 7. shows diagram of stack caissons and also soil borings taken in vicinity of work.

(4). CORE EXCAVATION.

After four walls in pump room had been constructed, there remained a core of earth 218' long, 46' wide and 25'- 9" deep approximating 9200 cu. yards in volume. At this stage the steel swinging derrick and 90 H.P. electric hoist were raised to surface and installed at south east corner of pump room, the mast of derrick resting on top of wall at elev. + 33.00'. The steam shovel was stripped of its boom and the dipper stick put back in place. A double track system of narrow guage connected by a switching device was laid on surface of core at elev.+ 12.75', and several flat-bottomed wooden dump cars of two yard capacity each brought into service. As

the shovel cut into the ground it unloaded the excavated material into cars on track alongside. The loaded cars were switched to opposite track and pushed by hand to east end of pump room, at which point the chains of car were caught by hook on fall lines of derrick and elevated to surface. On top alongside east and south walls was laid a timber platform on trestle bents to carry a track of similar guage to that in pit. Over this track was run the loaded cars and the spoil dumped through openings in platform as backfill behind walls. Proceeding in this manner the core was excavated in 12' drops until level of bottom of south wall footing was reached at elev.- 13.00'. In order not to undermine north wall footing, the bottom of which is at elev. - 10.15', a bank of ground ten feet in width was left alongside, the surface being at same elev.- 7.15' as top of footing. Between this bank and edge of south wall footing a series of struts, each consisting of twelve 10" x 10" timbers bound together, was laid at intervals of 31'- 0" coming

between proposed adjacent engine beds. The purpose of these struts was to counteract any sliding motion on the part of either south or north walls. They were left in place until engine beds had been concreted as well as pump room floor section between north ends of pump foundations and north wall footing. Plate No. 8. shows analysis of proccedure in core excavation. This practically completed all excavation for foundations of station.

(B). CONCRETE.-- (1). COAL RECEIVING ROOM.

On the completion of trench excavation in coal receiving room work was immediatedly started on the foundations. A temporary concreting plant was installed about 100 feet directly north of coal room site, being supplied with material from cars switched from C.M.& St.P. line and delivered on track alongside. The mixer consisted of a chain belt machine of 3/4 yard capacity operated by steam engine. The sand, gravel and cement were wheeled from material piles in barrows up incline and deposited in mixing drum. The con-

crete was received from mixer in buggies and wheeled to edge of foundation pit. A series of chutes placed around pit received the concrete and conducted it to place in foundations. The structure was completed in three separate pours, a 1:2:4 mixture being used throughout. The footing constituted the first step, the trench lagging taking the place of formwork. The second and third pours consisted of the surrounding walls and cross girders. Construction keys were provided in footings and walls after first and second pours, and extreme care was taken to secure a good bond of new concrete by thoroughly sweeping and washing the surface of old concrete and covering it with a layer of grout of 1:2 proportions. In view of the fact that this work was being done during the month of December, precautions were taken against the concrete freezing by covering the forms with canvas after pour had been made and placing salamanders alongside so as to keep the frost out until set had taken place. As an additional measure of safety the

sand and gravel were heated by means of steam lines before being placed in mixer. Plates No. 9. & 10. show sections of formwork and details of walls and girders in coal receiving room.

(2). MIXING PLANT.

A more permanent mixing plant was constructed at this stage to control entire building. The coal receiving room, being divided by cross girders into three separate compartments, offered an excellent location for central plant. The two north sections were separated by a dividing wall of 6" x 6" timbers, and served as storage bins for sand and gravel. The south section was cut off from storage bins by a similar shield of 6" x 6" timbers and subdivided into two hoppers, the bottoms of which were built on an incline of 3" x 8" planks. These hoppers for sand and gravel respectively were fed from storage bins by means of a grab bucket on Browning locomotive traveling crane, operating on material track alongside coal room. The coal bins, each of a storage capacity of 400 cu. yds., were supplied

from material cars switched from main line of C.M.& St.P.Ry. and unloaded by crane. On the west side of bins was situated a cement shed of a storage capacity of 9000bbls. of cement.

Beneath roadway slab and in direct connection with sand and gravel hoppers was located the mixing plant, which consisted of the same equipment as previously used in construction of coal room foundations. The mixer engine however, was operated by steam supplied by 90 H.P. scotch marine boiler on top alongside cement house. A detailed layout of this concreting plant is shown in Plate No.14. The hopper bucket which received sand and gravel through hopper openings regulated by slides, had been previously gauged for a 1:2:4 mixture of concrete, and the marks representing the proper volumes visibly placed on sides. By referring to these indentations the operator was able to regulate the flow of material for each batch. The corresponding amount of cement was set aside in cement house and delivered to bucket below through small grav-

ity chute, on receiving signal from operator. The material, being properly proportioned, was released from bucket through opening in bottom and dumped into mixing drum. The water for each batch was received from water barrel connected with supply pipe, the proper quantity being determined by gauge glass on side of barrel.

The central concreting tower was located in center of roadway slab, the concrete bucket moving through slab opening in 4" x 4" guides fastened to sides of tower. This bucket was fed from mixing drum by means of an apron on mixer and hoisted to top of tower, 50 feet above roadway slab, by electric hoist situated alongside cement house. Two additional towers of a proportional decrease in height were placed, one in boiler room and one in pump room, supporting Ransome concrete chutes. The location of these towers could be changed so as to control any part of structure.

(3). BOILER ROOM.

The boiler room walls were constructed

in two pours, the footings forming the first step and the neatwork section of walls the second. In concreting the footing the trench lagging served as formwork, a construction key being provided to properly bond the wall sections to footings. Moreover the concrete was carefully scrubbed and covered with a 1:2 mixture of grout after forms for walls had been erected, and shortly before second pour was made. For details of walls and formwork in boiler room see Plate No. 11.

The north wall of boiler room was concreted before central concreting plant had been installed, and the same methods were employed in pouring as in constructing coal receiving room foundations. The east and west exterior and interior walls of boiler room were concreted by means of the main plant then under operation. Throughout a 1:2:4 mix was used for walls and footings of this part of station. As the work was being carried on in cold weather the same precautions were taken against the concrete freez-

ing as employed in pouring coal room walls.

(4). PUMP ROOM.

Immediatedly after the bottom of caissons under south wall of pump room had been belled out, the lower sections, the sides of which were unprotected by lagging, were concreted so as to secure the ground. The upper sections were poured at a later date when several wells were ready, together with a four inch layer over the entire bottom of wall trench to serve as a bed for footing reinforcement. This facilitated the laying of the heavy steel bars specified, and kept the reinforcing comparatively free from contact with any foreign matter, such as mud and slime which otherwise might have accumulated in trench bottoms due to the thawing of the frozen ground together with the spring rains. In order to guard against a horizontal joint in footing in plane of reinforcing this four inch bed was thoroughly cleaned and covered with a layer of grout before next pour was started. This precaution was taken in all cases where it was neces-

sary for horizontal joints in structure. In view of the fact that the wall section between counterforts was designed as a continuous slab, all vertical construction joints were made at the quarter point in span, this being theoretically the point of zero bending moment. By a judicious handling of the trench shoring, as illustrated in Plate No. 13., it was possible to bring pump room wall sections to top, a distance of 40 feet, without leaving any holes in structure for bracing.

This method, although involving some additional expense due to reshoring against walls, justified itself by the results obtained. No serious leaks were encountered in all four walls of pump room, practically a water-proof structure being secured which was the chief object sought after in its construction. The formwork for these walls was of a similar nature to that employed in coal receiving room and boiler room walls, sections of which are shown in Plate Nos. 10 & 11. This work was done during the early

spring and part of the summer following. The proportions of 1:2:4 were adhered to in pouring caissons, footings and walls throughout this part of structure. Plate No. 12. shows a section of south wall of pump room. The same methods were followed in constructing north, east and west walls as previously explained.

This completed the concreting in engine room until core of earth from elev.+ 12.75' to elev.- 13.00' was removed. Work was then resumed on the engine beds, each of the seven being concreted in one pour, a 1:2:4 mix being used. The pump room floor, condenser piers, pipe piers and other foundations of smaller volume were taken in order until concrete work in this section of building was entirely finished.

(5). CHIMNEY FOUNDATION.

As soon as stack caisson excavation had been completed for two diagonally opposite wells, the lower sections were concreted, and work started on other two wells. The lower sections of these were poured together with upper

sections of first pair of caissons. The slab, resting on caissons was constructed in one pour, a 1:2:4 mix being used throughout.

(C). PLANT EQUIPMENT.

In so far as possible in the course of work on the pumping station, the policy adopted was to employ machinery in the handling of all materials, and to carry out the actual construction on building.

A Browning locomotive crane of 15 ton capacity served to handle all material cars received from C.M.& St.P.Ry. alongside building site. By means of a grab bucket all sand and gravel were unloaded from cars into storage bins in coal room foundations, and the material hoppers supplied from storage bins in same fashion. The grab bucket could be replaced by a hook and chain, and thus enable the crane to act as a derrick in lifting or moving heavy objects such as structural steel, stone, granite and other miscellaneous material. A second track was installed at a later date alongside east walls of

boiler and pump rooms, which made it possible for crane to operate in that vicinity and thus control these sections of the station. As a typical instance of the adaptability of this machine, the following case is cited.

After excavation had been completed in pump room, the steel swinging derrick was dismantled and elevated to surface by crane, at which level it was then installed. The steam shovel was raised in like manner from pit, a lift of approximately 12 tons being made through a vertical distance of nearly 50 feet. During superstructure construction the crane was used in erection as well as handling materials.

The uses of the steel swinging derrick have been mentioned in previous description of methods of excavation. On being no longer of service in pump room pit, it was elevated to surface and there employed in conjunction with the locomotive crane.

The Osgood steam shovel was used principally in straight open cut excavation, although

it was also employed in the role of a derrick in pump room excavation the dipper stick being replaced by boom. After foundation excavation had been completed its period of service was ended, and it was raised to street grade from pump room pit and moved to another construction site.

Electric hoists of various ratings were used to carry on construction work. A 90 H.P. machine was used continuously in conjunction with swinging derrick. Hoists of smaller capacity were employed in excavating chimney wells, and boosting dump wagons up runway from pit, as described in article on open cut excavation.

The steam supply for building was obtained from 90H.P. scotch marine boiler, installed directly west of coal room site. The concrete mixer engine received its steam supply from this boiler as well as the drainage pumps in boiler and pump rooms. Pipe lines were connected to the main supply in thawing out frozen

sand and gravel and also to heat concreting materials in cold weather.

Directly north of coal room and east of rock pile was located a plot of ground which served for storage of materials, such as reinforcing steel, lumber for bracing and formwork, structural steel, brick, stone and other building products. Photograph No.1. shows view of material yard.

ORGANIZATION AND COSTS.

Construction work on the substructure of the Mayfair Pumping Station was prosecuted on the day labor plan. All building material was ordered either directly from job site in small assortments, or let out by contract in large lots through main office. Labor, skilled and common, was obtained through civil service commission, the men being certified to their places of work when requisition was made from job by engineer in charge. The wage rates were in accordance with the union scale and the working hours from 8:00 A.M. to 4:30 P.M.

The following system was adopted in recording all charges and costs of work.

Each name on the payroll was represented by a numbered brass check. On reporting for work the men received their checks at the timekeeper's office, and on leaving returned the checks to same office. No man was permitted to work without a check. A man failing to return his check at the close of the day's work was given time up to the last hour he was noted in field by timekeeper.

A daily list, called a check sheet, was made, showing numbers of checks which had been called for at the beginning of the day's work. On the first trip around job in morning these numbers were located and checked off by timekeeper on this sheet. A similar trip was made in the afternoon and the same procedure followed. The hours and rates of each employe were entered on sheet opposite corresponding number, and turned in to payroll clerk about 8:00 A.M. the following day.

The distribution of time was also made by field timekeeper, who was constantly on the outside and in contact with work. The time of each man was charged against the proper class and location of work on a field distribution sheet. These charges were classified by symbols in accordance with schedule as submitted on Plates No. 15, 16 and 17. All special occurrences as to the beginning and completion of work, etc. were recorded, the sheet practically constituting a field diary. This sheet was delivered to payroll clerk with check sheet.

The office distribution consisted in bringing together all charges of same symbol, from which the daily force account was made. This sheet contained all charges properly classified as well as unit costs of work and other information bearing on the job. A copy of each daily force account was sent to main division office together with a cost sheet at the end of each period, of approximately two weeks in length, which consisted of a general summary of all money

expended for labor and material for the foregoing period.

The personnel of overhead organization was as follows:

Engineer in charge.

General foreman.

Junior engineer.

Rodman - instrumentman.

Rodman - draftsman.

Field time clerk.

Cost clerk.

Material clerk.

Payroll clerk.

Messenger.

The work was carried on under the supervision of Mr. Henry W. Clausen, Engineer of Water Works Construction. Mr. F.C. Martini is the engineer in local charge of construction, and the writer is first assistant to engineer in charge.

The following unit costs of work are submitted.

EXCAVATION. (Steam Shovel.)

General Excavation and Engine Room Core.

39,750 cu. yds. @ $ .35 per cu. yd.

EXCAVATION. (Hand Digging.)

South, West and East Wall Trenches of Eng. Room.

9,000 cu. yds. @ $1.70 per cu. yd.

North Wall Trench of Eng. Room.

2,882 cu. yds. @ $1.50 per cu. yd.

Caissons under South Wall of Engine Room.

777 cu. yds. @ $4.29 per cu. yd.

Caissons under Chimney of Boiler Room.

230 cu. yds. @ $4.20 per cu. yd.

BRACING & LAGGING.

South, West and East Wall Trenches of Eng. Room.

9,000 cu. yds. @ $1.22 per cu. yd.

North Wall Trench of Eng. Room.

2,882 cu. yds. @ $1.21 per cu. yd.

Caissons under South Wall of Eng. Room.

777 cu. yds. @ $1.99 per cu. yd.

BRACING & LAGGING.

Caissons under Chimney of Boiler Room.

230 cu. yds. @ $1.95 per cu. yd.

ELEVATING & HOISTING.

Core of Engine Room.

9,000 cu. yds. @ $ .46 per cu. yd.

South, West and East Wall Trenches of Eng. Room.

9,000 cu. yds. @ $ .77 per cu. yd.

North Wall Trench of Eng. Room.

2,882 cu. yds. @ $ .81 per cu. yd.

DISPOSAL. (Including Backfill.)

Wall Trenches of Eng. Room.

11,882 cu. yds. @ $ .93 per cu. yd.

FORMWORK.

Walls of Engine Room.

69,100 sq. ft. @ $ .17 per sq. ft.

Walls of Boiler Room.

20,100 sq. ft. @ $ .17 per sq. ft.

Walls and Girders of Coal Receiving Room.

11,300 sq. ft. @ $ .17 per sq. ft.

Engine Foundations.

9,570 sq. ft. @ $ .17 per sq. ft.

CONCRETE. (Mixing & Placing.)

Engine Room Walls.

5,360 cu. yds. @ $ .75 per cu. yd.

Boiler Room Walls.

1,229 cu. yds. @ $ .75 per cu. yd.

Coal Receiving Room Walls and Girders.

569 cu. yds. @ $ .75 per cu. yd.

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INDEX OF DRAWINGS.

PLATE NO. 1

MAYFAIR PUMPING STATION
GENERAL PLAN
BUILDINGS AND PROPERTY

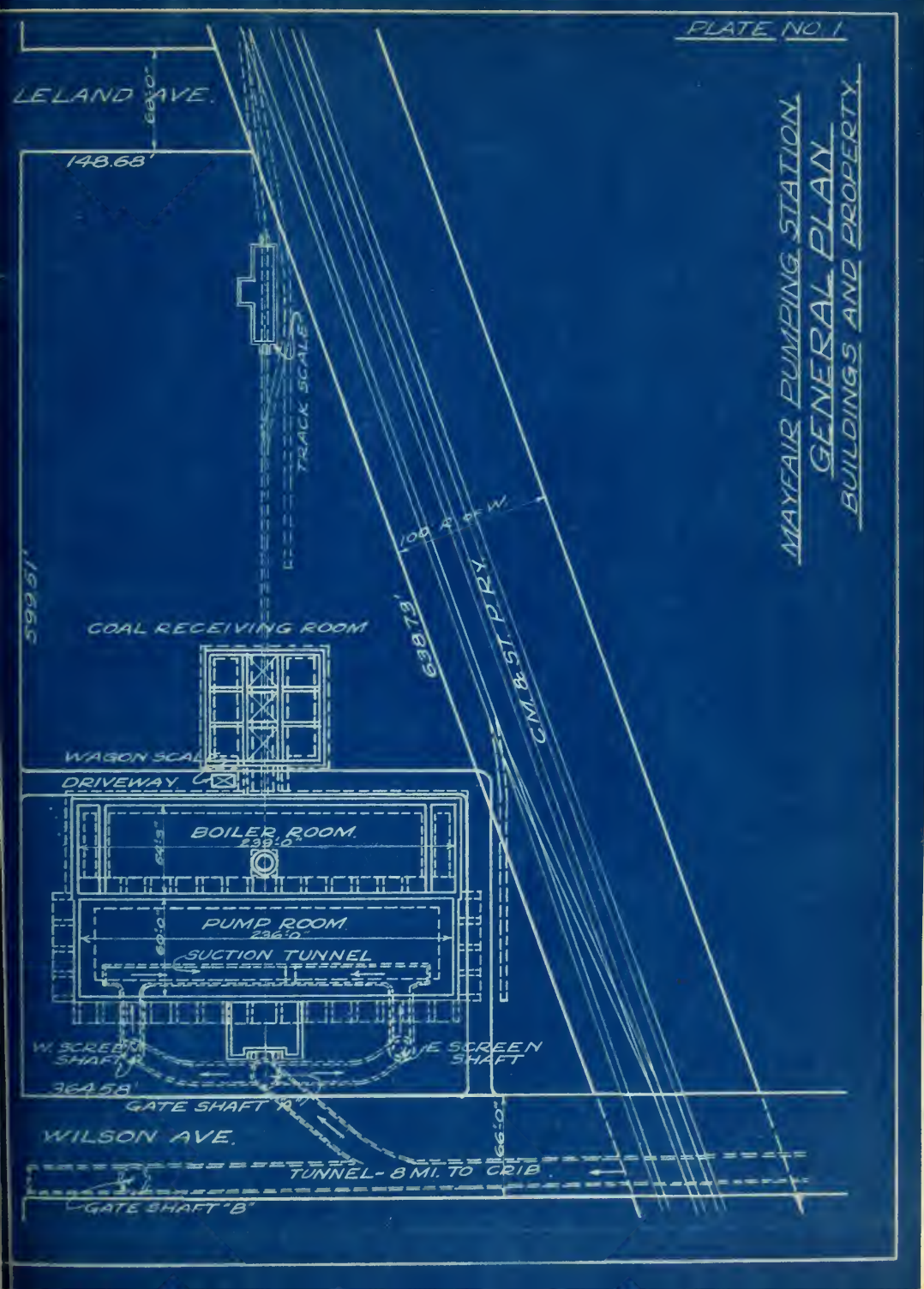
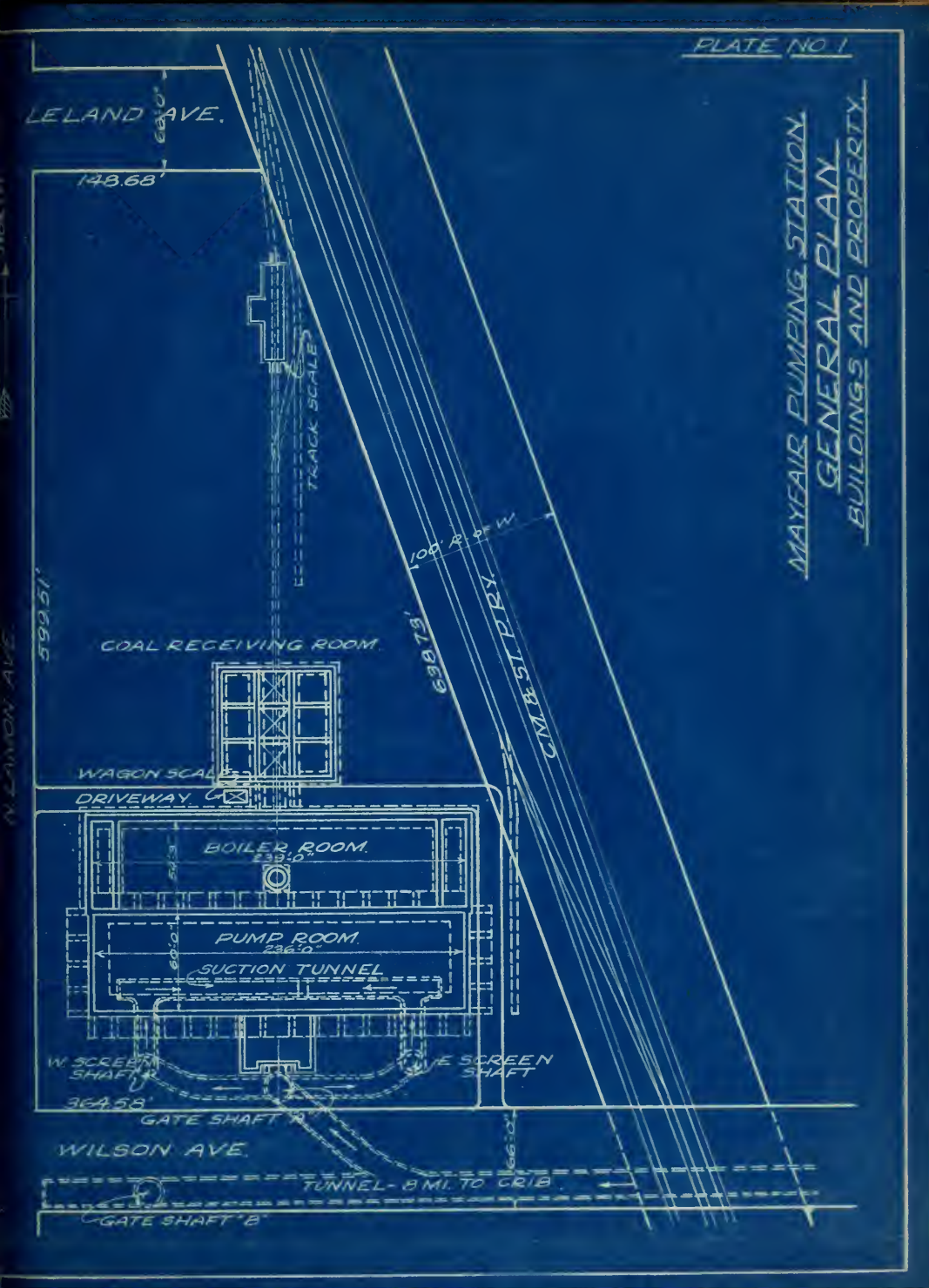
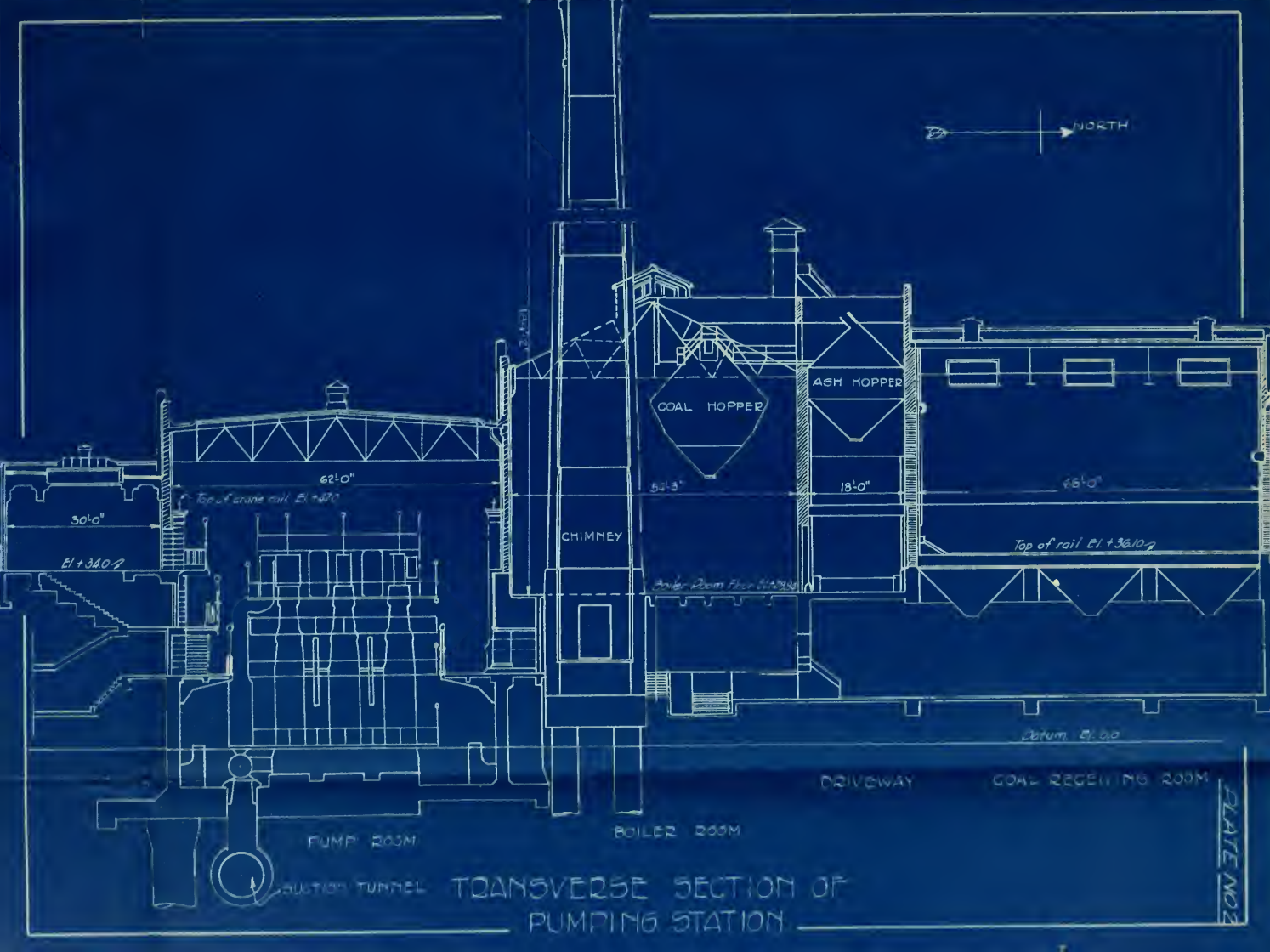


PLATE NO 1

MAYFAIR PUMPING STATION
GENERAL PLAN
BUILDINGS AND PROPERTY



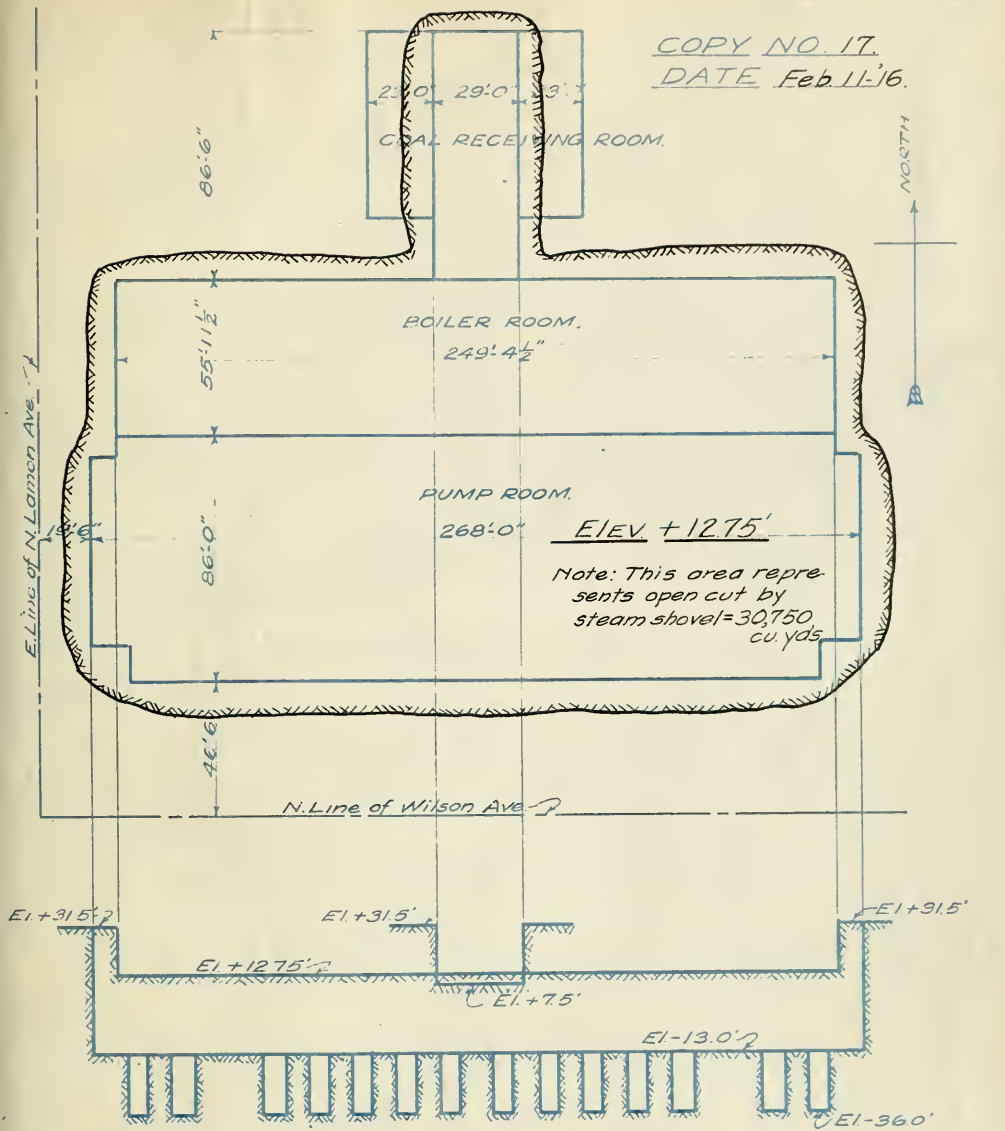


TRANSVERSE SECTION OF PUMPING STATION

PLATE NO 3

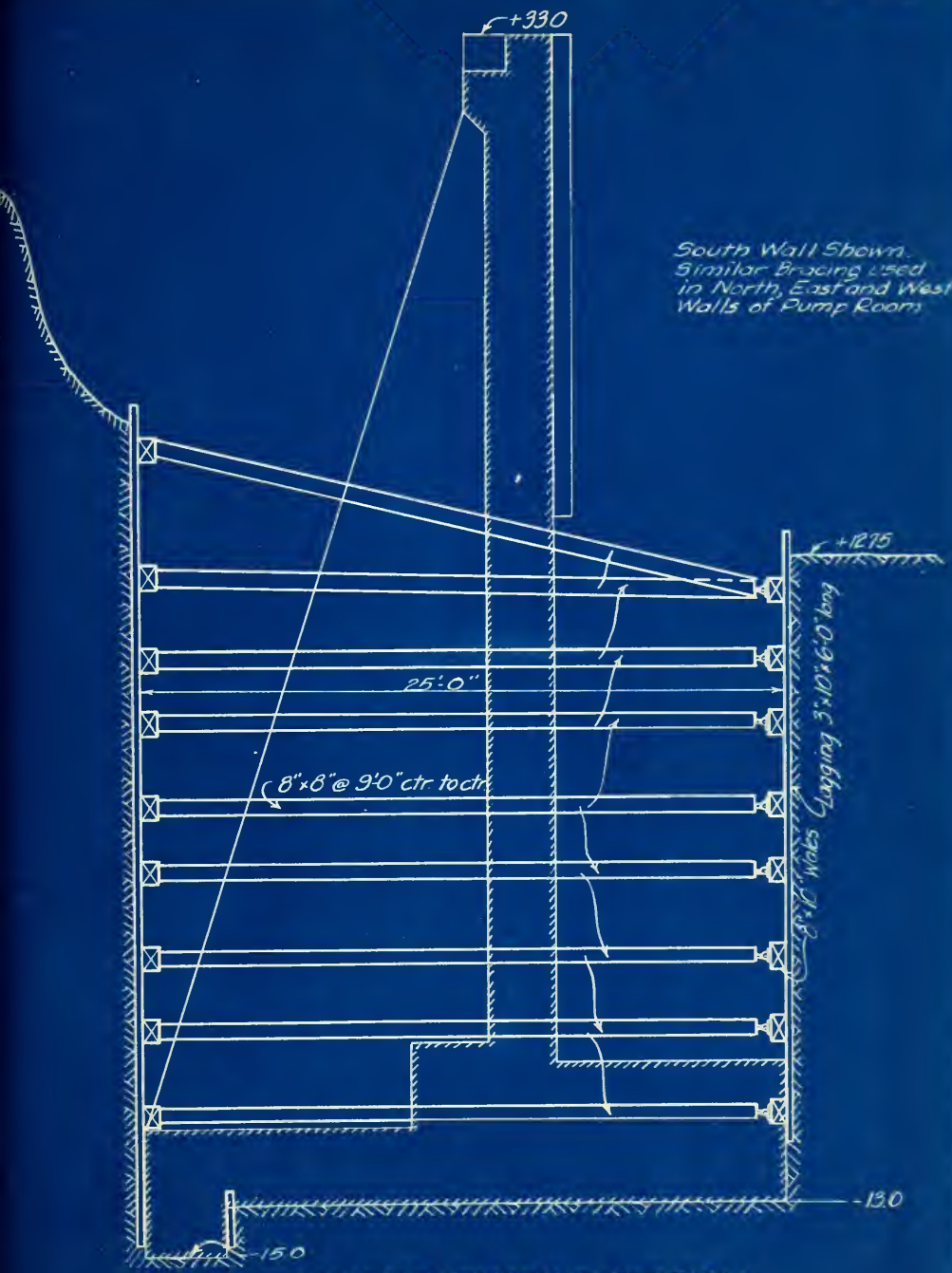
PLATE NO 3

COPY NO. 17.
DATE Feb. 11-'16.



MAYFAIR PUMPING STATION.
EXCAVATION PROGRESS CHART

PLATE NO. 4



MAYFAIR PUMPING STATION
TYPICAL TRENCH BRACING

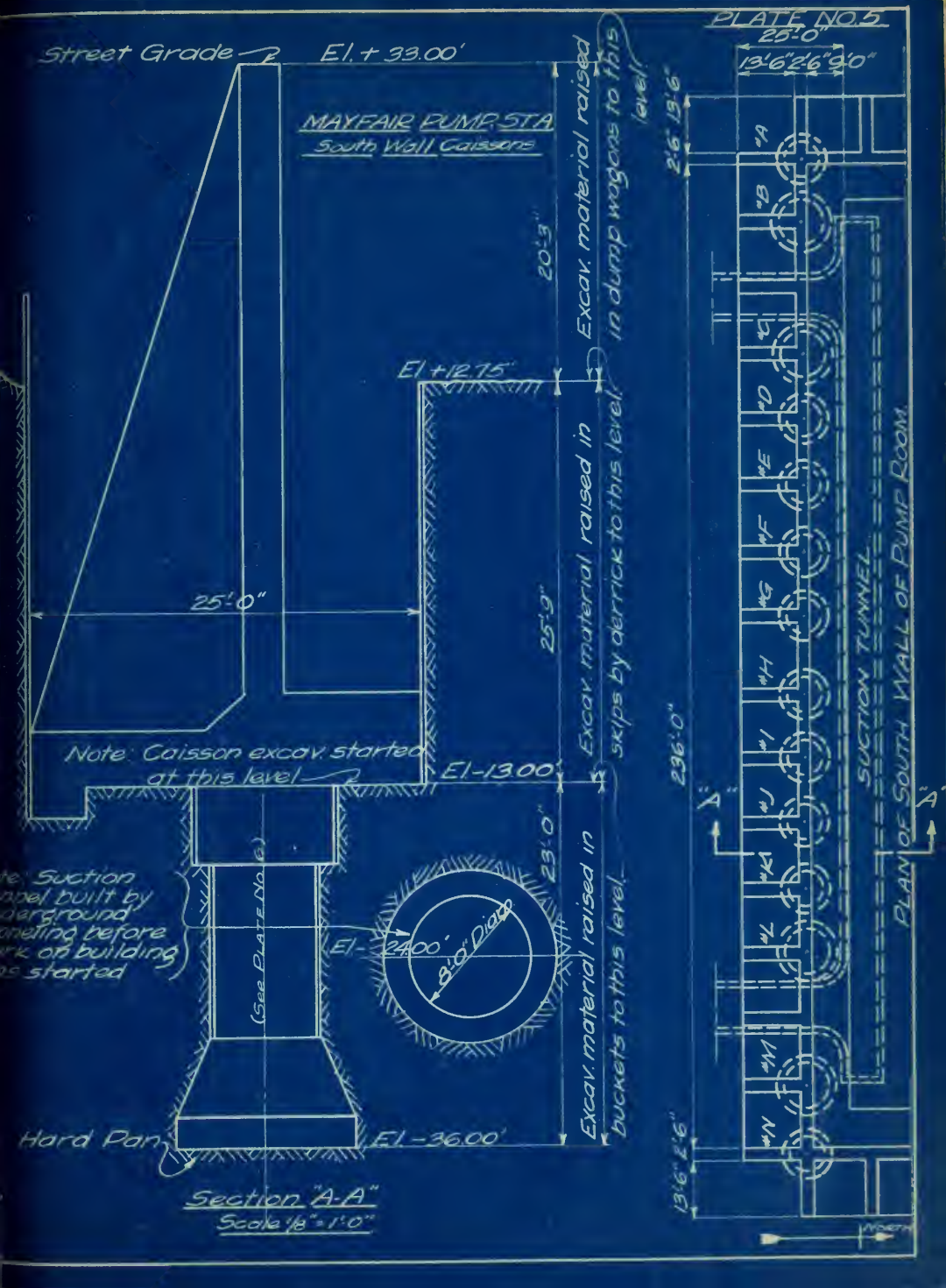


PLATE NO. 5
Street Grade
El. + 33.00'
MAYFAIR PUMP STA.
South Wall Caissons
20'-3"
Excav. material raised in skips by derrick to this level
El +12.75'
25'-0"
25'-9"
Excav. material raised in skips by derrick to this level
Note: Caisson excav. started at this level
El-13.00'
23'-0"
Excav. material raised in buckets to this level
(See Plate No. 6)
El-24.00'
8'-0" Diam.
Hard Pan
El.-36.00'
Section "A-A"
Scale 1/8" = 1'-0"
25'-0"
13'-6" 2'-6" 3'-0"
2'-6" 13'-6"
236'-0"
13'-6" 2'-6"
SUCTION TUNNEL
PLAN OF SOUTH WALL OF PUMP ROOM.

PLATE NO 6

Mayfair Pumping Station

Progress Diagram for Caisson Excavation.

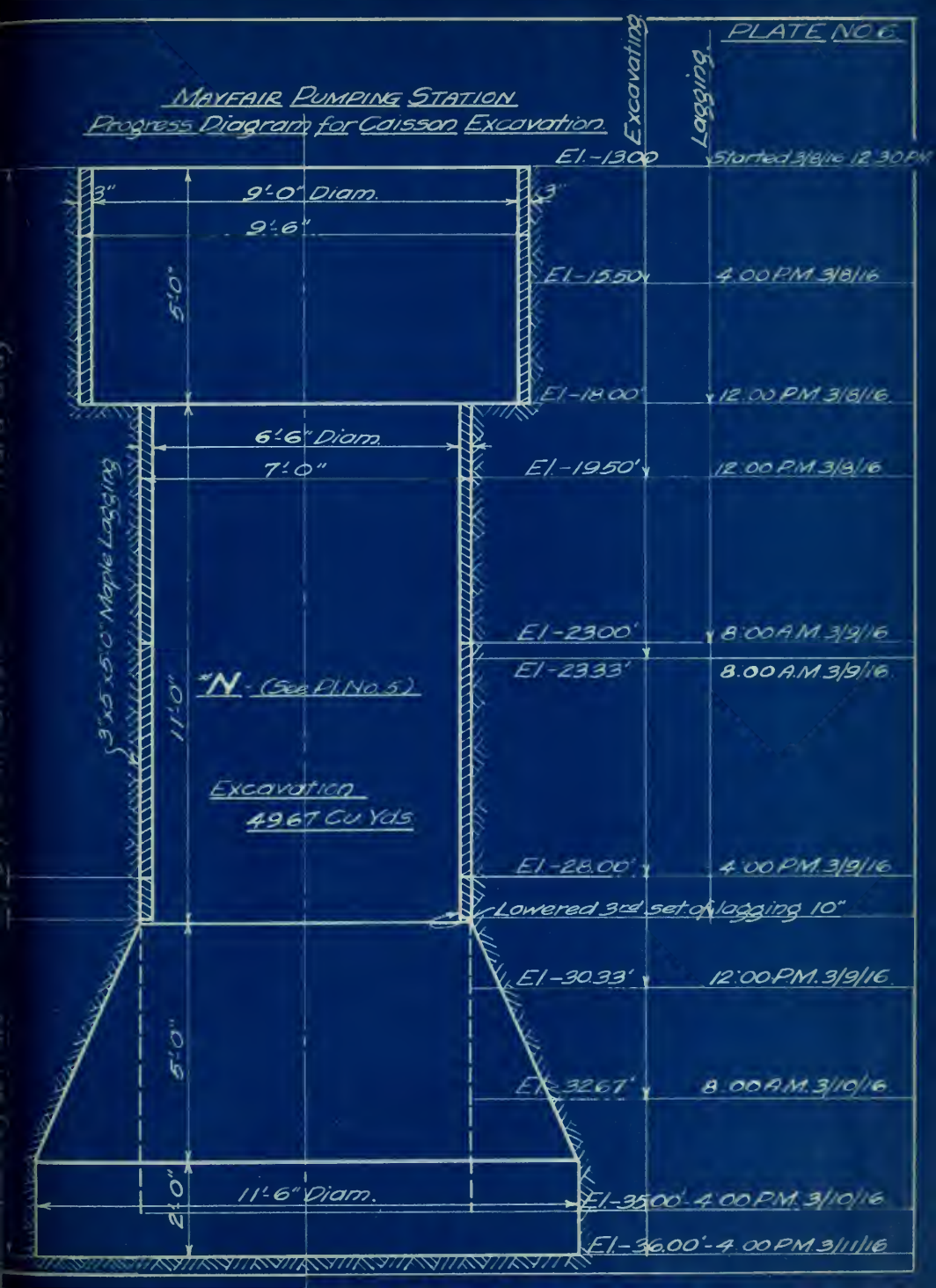
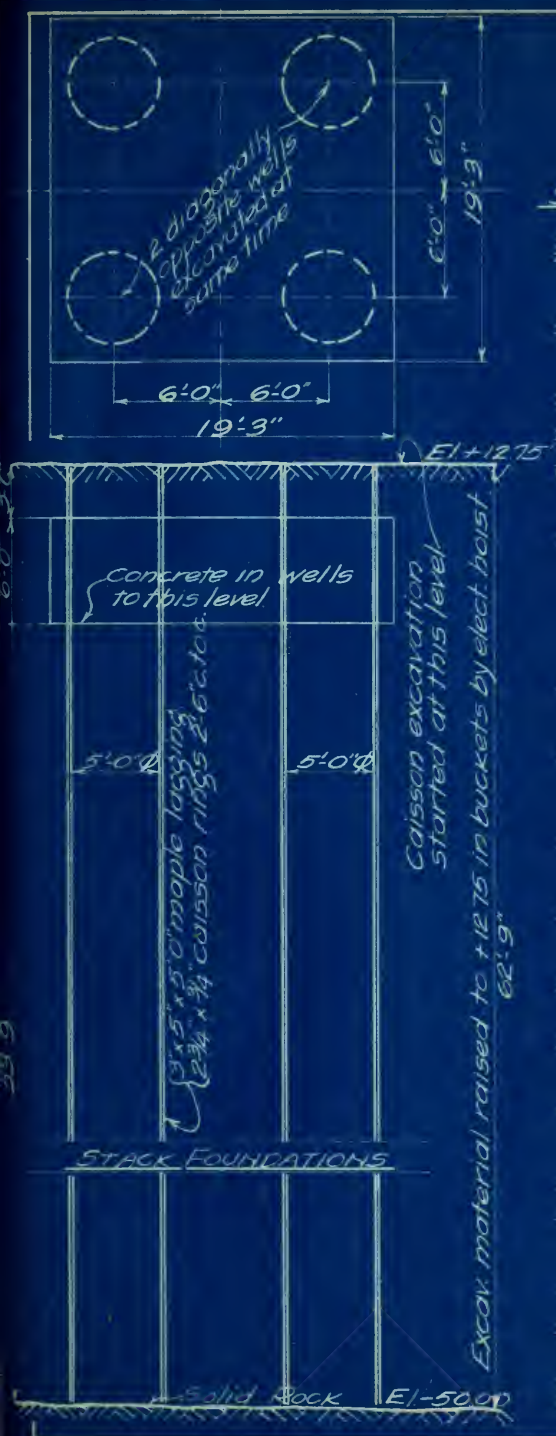
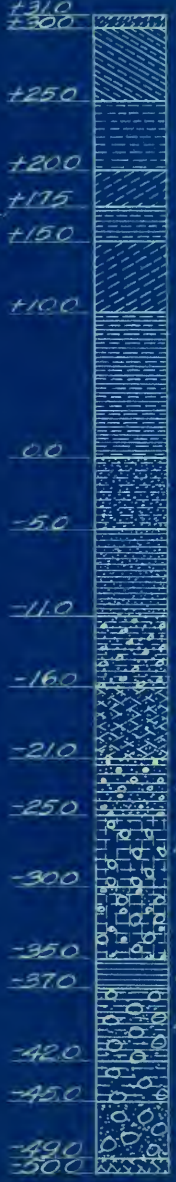


PLATE NO 7



MAYFAIR PUMP STATION
SOIL BORINGS NEAR STACK CAISSONS



black loam
yellow stiff clay
" " " & blue clay
stiff blue clay
hard " "
stiff " "
hard blue clay
stiff " " & dry loam
hard " " & little loam
hard clay & gravel & sand
red clay, blue clay & sand
loam, hard clay & gravel
hard pan & small boulders
" ", gravel & " "
hard clay
loam, boulders & water
" , hard clay, boulders & water
boulders & sand
rock with clay seams

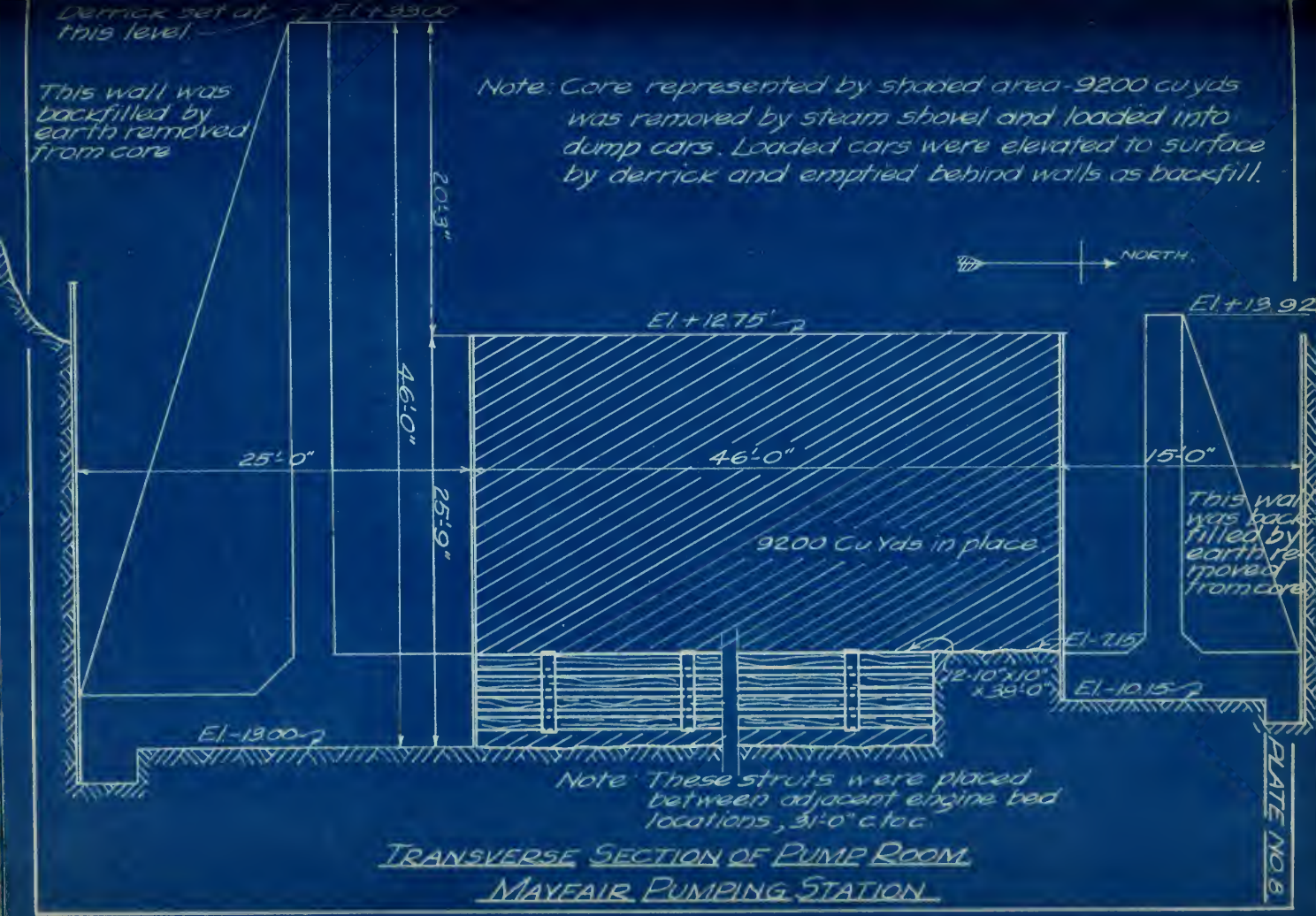
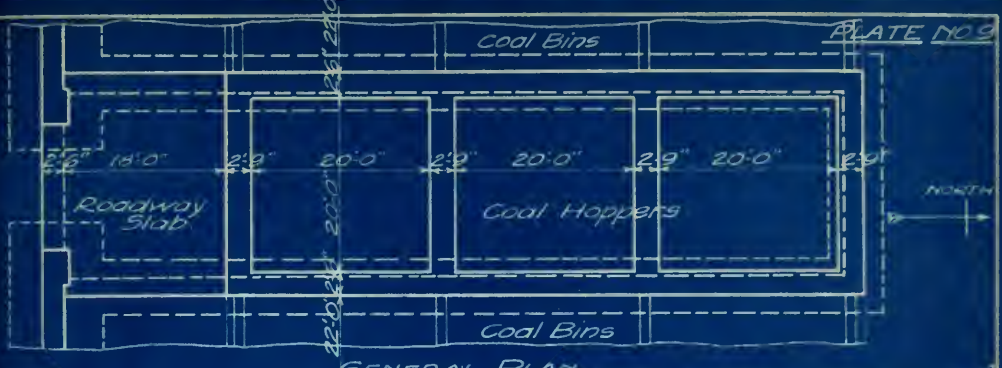
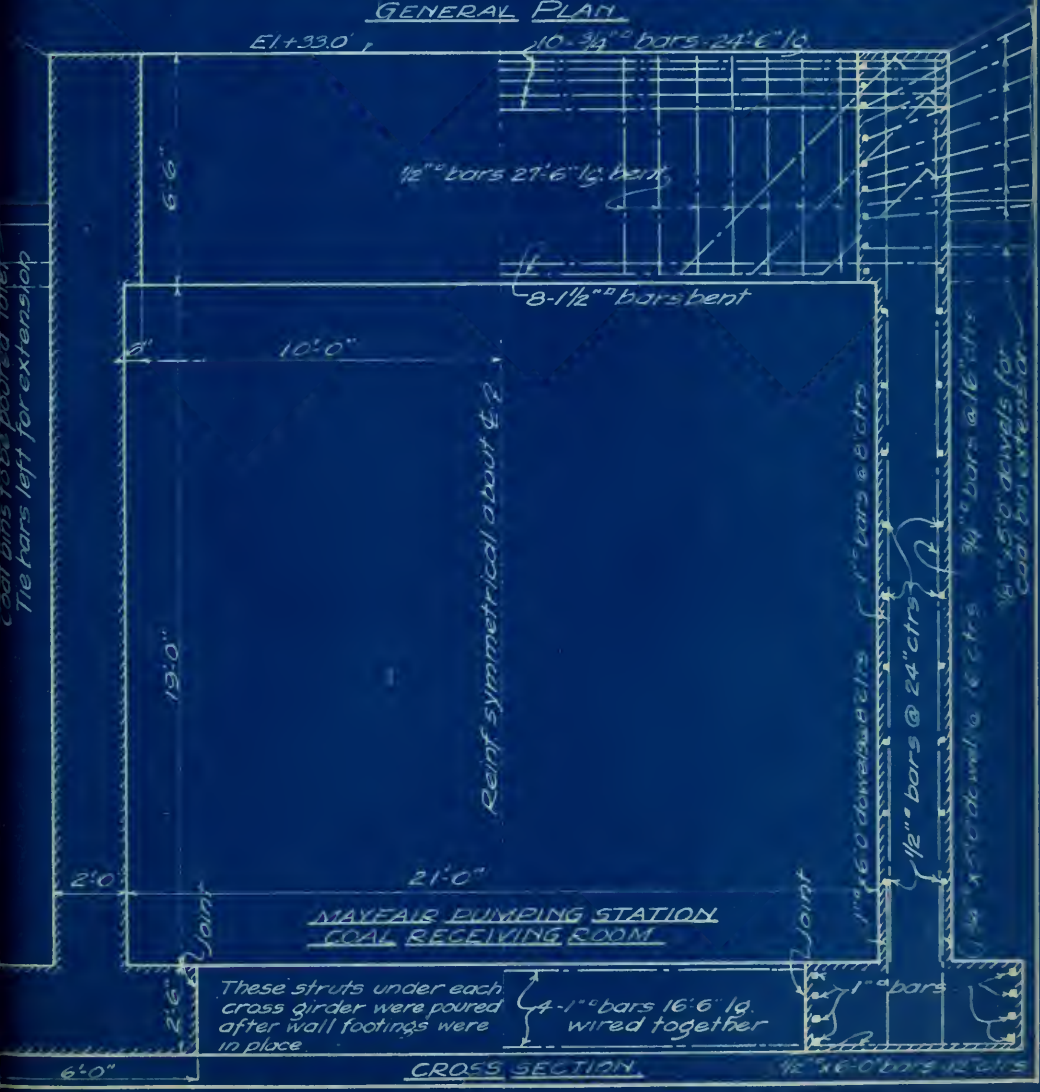
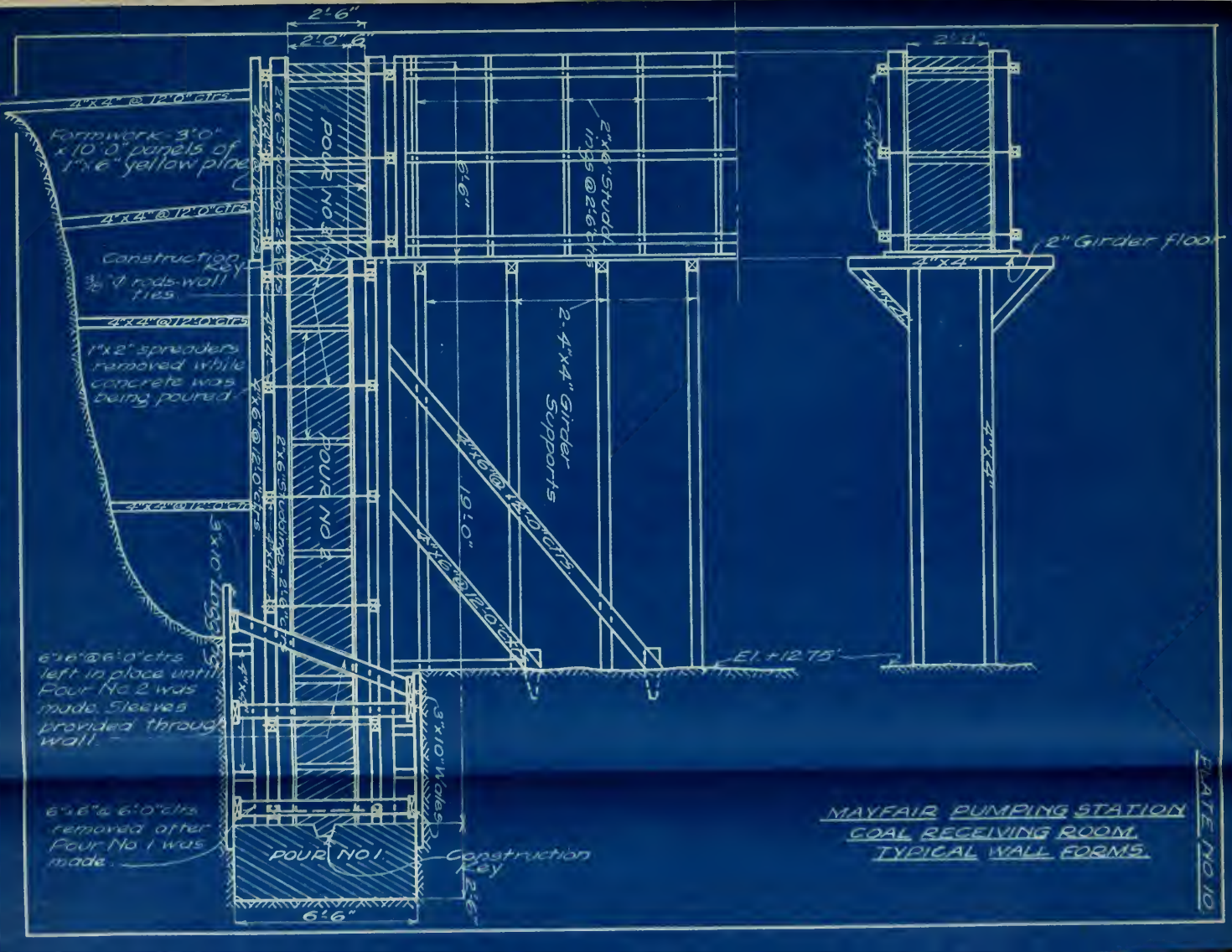

Derrick set at this level
El. +33.00
This wall was backfilled by earth removed from core
Note: Core represented by shaded area - 9200 cu yds was removed by steam shovel and loaded into dump cars. Loaded cars were elevated to surface by derrick and emptied behind walls as backfill.
NORTH.
El. +13.92
El. +12.75
20'-3"
46'-0"
25'-0"
46'-0"
15'-0"
25'-9"
9200 Cu Yds in place.
This wall was backfilled by earth removed from core
El. -7.15
12'-10" x 10" x 39'-0"
El. -10.15
El. -19.00
Note: These struts were placed between adjacent engine bed locations, 31'-0" c to c
TRANSVERSE SECTION OF PUMP ROOM
MAYFAIR PUMPING STATION
PLATE NO. 8

PLATE NO 9



GENERAL PLAN

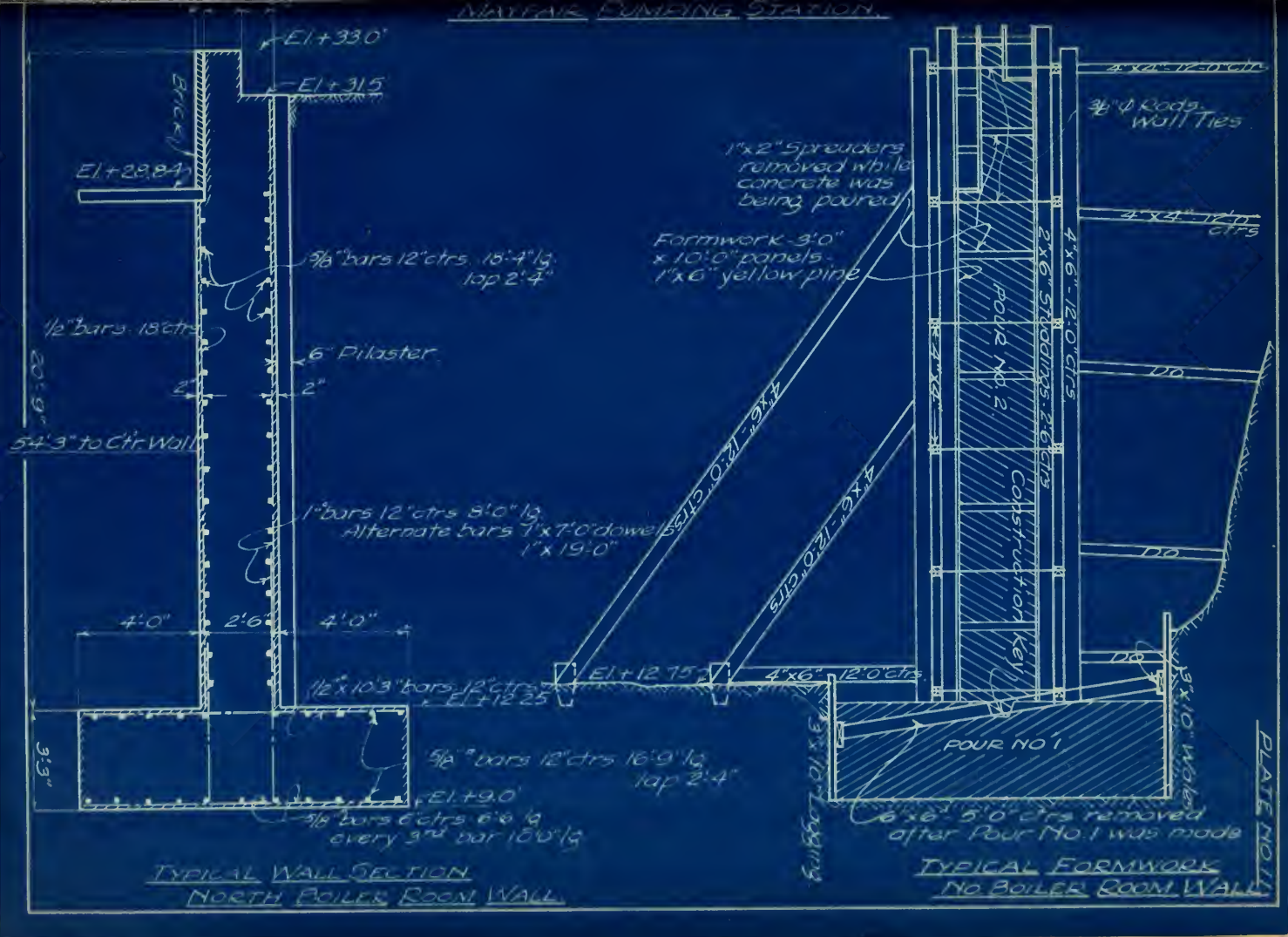




MAYFAIR PUMPING STATION
COAL RECEIVING ROOM.
TYPICAL WALL FORMS.

PLATE NO 10

NIAGARA PUMPING STATION



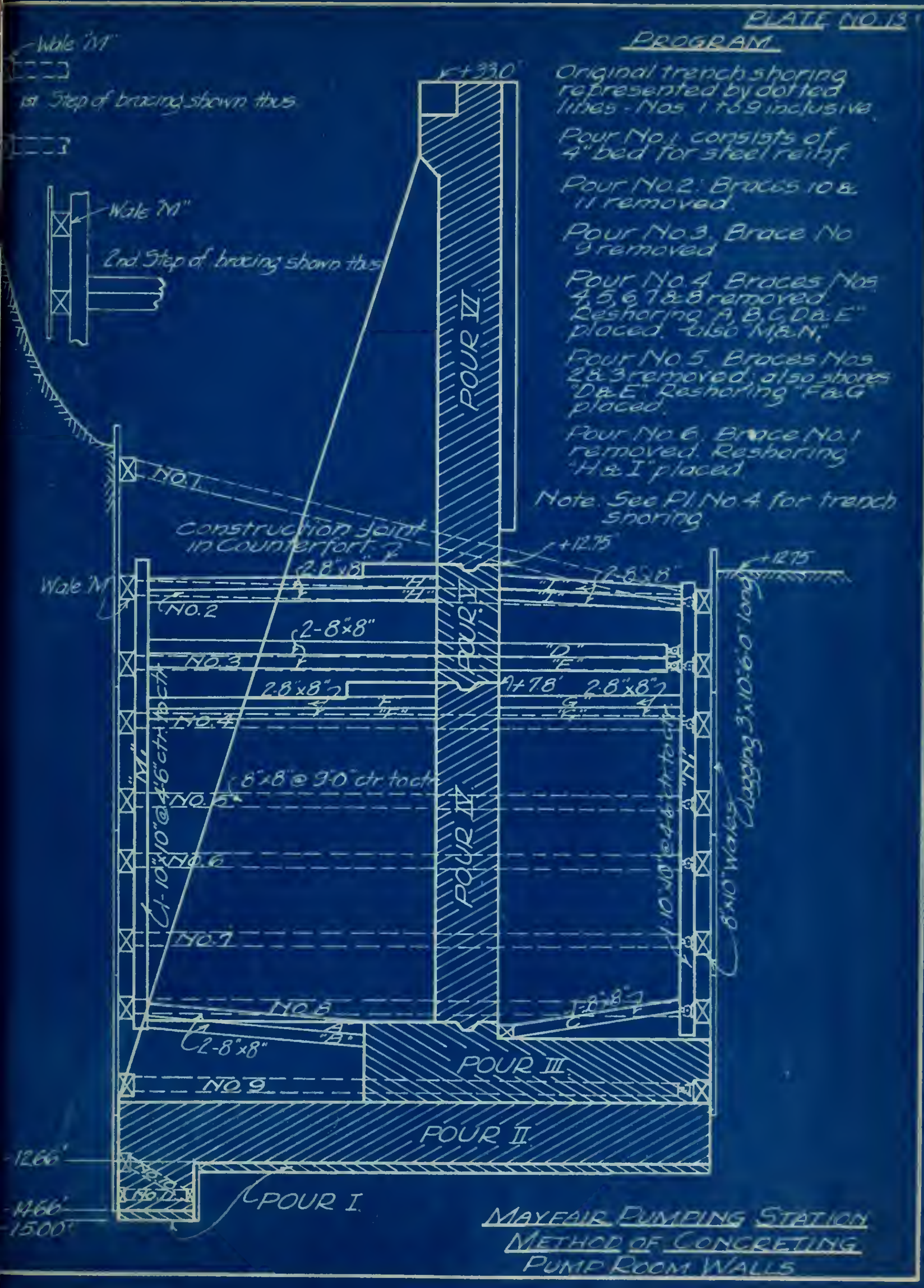
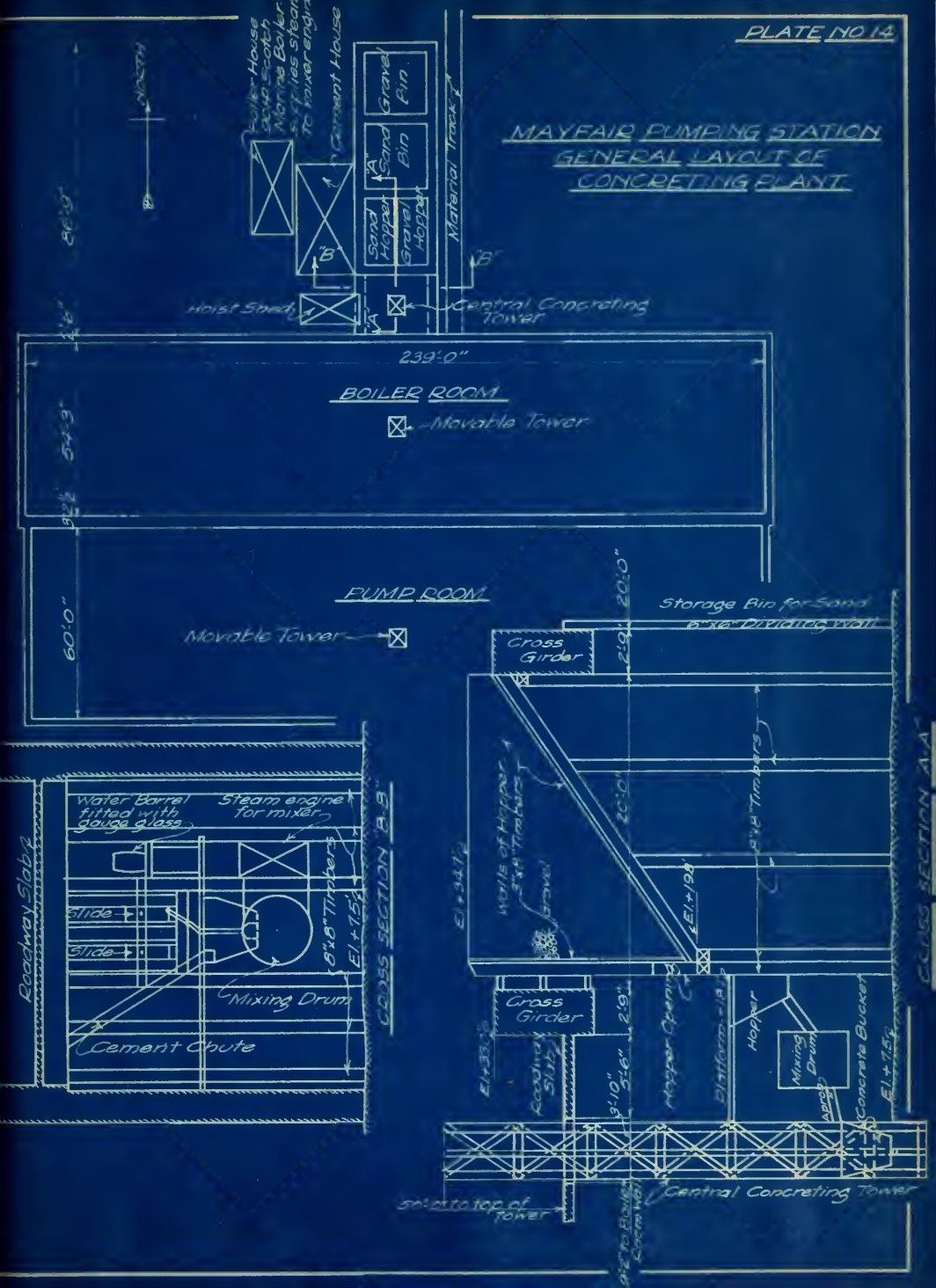


PLATE NO. 13
PROGRAM
Original trench shoring represented by dotted lines - Nos. 1 to 9 inclusive.
Pour No. 1 consists of 4" bed for steel reinf.
Pour No. 2: Braces 10 & 11 removed.
Pour No. 3. Brace No. 9 removed.
Pour No. 4. Braces Nos. 4, 5, 6, 7 & 8 removed. Reshoring "A, B, C, D & E" placed. Also "M & N,"
Pour No. 5. Braces Nos. 2 & 3 removed; also shores "D & E". Reshoring "F & G" placed.
Pour No. 6. Brace No. 1 removed. Reshoring "H & I" placed.
Note. See Pl. No. 4 for trench shoring.
Wale "M"
1st Step of bracing shown thus.
Wale "M"
2nd Step of bracing shown thus.
+33.0'
POUR VI.
Construction joint in Counterfort
+12.75
+12.75
NO. 1
NO. 2
NO. 3
NO. 4
NO. 5
NO. 6
NO. 7
NO. 8
NO. 9
2-8"x8"
2-8"x8"
2-8"x8"
2-8"x8"
2-8"x8"
+7.8'
POUR V.
POUR IV.
POUR III.
POUR II.
POUR I.
8"x8" @ 9'-0" ctr. to ctr.
1-10"x10" @ 4'-6" ctr. to ctr.
10"x10" @ 4'-6" ctr. to ctr.
8"x10" Wales
Logging 3"x10"x16'-0" long
Wale "M"
-12.66'
-14.66'
-15.00'
MAYFAIR PUMPING STATION
METHOD OF CONCRETING
PUMP ROOM WALLS

PLATE NO 14

MAYFAIR PUMPING STATION
GENERAL LAYOUT OF CONCRETING PLANT



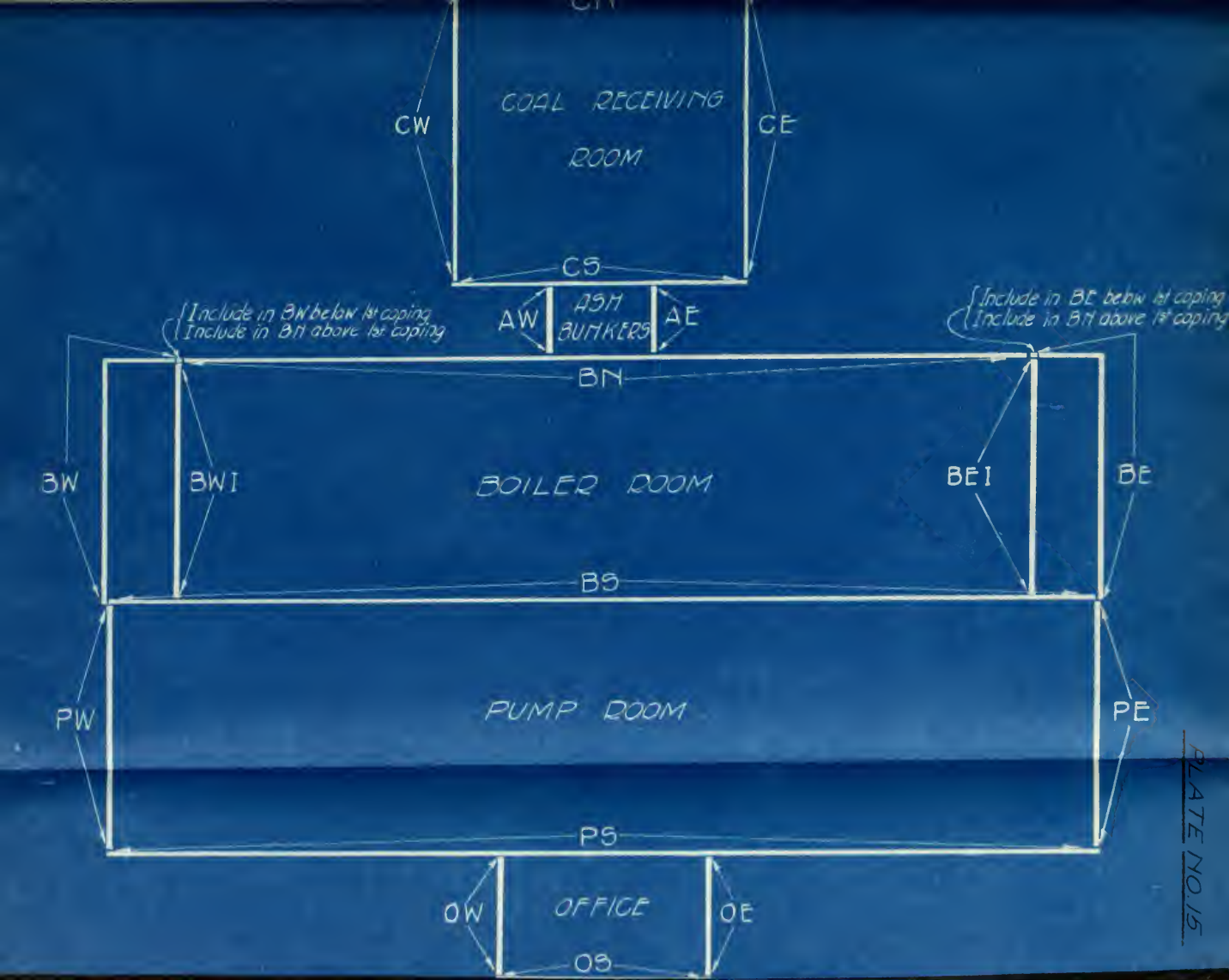
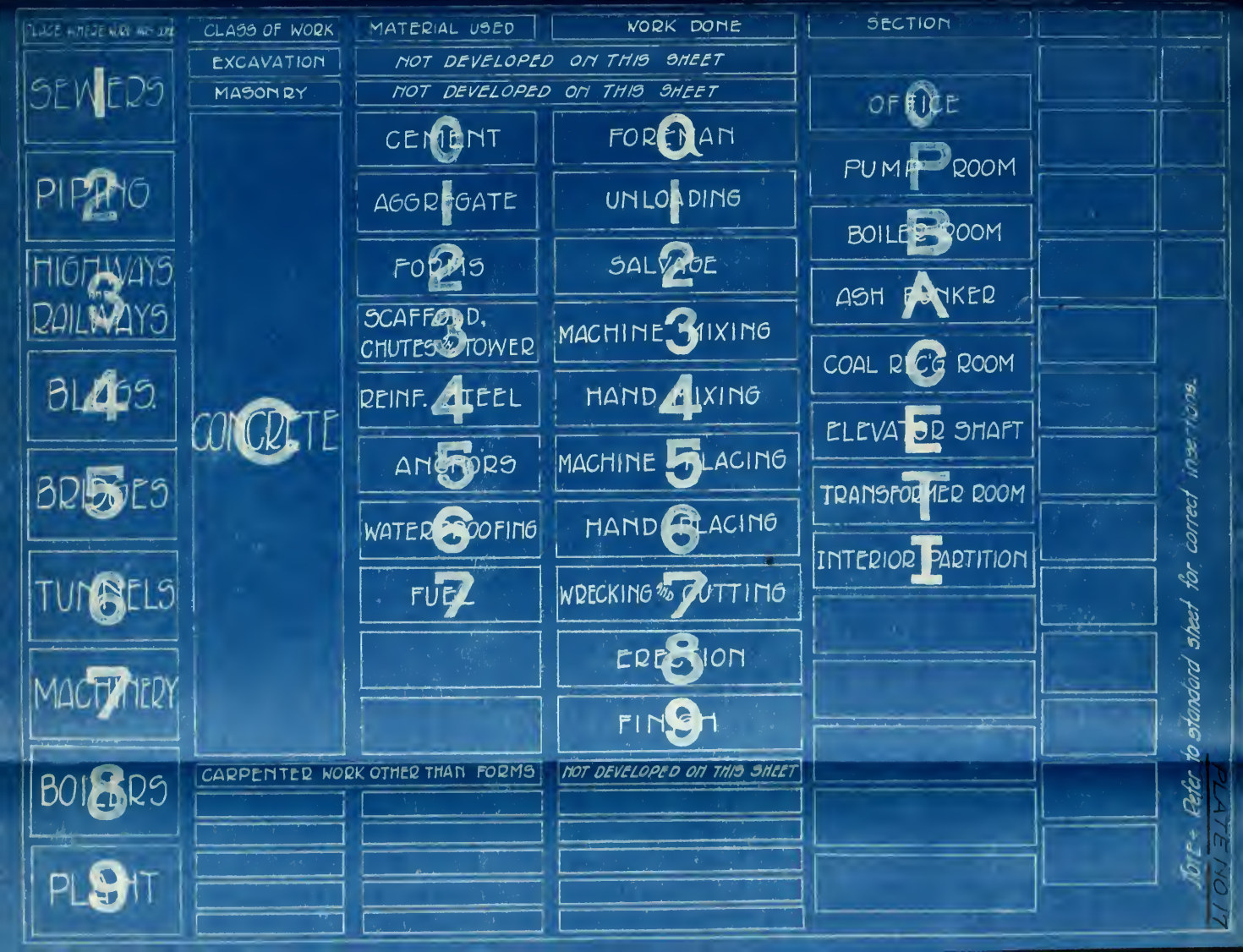

CN
COAL RECEIVING ROOM
CW
CE
CS
AW
ASH BUNKERS
AE
{Include in BW below 1st coping
Include in BN above 1st coping
{Include in BE below 1st coping
Include in BN above 1st coping
BN
BW
BWI
BOILER ROOM
BEI
BE
BS
PW
PUMP ROOM
PE
PS
OW
OFFICE
OE
OS

PLATE NO. 15

PLACE WHERE WORK WAS DONE	CLASS OF WORK	WORK DONE				
1 SEWERS	CONCRETE	NOT DEVELOPED ON THIS SHEET				
2 PIPING	MASONRY	NOT DEVELOPED ON THIS SHEET				
3 HIGHWAYS AND RAILWAYS	1 EXCAVATION	0 FOREMAN				
4 BRIDGES		0 DIGGING	1 HAND			
5 TUNNELS		1 HOISTING	2 TEAM			
6 MACHINERY		2 PUMPING	3 STEAM SHOVEL			
7 BORERS		3 CLEARING SITE				
8 PLANT		4 BACKFILLING	5 HOIST			
		5 BRACING				
		6 GRADING	7 DERRICK			
		7 TRANSPORTING				
			9 CRANE			
	CARPENTER WORK OTHER THAN FORMS		NOT DEVELOPED ON THIS SHEET			

NOTE Refer to standard sheet for correct insertions.

PLATE NO. 6


PLACE A PIECE WHERE WORK IS DONE
SEWERS 1
PIPING 2
HIGHWAYS AND RAILWAYS 3
BLASTS 4
BRIDGES 5
TUNNELS 6
MACHINERY 7
BOILERS 8
PLANT 9
CLASS OF WORK
EXCAVATION
MASONRY
CONCRETE 0
CARPENTER WORK OTHER THAN FORMS
MATERIAL USED
WORK DONE
NOT DEVELOPED ON THIS SHEET
NOT DEVELOPED ON THIS SHEET
CEMENT 0
AGGREGATE 1
FORMS 2
SCAFFOLD, CHUTES & TOWER 3
REINF. STEEL 4
ANCHORS 5
WATERPROOFING 6
FUEL 7
FOREMAN 0
UNLOADING 1
SALVAGE 2
MACHINE MIXING 3
HAND MIXING 4
MACHINE PLACING 5
HAND PLACING 6
WRECKING & CUTTING 7
ERECTION 8
FINISH 9
NOT DEVELOPED ON THIS SHEET
SECTION
OFFICE 0
PUMP ROOM P
BOILER ROOM B
ASH BUNKER A
COAL RE'G ROOM C
ELEVATOR SHAFT E
TRANSFORMER ROOM T
INTERIOR PARTITION I
NOTE - Refer to standard sheet for correct insertions.
PLATE NO 17

INDEX OF PHOTOGRAPHS.


PHOTO NO. 1.
MAYFAIR PUMPING STATION
LOOKING S. FROM ROCK PILE
NOV. 16 1915
J.R.TAYLOR
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PHOTO NO. 2.

MAYFAIR PUMPING STATION
LOOKING W. SHOWING N. BOILER ROOM WALL
DEC. 7 1915


J.R.TAYLOR
137
MAYFAIR PUMPING STATION
LOOKING W-
JAN - 11 - 1916
PHOTO NO. 3.

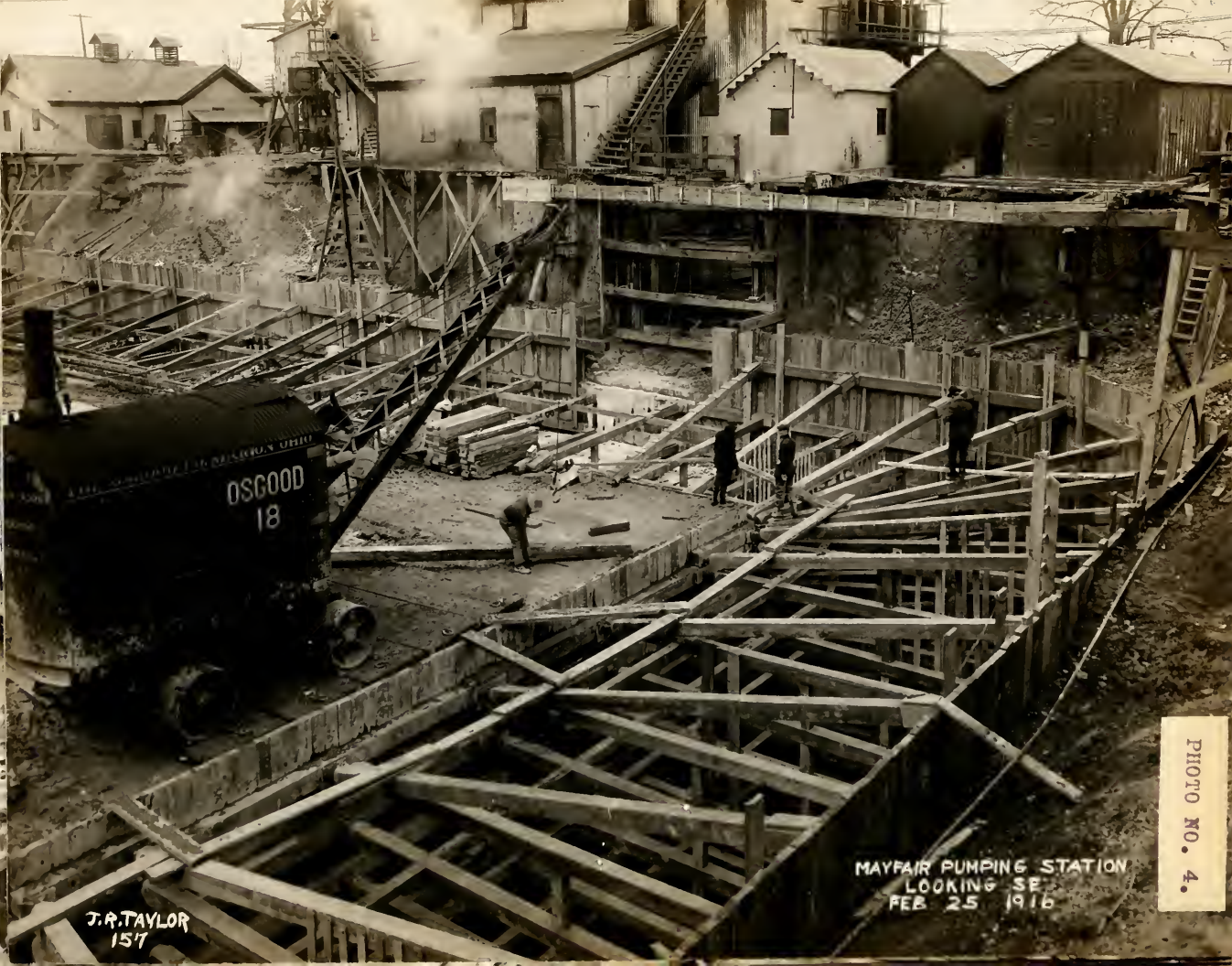
OSGOOD
18
MAYFAIR PUMPING STATION
LOOKING SE
FEB 25 1916
PHOTO NO. 4.
J.R.TAYLOR
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PHOTO NO. 5.


PHOTO NO. 6.
J.R. TAYLOR
140
MAYFAIR PUMPING STATION
COAL RECEIVING ROOM LOOKING S
JAN 11 1916

PHOTO NO. 7.

PHOTO NO. 8.