RhinoOne GEOTECHNICAL

July 08, 2014

Portland Public School
Attn: Mr. Steve Effros
Project Manager, Facilities and Asset Management
501 N. Dixon Street
Portland, Oregon 97227

Re: Report of Geotechnical Engineering Services
Vertical Settlement and Lateral Movement
Tubman School Site for Portland Public Schools
Portland, Oregon
RhinoOne Project No. PPS-2013-003

Dear Mr. Effros:

RhinoOne Geotechnical Engineering is pleased to submit this report of our preliminary analysis of the settlement and lateral movement issues at the Tubman Middle School Site in Portland, Oregon. We conducted a site walk with you on December 30, 2013. You subsequently provided us with a set of documents for review. These documents are referenced below:

- Burns, Bear, McNeil & Schneider, Grading and Roof Plan, Eliot Elementary School For Multnomah County School District Number 1, Sheet 1 of 9, 1952 (BBMS).

- ODOT, Retaining Wall East Bank Freeway Section, Plan & Elevation, Sheet Number 15928 dated 5/5/1960; Standard Retaining Walls, Front Face Vertical, Sheet Number 15552, dated 1/14/1960.

- Kelly Strazer & Associates Geotechnical Investigation and Report, Proposed Additions to Harriet Tubman Middle School, Portland, Oregon dated March 29, 1983 (KSA-1).

- Unthank Seder Poticha Architects, PC, Set of Plans for “Additions and Remodeling”, dated October 1983 (USPA).

- Kelly Strazer & Associates, Slope Failure Problem, Harriet Tubman Middle School Project, Portland, Oregon dated April 15, 1983 (KSA-2).

- Kelly Strazer & Associates, Unstable Soil Area, Harriet Tubman Middle School Project, Portland, Oregon letter dated January 18, 1984 (KSA-3).

- Kelly Strazer & Associates, Observation of Pile Driving during Construction, Harriet Tubman Middle School Project, Portland, Oregon dated March 14, 1984 (KSA-4).

Current Conditions:
We completed a site walk with you and representatives of Oregon Department of Transportation (ODOT) on April 18, 2014. Building settlements were observed at the southwest corner and at the generator room with some additional distress observed between these two points. Distress was observed in the parking lot on the west side of the building as evidenced by various asphalt repairs over the years. Standing water was also observed in a clean-out which indicates that the water is not draining properly. A 2- to 4- inch crack running along the entire height was observed in the ODOT retaining wall downslope from the southwest corner of the building. Figure 1 shows a schematic of observed building movements. The pattern of movement appears to be lateral ground movement which subsequently causes vertical movements.

Review of Existing Data:
We understand that the original school building was constructed in 1952. Figure 2 of the KSA-1 (1983) report (see attachments) indicates the approximate top of pre-fill slope based on 1908 Sanborn Insurance Maps. Review of the contours on the 1952 grading plan (see attachments) indicates that the elevations along the edge of bank were ± 129 feet to ± 136 feet in 1952 and therefore the site was filled sometimes before 1952. The top of the bank has also moved towards the west and south of the 1908 line. Based on this map, most of the 1952 structure was placed on native ground except the southern-most 30 feet and a small portion of the northwest corner of the building. The central area of the site which is indicated as “Play Area and Night Parking” and where the 1983 addition was constructed has significant depth of un-documented fill. The grading plan also indicates the finished elevations for “Play Area and Night Parking” areas on the order of ± 134 feet to ± 138 feet. This indicates that some additional fill was also placed for this addition in 1952. Our review indicates that there are several areas of undocumented fills on this site. Review of the KSA-1 report indicates that the 1952 structure was placed on timber piles.

We understand that ODOT built a retaining wall near the southwest side of the school property in 1960’s. We reviewed sheets 15928 and 15552 (see attachments) provided to us by ODOT and also conducted an on-site meeting on April 18 between the staff of PPS and ODOT. The retaining wall is approximately 200 feet long with a maximum height of 14 feet from base of foundation to the top of wall. The wall was designed for a 2H: 1V slope. Based on the standard plans (Sheet 15552), the base width of the foundation is 8’6” with the section towards the school being 3’3”. We do not have access to as-builds so the limits and type of backfill for the wall could not be determined. A 2- to 4- inch separation along the entire height of the wall was observed between the panels of the retaining wall which indicates that the wall has moved over the years. We also understand that ODOT constructed a viaduct for both the north and south bound lanes of I-5 above a ravine north of the retaining wall. It is possible that un-documented fill has been placed over the years encroaching over the ravine.

Expansion to the school building was planned in 1980’s. KSA was contracted by the School District to complete a geotechnical study (KSA-1). KSA completed five (5) borings in 1980 and an additional eleven (11) borings in 1983. Figure 2 from KSA report shows the location of these borings. KSA also observed shallow surficial sliding, block movements, cracking and previous asphalt patching during this study. These features are also shown on Figure 2 of KSA-1 report. Based on these borings, KSA developed fill depth contour maps as indicated in Figure 14 of the KSA-1 report (attached). The depth of fill is zero near the east side the site to as much as 30 feet or more near the south west portions of the site. The fill has been described as un-documented fill. KSA recommended that the new building addition be

supported on driven timber piles to an ultimate capacity of 25 tons. Review of grading plans indicates that some minor filling was also performed for this addition.

The piles were subsequently driven as summarized in KSA-4 (1984) report dated March 14, 1984. A total of 220 piles were installed for the main building. The lengths of piles were from a low of ± 18 feet to about ± 40 feet. Pile driving was terminated based on the Engineering News Formula. Review of the as-builds indicates that the piles are embedded approximately 4 inches into the pile cap. This indicates that the piles are free head and have potentially lost contact with the cap in areas of large movement. Piles with this condition have limited lateral load capacity.

The new generator room was located on the west side near the northwest side of the building. The generators were mentioned in KSA-3 report. We were not able to establish the foundation conditions for this room, but we postulate that it is placed on shallow foundations. This is because we did not find any pile driving records for the generator room.

Causation:
Based on our observation and discussions with you, it appears that most of the building distress is on the west wall with large settlements noted at the southwest corner. The parking area and the driveways are showing distress as indicated by un-even surface and previous asphalt patching. The generator room is also showing separation from the main building.

The site has undergone several instances of filling. Based on the previous boring logs, it appears that 30 feet or more of fill is placed at some locations. In addition, the subgrade was not prepared for filling with the old topsoil and organics still present. We interpret that the fill slope is moving laterally. This lateral movement is causing large lateral loads on the piles. Timber piles with minimum embedment in the pile caps are not adequate to carry loads of this magnitude. The lateral movement is likely causing the piles to separate from the pile cap. This lateral movement with subsequent vertical settlement is most likely causing distress to the building as observed along the west wall.

The effect of lateral movement is more pronounced in the parking lot area with uneven settlements, several asphalt patches and movement of the generator room. These movements have also changed the drainage patterns which may explain why standing water is observed in the cleanouts.

The ODOT retaining wall was constructed per the standard plans in 1960's. Since we do not have access to as-builds, the limits and types of backfill and drainage systems are not known. The retaining wall has shown distress as evidenced by the wall separation. The retaining wall movement indicates that the slope behind the wall has moved in the past. This wall movement with subsequent slope movements could also explain some of the distress observed in the driveways and parking areas.

Potential Remedial Options:
Based on our review, we have discussed conceptual review options and preliminary budgets. These budgets do not include any internal building work that may be needed as part of this remediation system. The remedial options can be divided into three distinct items.

Building Wall– The west and south wall of the building in the impacted area is recommended to be underpinned using a micropile and grade beam system. The micropiles should be installed in groups of 2 at a spacing of approximately 6 feet on center. The first micropile installed inside the building should be vertical whereas the second micropile installed from outside the building should have a batter of 15 degrees. The micropiles should be a minimum of 8-inches in diameter with an outer casing for lateral loads installed to a minimum depth of 25 feet or possibly more in some areas. The total depth of micropile will be on the order of 45- to 50- feet. A continuous grade beam should be installed below the existing wall with the micropiles connected to it. For preliminary budget estimate, we have assumed a 200 feet length of wall will require remedial measures. The grade beam will most likely be 3 feet thick and 3- to 4- feet wide running along the entire length of the wall.

Soldier Pile Wall for Slope Stabilization – We recommend that a soldier pile wall system be constructed at the edge of the slope upslope from the ODOT retaining wall. The soldier pile wall system consists of steel beams installed in a drilled hole and backfilled with structural concrete. For this site, a soldier pile wall constructed from the top will be the most practical option. The soldier piles will be installed at spacing of 6- feet, with 30- to 36- inch diameter and to a depth of 45 to 50 feet. A steel beam like HP 14x117 will be placed entire depth. For preliminary budget purposes, assume that the length of this wall will be on the order of 200 feet.

Parking Lot Reconstruction – The district should decide on the potential use of the parking lot. If this lot will be used for bus traffic then remedial measures will be required. Most of the parking lot is located on un-documented fill. We recommend that five feet of this fill be removed. The exposed subgrade should then be compacted. A bi-axial geogrid with a geotextile composite should then be installed over the prepared subgrade. Four feet of 3” minus clean rock should then be installed over the geogrid and compacted in layers. The pavement structural section of asphalt concrete over crushed rock should then be installed. The actual design of the section should be done based on the intended use.

Slopes on the North end of the Project: The slopes on the north side of the property in the vicinity of the ODOT viaducts have not shown severe signs of distress and therefore were not considered in this study. We recommend that these slopes be monitored for any future signs of distress before any remedial measures are taken.

Budget Cost Estimate:
We have prepared budget estimates for the items mentioned above. Please note that these are “order of magnitude” numbers only. Additional geotechnical study is required to delineate the lists of stabilization areas. Calculations of building loads, micropile and/or soldier pile wall design and the parking lot design will need to be finalized before the budgets are finalized.

Table 1: Estimated Budgets

Item	Estimated Budget	
	Low	High
Building Underpinning (Micropile Wall with new Foundation - 200 Feet of Wall)		
Number of Micropiles	70 (8" Diameter, 25 Feet Cased, 45- to 50- Feet Long)	
Construction Costs	$525,000	$612,500
New Foundation (200L x 4 W x 3 D)	$36,000	$45,000
Design	$35,000	$45,000
Construction Engineering/Observation	$45,000	$55,000
Sub-Total	**$641,000**	**$757,500**
Soldier Pile Wall for Slope Stabilization		
Number of Soldier Piles	35 (30 Inch Diameter, 50 Feet Deep)	
Construction Costs	$350,000	$437,500
Design	$40,000	$50,000
Construction Engineering/Observation	$30,000	$40,000
Sub-Total	**$420,000**	**$527,500**
Parking Lot Re-construction		
Area	Assume 250 Feet Long by 40 Feet Wide by 5 Feet (1850 Yards)	
Construction Costs	$138,750	$175,750
Design and Construction Observation	$25,000	$35,000
Sub-Total	**$163,750**	**$210,750**
Total Estimate Costs	**$1,224,750**	**$1,495,750**
These are order of magnitude numbers only. More field work, analysis and design is required before refining these estimates		

Additional Geotechnical Studies:

We recommend that additional geotechnical studies be completed to better characterize the slide movement and to refine the remedial options. These studies will include installation of at least three inclinometers with vibrating wire piezometers on the downslope sections. The vibrating wire piezometers can be used to record water levels over time. Initialize these inclinometers and monitor them over the next three years on an annual frequency. We also recommend that you engage a surveyor to install some settlement monitoring points on the building, retaining walls and certain selected locations and monitor these at the same time as the inclinometers. We will select these monitoring locations in conjunction with you and the surveyors. This monitoring data will enable determination of depth, direction and rate of movement over time which will enable us to refine our stabilization approach. The services of a structural engineer will also be required as the project moves forward to design the new foundation and connection details.

Limitations

This letter report has been prepared for the exclusive use of the addressee for preparing budgets for this project. The opinions, comments and conclusions presented in this report were based upon information derived from our review of previous work completed at this site and also a review of previous timber pile installations. Conditions between, or beyond, the previous exploratory borings may vary from those encountered. The budgets are to be used only as an order of magnitude number. Additional field investigation and design is required to refine the remedial measures and budgets.

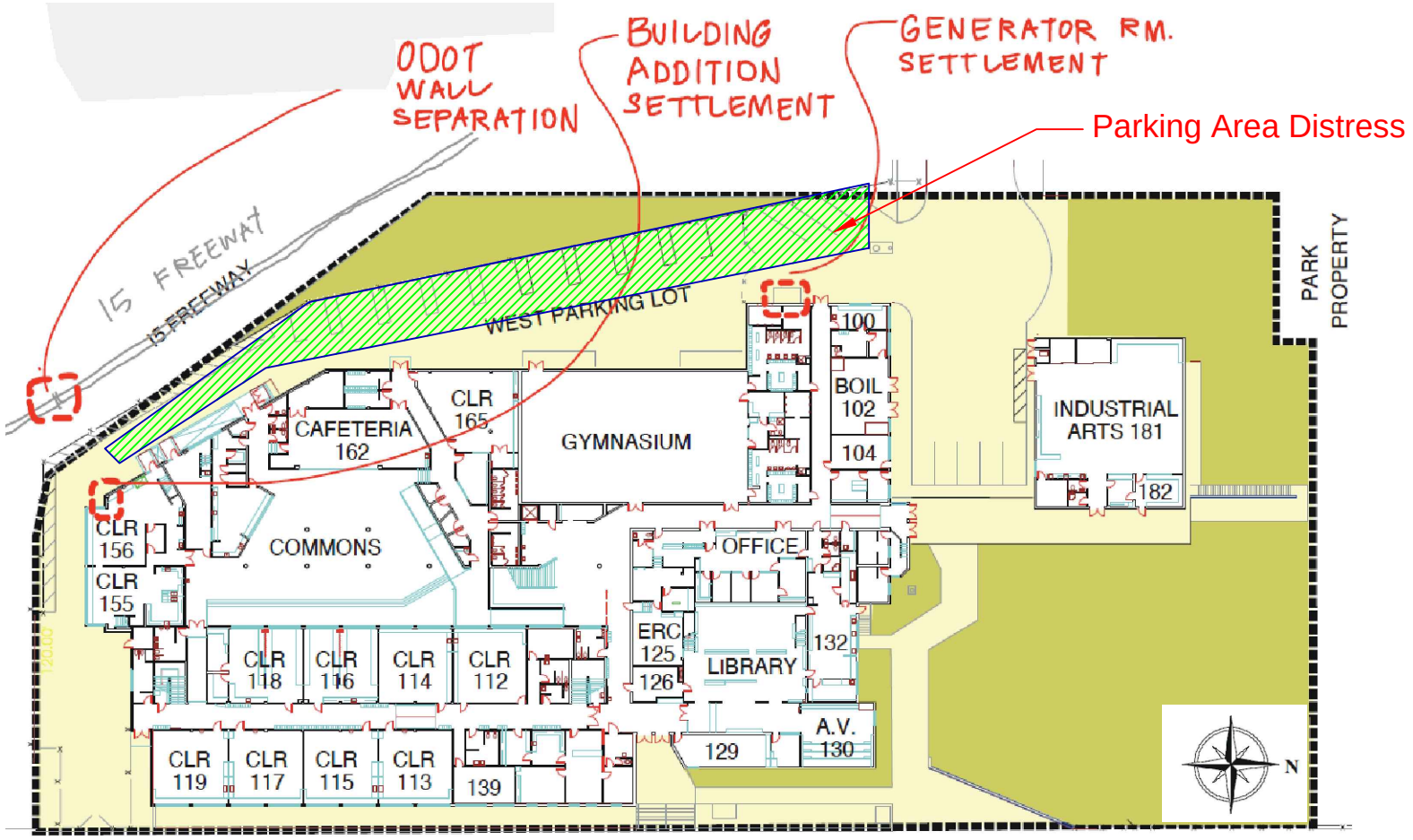
Closure

RhinoOne appreciates this opportunity to provide these services to you and look forward to future involvement in this project. If you have any questions or wish to further discuss this project, please contact me at 360.852.6367.

Sincerely,

Rajiv Ali, PE, GE
Managing Principal
RhinoOne Geotechnical
rajiv@rhinooneeng.com

Attachments:
Figure 1: Site Plan and Current Conditions
Attachments 2: Figure 2 from KSA-1
Attachments 3-5: Sheet 1 of 9 – 1952 Tubman Site Plan
Attachments 6-7: ODOT Sheets 15552 and 15928
Attachments 8: Figure 14 from KSA-1



Legend

Parking Area Distress

Drawing Not to Scale

RhinoOne GEOTECHNICAL
4610 NE 77th Avenue, Suite 126
Vancouver, Washington 98662
360-258-1738

Tubman Middle School 2231 N. Flint Avenue, Portland, OR 97227	Project No: PPS-2014-003	Drawn By: ST
Figure 1 - Current Conditions	Date: June 2014	Reviewed by: RA

LEGEND

K-1 ⊕ EXPLORATORY TEST BORINGS made by KELLY/STRAZER Associates, Inc.

B-1 ⊕ PREVIOUS EXPLORATORY TEST BORINGS made by KELLY/STRAZER Associates, Inc. (refer to report dated July 21, 1980)

BLOCK MOVEMENT

SHALLOW SURFICIAL SLIDING

PHOTOS OF THIS AREA TAKEN 3/2/83

B-4

STRESS CRACKING

SECTION A-A'

SECTION B-B'

K-1 K-2 K-3 K-4 K-5 K-6 K-7 K-8 K-9 K-10 K-11

B-1 B-2 B-3 B-4 B-5

PROPOSED PERFORMING ARTS

PROPOSED

PHYSICAL EDUCATION

mech.

service

EXISTING BUILDING OUTLINE

ENTRY

CENTER

ADMIN.

PROPOSED

PROPOSED COMMONS

COMPUTER EDUCATION

MEDIA CENTER

PROPOSED

PROPOSED INDUSTRIAL ARTS

parking

courtyard - amphitheater

flag

PROPOSED

PARK

shelter

entry

bus loading

n. flint ave.

APPROXIMATE LOCATION OF TOP OF ORIGINAL SLOPE (PRE-FILL) (interpreted from 1908 Sandborn Fire Map)

EXISTING BUILDING OUTLINE

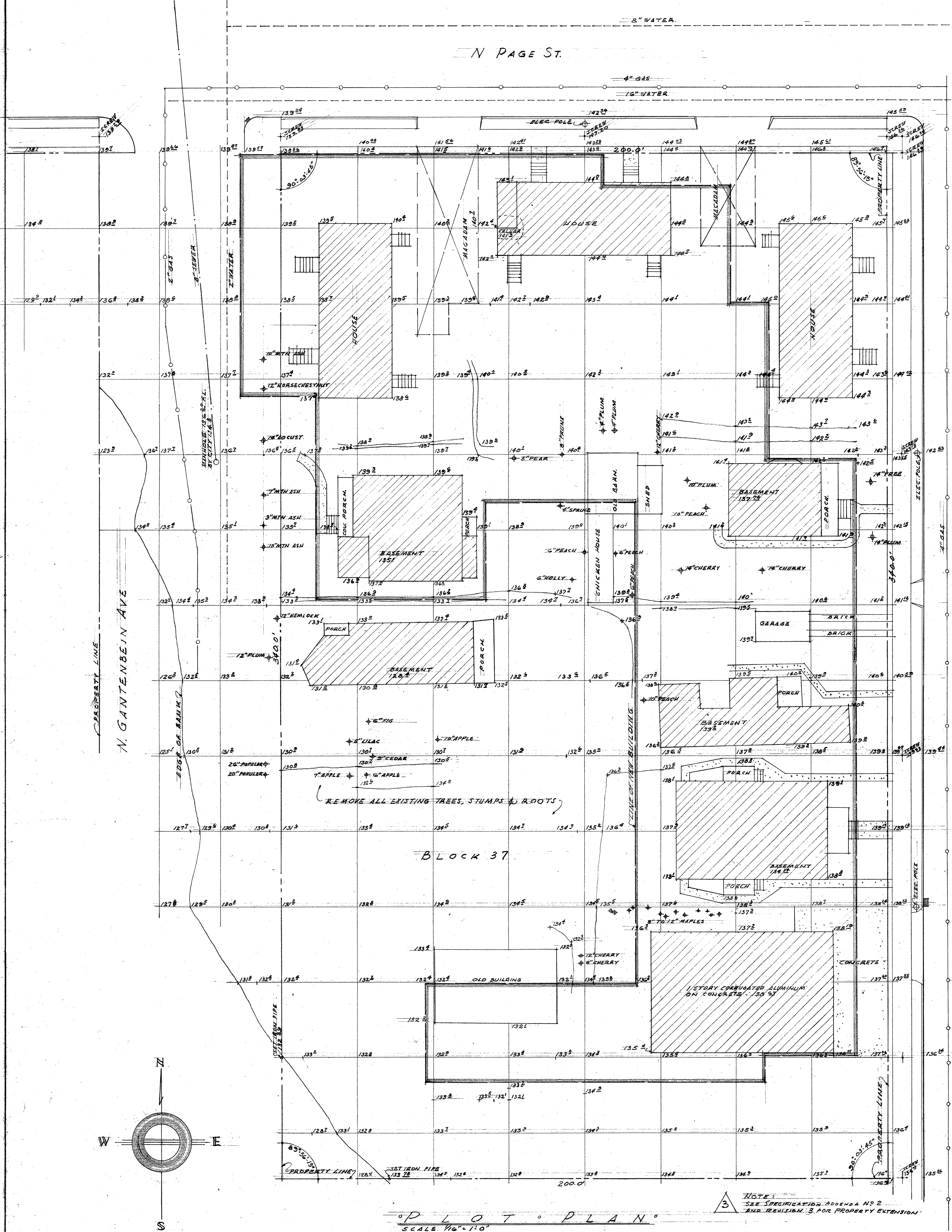
GRAPHIC SCALE

32 0 32 64 FT

1" = 32 FEET

N

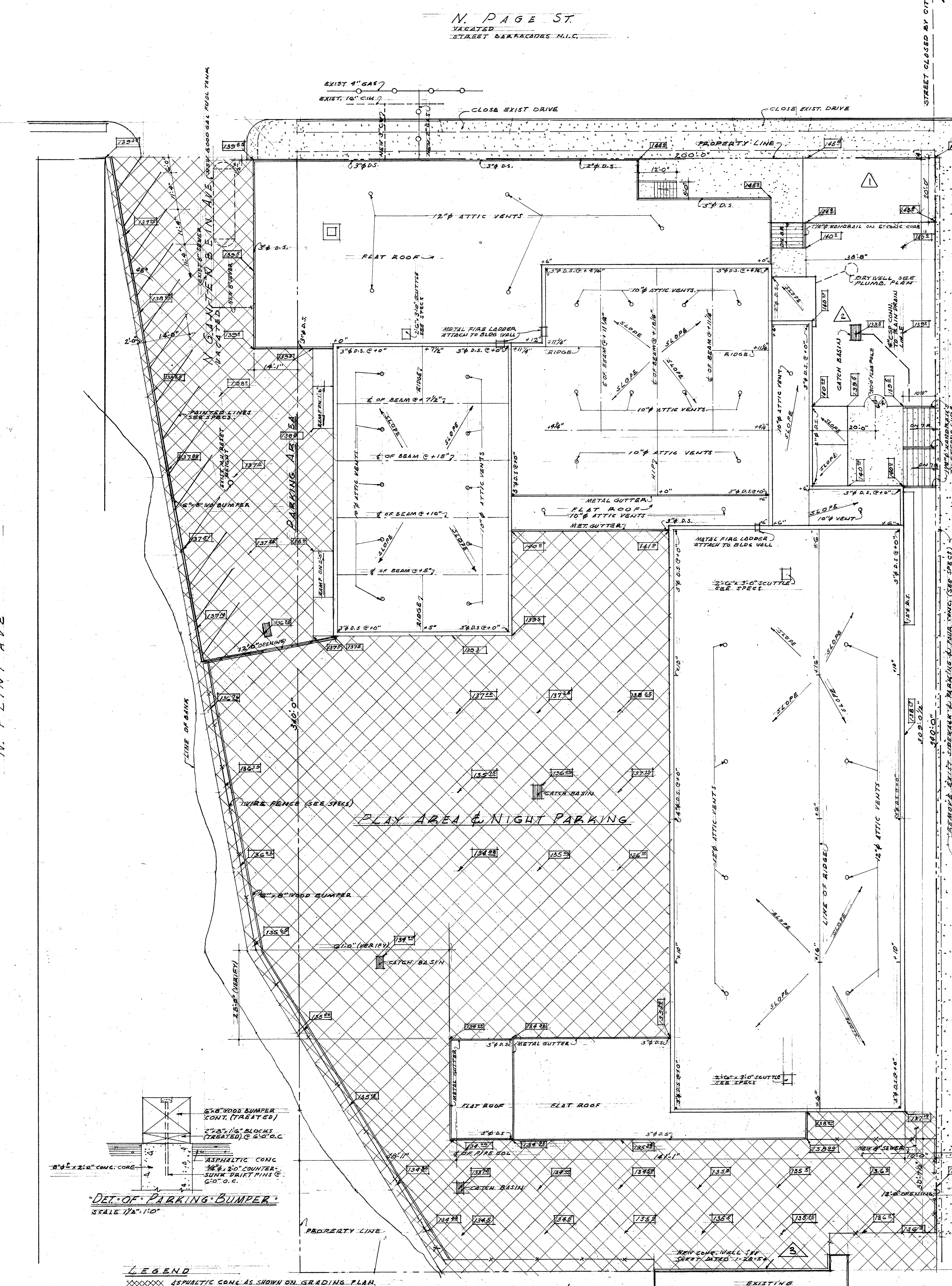
Kelly/Strazer Associates: Geotechnical Consultants	HARRIET TUBMAN MIDDLE SCHOOL PROJECT Portland, Oregon	EXPLORATIONS LOCATION PLAN Mar., 1983 0-192.02	FIGURE 2



·PLOT·PLAN·
SCALE 1/16" = 1'-0"
SURVEYED BY MARSHALL BROS. PORTLAND, OREG. AUG. 1952

NOTE:
CONTRACTOR TO VISIT SITE TO ASSERTAIN WORK REQUIRED FOR DEMOLITION.
SEE SPECIFICATIONS FOR DISPOSITION OF EXISTING BUILDING ON JOB SITE

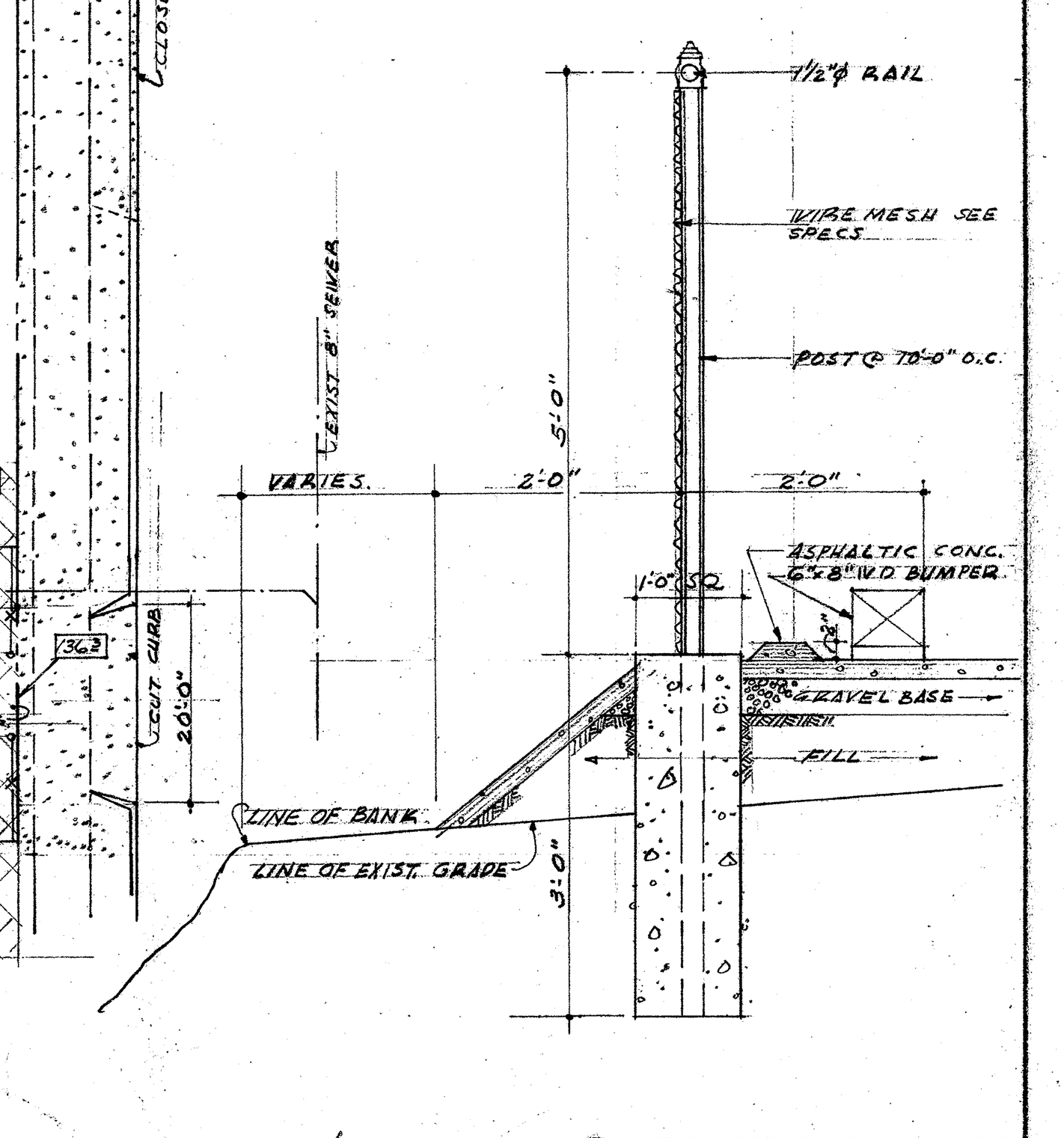
3 NOTE:
SEE SPECIFICATION ADDENDA No 2 AND REVISION 3 FOR PROPERTY EXTENSION



·DET.·OF·PARKING·BUMPER·
SCALE 1/2" = 1'-0"

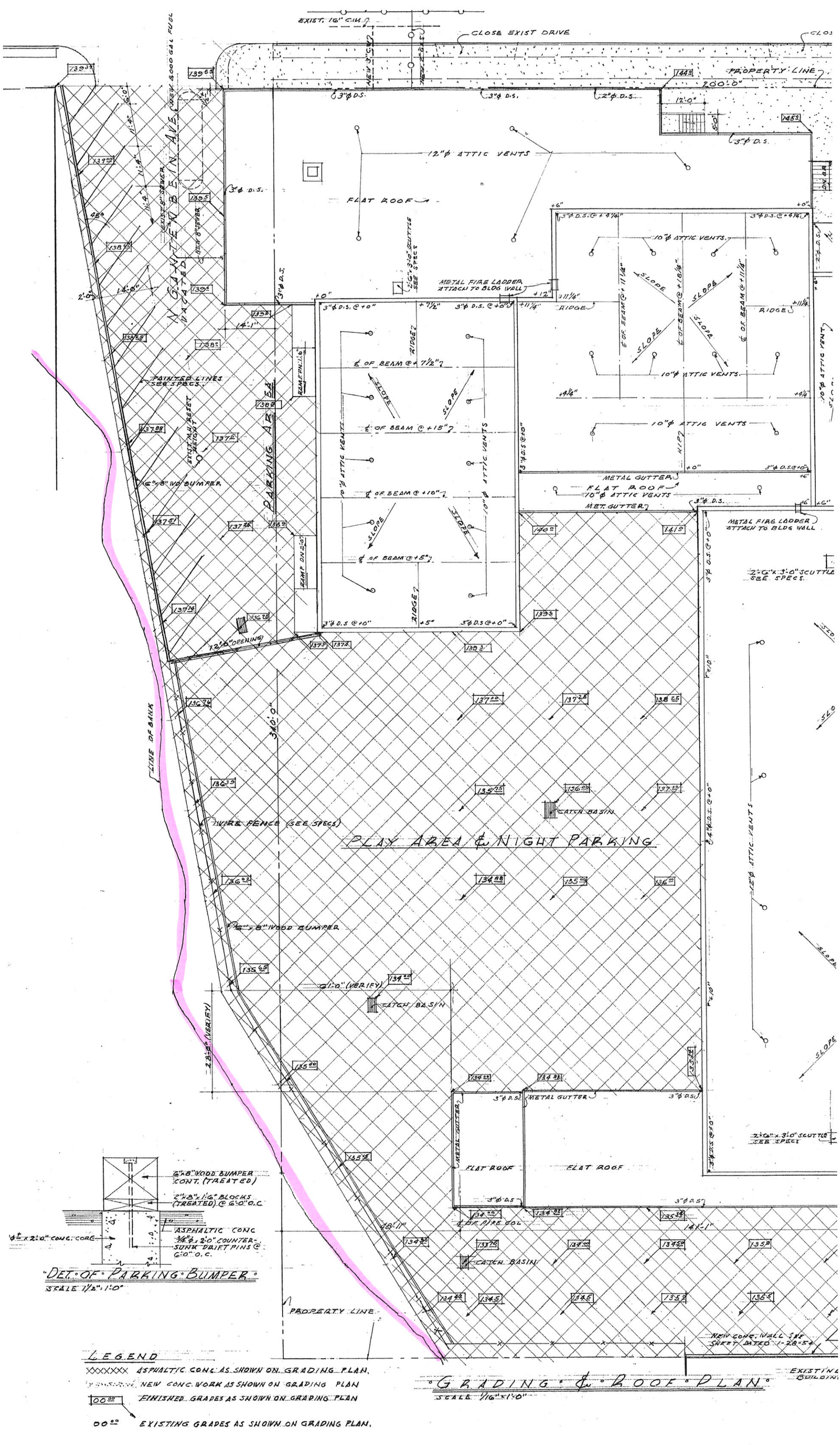
LEGEND
XXXXXXX ASPHALTIC CONC. AS SHOWN ON GRADING PLAN.
NEW CONC. WORK AS SHOWN ON GRADING PLAN
00.00 FINISHED GRADES AS SHOWN ON GRADING PLAN
00.00 EXISTING GRADES AS SHOWN ON GRADING PLAN.

·GRADING·&·ROOF·PLAN·
SCALE 1/16" = 1'-0"



·FENCE·&·BERM·DETAIL·
SCALE 3/4" = 1'-0"

REVISIONS	PLOT ROOF & GRADING PLANS
1 3-AUG-53 - DELETE PARKING AREA & WOOD & CONC. BUMPER SURFACE WITH CONC. IN LIEU OF ASPHALTIC CONC.	ELIOT ELEMENTARY SCHOOL FOR MULTNOMAH COUNTY SCHOOL DIST. No. 1
2 3-AUG-53 - ADD CATCH BASIN.	LOTS 1 THROUGH 7 & 14 THROUGH 20 - BLOCK 37 - ALBINA ADDITION
3 SOUTH PROPERTY LINE REVISED 23-AUG-54	N. PAGE - FLINT AND GANTENBEIN AVE. - PORTLAND, OREGON
DATE 28 NOV 52	BURNS, BEAR, McNEIL & SCHNEIDER ARCHITECTS
JOB NO. 52-26	2940 S. E. BELMONT ST. - PORTLAND 15, OREGON
SHEET NO. 1	OF 19



"DET. OF PARKING BUMPER"
SCALE 1½": 1'-0"

6"x8" WOOD BUMPER CONT. (TREATED)
2"x8"x16" BLOCKS (TREATED) @ 6'-0" O.C.
ASPHALTIC CONC
¾"ϕ x 2'-0" COUNTER-SUNK DRIFT PINS @ 6'-0" O.C.
4'-0" x 2'-0" CONC. CORE

"GRADING & ROOF PLAN"
SCALE 1/16" = 1'-0"

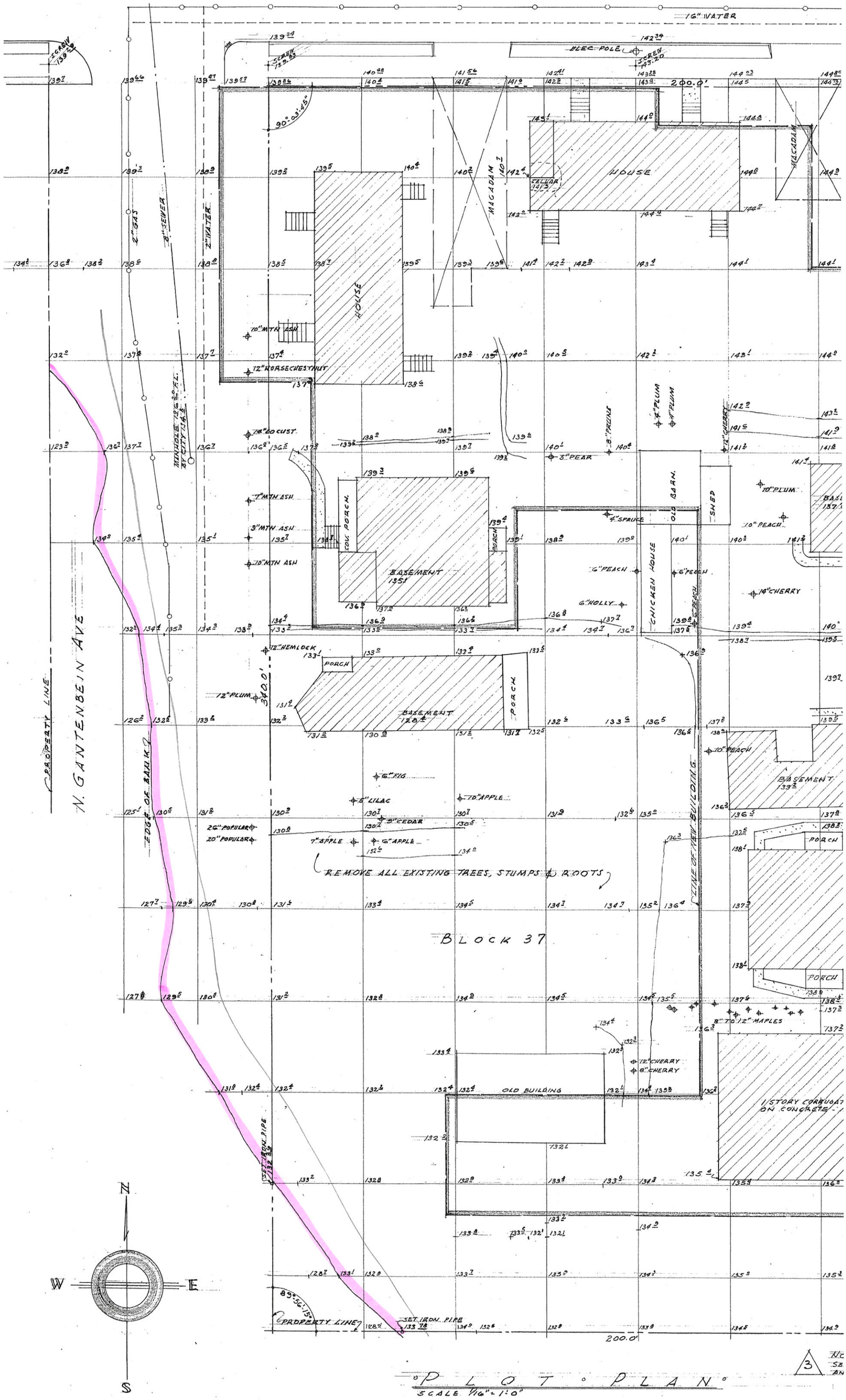
LEGEND

XXXXXXX ASPHALTIC CONC AS SHOWN ON GRADING PLAN.

NEW CONC. WORK AS SHOWN ON GRADING PLAN

FINISHED GRADES AS SHOWN ON GRADING PLAN

EXISTING GRADES AS SHOWN ON GRADING PLAN.



3

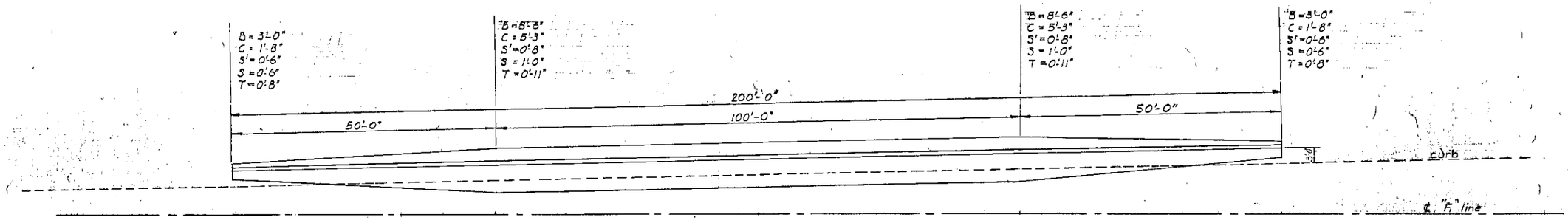
PLOT PLAN

SCALE 1/16" = 1'-0"

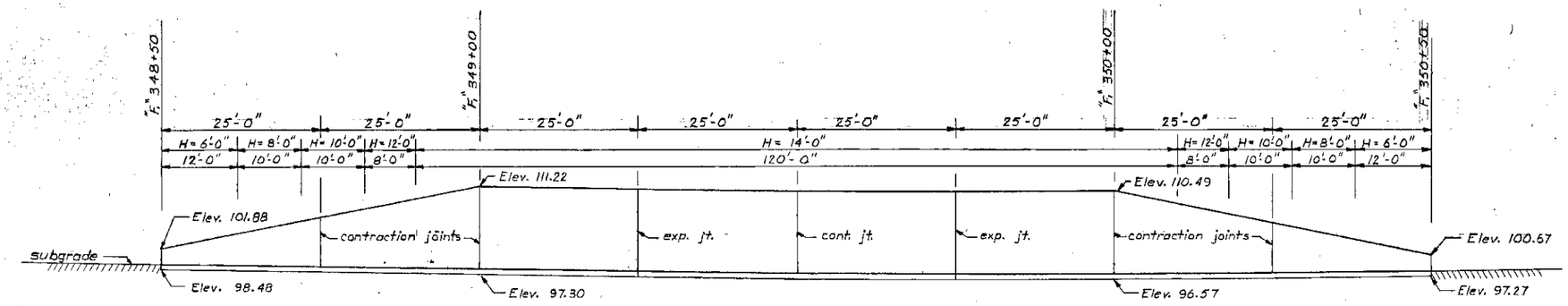
SURVEYED BY MARSHALL BROS. PORTLAND, OREG. AUG. 1932

NOTE:

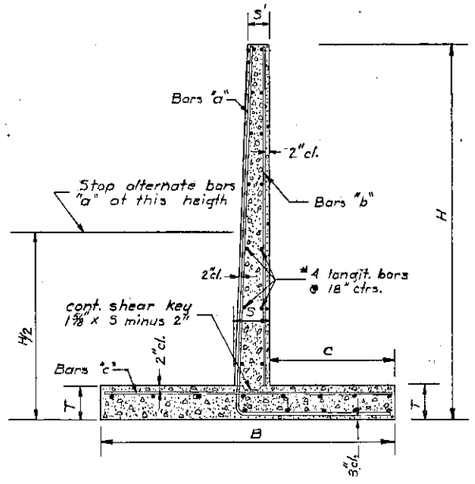
CONTRACTOR TO VISIT SITE TO ASSERTAIN WORK REQUIRED



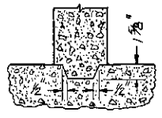
PLAN VIEW
Scale 1" = 10'-0"



ELEVATION
Scale 1" = 10'-0"

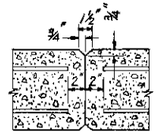


TYPICAL WALL SECTION



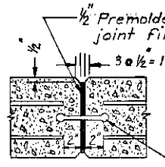
SHEAR KEY DETAIL

Note:
All bars "a" are full height in 4 ft wall. Stop all longit. bars 2" cl. of contraction and expansion joints.



CONTRACTION JOINT

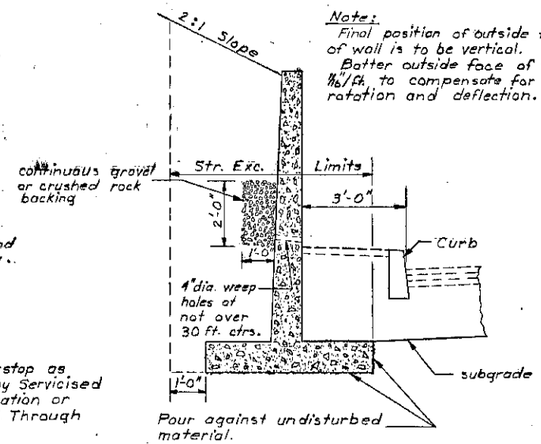
Use outside face, across top and 1'-0" down back of wall.



½" Premolded expansion joint filler thru. wall and footing.

EXPANSION JOINT

6" rubber waterstop as manufactured by Servicised Products Corporation or approved equal. Through wall only.



TYPICAL WALL SECTION

Note:
Final position of outside face of wall is to be vertical. Batter outside face of wall 1/16"/ft. to compensate for wall rotation and deflection.

Note:
See Dwg. # 15552 for standard retaining wall with 2:1 slope.

DATE	REVISION

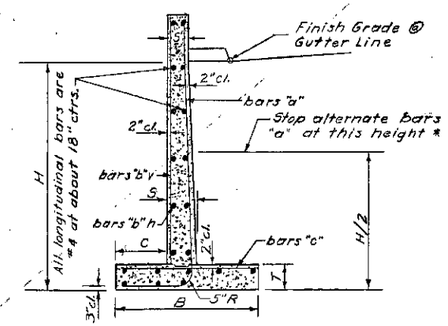
APPROVED: Leon V. Merchant
BRIDGE ENGINEER

DESIGNED: | CHECKED:
DRAWN: PAA. | CALC. BOOK 551

OREGON STATE HIGHWAY DEPARTMENT
BRIDGE DIVISION

RETAINING WALLS
EAST BANK FREEWAY SECTION
PLAN & ELEVATION & DETAILS

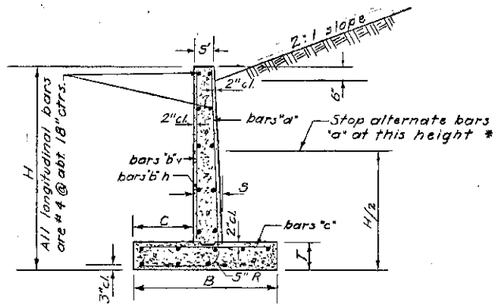
DATE 4-5-60 SHEET 1 OF 2
ACCOMPANIED BY DWG NO. 15552
BRIDGE NO. 8783 DRAWING NO. 15928



H	B	C	S'	S	T	Toe Press lbs/sq.ft	Quan./Lin. ft Conc.	Quan./Lin. ft Steel	Reinforcing Steel in Stem of Wall: Bars "a" Size	Bars "a" Spacing	Bars "b" v + "b" h Size	Bars "b" v + "b" h Spacing	Steel in Ftg: Bars "c" Size	Bars "c" Spacing
4'-0"	4'-0"	2'-8"	6"	6"	8"	451	0.203	14.64	#4	10"	None		#4	12"
6'-0"	6'-0"	3'-6"	7"	8"	8"	525	0.320	20.05	#4	9"	"		#4	12"
8'-0"	7'-6"	4'-9"	8"	9"	9"	585	0.456	34.26	#5	8"	"		#4	12"
10'-0"	9'-0"	4'-10"	8"	10"	10"	733	0.589	64.49	#6	7½"	#4	18"	#4	7"
12'-0"	10'-6"	6'-0"	8"	1'-0"	1'-0"	806	0.785	92.46	#7	7½"	#4	18"	#4	6½"
14'-0"	12'-0"	6'-0"	8"	1'-0"	1'-0"	966	0.902	145.15	#8	7"	#4	18"	#6	7"
16'-0"	13'-6"	7'-4"	8"	1'-2"	1'-2"	1042	1.147	182.87	#8	6"	#4	18"	#6	7"
18'-0"	14'-6"	7'-11"	9"	1'-4"	1'-3"	1176	1.380	229.08	#9	6½"	#4	18"	#7	8"
20'-0"	15'-6"	8'-6"	9"	1'-6"	1'-4"	1260	1.602	298.19	#10	6½"	#4	18"	#8	10"
3 22'-0"	16'-6"	9'-0"	10"	1'-8"	1'-5"	1440	1.832	362.01	#10	6"	#4	18"	#8	10"
3 24'-0"	18'-0"	9'-6"	10"	1'-10"	1'-6"	1640	2.111	456.19	#11	6½"	#4	18"	#9	9½"

DESIGN OF RETAINING WALL
WITH LEVEL ROADWAY

1 TYPE (A) WALL

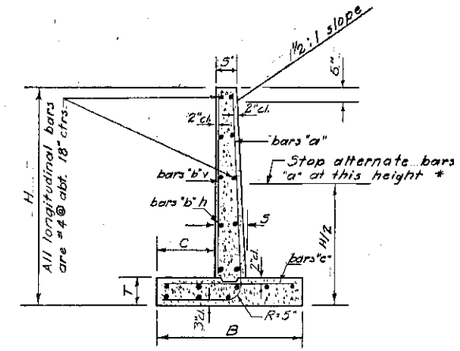


H	B	C	S'	S	T	Toe Press lb/sq.ft.	Quan./Lin. ft Conc.	Quan./Lin. ft Steel
4'-0"	3'-0"	1'-8"	6"	6"	8"	536	0.136	9.95
6'-0"	4'-0"	2'-6"	6"	6"	8"	637	0.198	14.38
8'-0"	5'-0"	3'-1"	8"	8"	8"	755	0.305	22.88
10'-0"	6'-3"	3'-10"	8"	9"	9"	824	0.417	38.00
12'-0"	7'-6"	4'-9"	8"	11"	10"	903	0.558	77.68
14'-0"	8'-6"	5'-3"	8"	1'-0"	11"	1062	0.693	92.79
16'-0"	9'-6"	5'-10"	8"	1'-2"	1'-0"	1203	0.863	113.83
18'-0"	10'-6"	6'-5"	9"	1'-4"	1'-2"	1372	1.103	168.00
20'-0"	11'-6"	7'-0"	9"	1'-6"	1'-4"	1545	1.341	207.73
4 22'-0"	14'-6"	9'-0"	9"	1'-9"	1'-6"	1992	1.755	362.85

H	Reinforcing Steel in Stem of Wall: Bars "a"	Bars "b" v & "b" h	Steel in Ftg.: Bars "c"
4'-0"	#4 bars @ 12"	None	#4 bars @ 12"
6'-0"	#4 bars @ 9"	"	"
8'-0"	#5 bars @ 9"	"	"
10'-0"	#6 bars @ 8"	"	"
12'-0"	#7 bars @ 6½"	#4 bars @ 18"	"
14'-0"	#8 bars @ 8"	"	"
16'-0"	#9 bars @ 8"	"	"
18'-0"	#10 bars @ 8"	"	"
20'-0"	#10 bars @ 7"	"	"
4 22'-0"	#11 bars @ 6½"	"	#5 bars @ 12"

DESIGN OF RETAINING WALL
WITH 2:1 SLOPE

1 TYPE (B) WALL



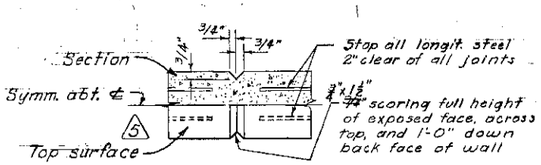
H	B	C	S'	S	T	Toe Press lb/sq.ft.	Quan./Lin. ft Conc.	Quan./Lin. ft Steel
4'-0"	3'-0"	1'-6"	6"	6"	8"	578	0.136	10.52
6'-0"	4'-0"	2'-3"	6"	6"	8"	704	0.197	16.37
8'-0"	5'-0"	2'-10"	8"	8"	8"	875	0.304	27.14
10'-0"	6'-0"	3'-2"	8"	10"	8"	1083	0.407	42.70
12'-0"	7'-3"	3'-9"	8"	1'-0"	10"	1225	0.569	70.13
14'-0"	8'-6"	4'-4"	8"	1'-2"	1'-0"	1423	0.758	107.32
16'-0"	9'-6"	4'-8"	9"	1'-4"	1'-2"	1616	0.982	144.18
18'-0"	10'-10"	5'-4"	9"	1'-6"	1'-2"	1834	1.168	184.43
20'-0"	12'-0"	5'-9"	10"	1'-9"	1'-4"	2049	1.485	230.98

H	Reinforcing Steel in Stem of Wall: Bars "a"	Bars "b" v + "b" h	Steel in Ftg: Bars "c"
4'-0"	#4 bars @ 12"	None	#4 bars @ 12"
6'-0"	#4 bars @ 6½"	"	"
8'-0"	#5 bars @ 6½"	"	"
10'-0"	#6 bars @ 6½"	"	"
12'-0"	#8 bars @ 9"	#4 bars @ 18"	"
14'-0"	#8 bars @ 6½"	"	"
16'-0"	#9 bars @ 6½"	"	"
18'-0"	#10 bars @ 7"	"	"
20'-0"	#10 bars @ 6"	"	"

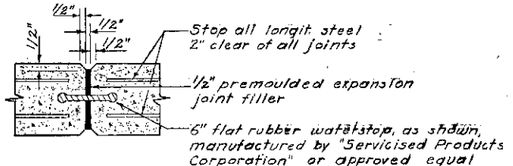
DESIGN OF RETAINING WALL
WITH 1½:1 SLOPE

1 TYPE (C) WALL

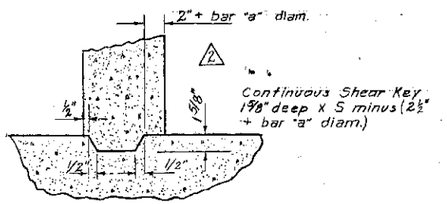
* Note:
All bars "a" are full height in 4'-0" wall.



CONTRACTION JOINT



EXPANSION JOINT

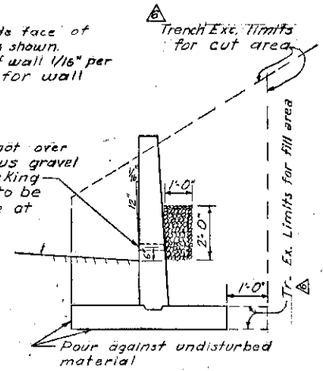


SHEAR KEY DETAIL

FOR INFORMATION ONLY

Final position of outside face of wall to be vertical as shown. Batter outside face of wall 1/16" per foot to compensate for wall rotation and deflection

4" dia. weep holes at not over 30'-0" ctrs. Continuous gravel or crushed rock backing
6 Center of weep hole to be 6" above finish grade at face of wall.



TYPICAL WALL SECTION

General Notes:
These walls designed with resultant of all forces striking at midpoint of base, giving uniform bearing pressure.
All concrete to be class "A" and shall attain a breaking strength of 3300 p.s.i. in 28 days, (f_c = 1320 p.s.i.)
All reinforcing steel shall be intermediate grade deformed bars. Bars from #3 to #11 inclusive shall conform to ASTM Specification A 305 and shall be lapped 20 diameters at all splices unless noted or shown otherwise. All bars shall be placed 2" clear of nearest face of concrete unless noted or shown otherwise. (f_s = 20,000 p.s.i.)
Place expansion joints at approx. 90' ctrs. through wall and footing and contraction joints at approx. 30' ctrs. in wall only. See Plan & Elev. for location.
All workmanship and materials shall conform to the specifications for bridges of the Oregon State Highway Commission.

	DATE	REVISION
1	10-19-60	Added wall types
2	10/19/60	Shear Key Detail
WMT/3	7-10-63	add H=22'& 24', Type "A"
WMT/4	9-30-63	add H=22', Type "B"
5	7-20-64	Revised scoring detail.
CLY 6	11-20-68	Weephole, Title, Trench Exc.

APPROVED: Bruce A. Marchant
BRIDGE ENGINEER

DESIGNED MAC CHECKED
DRAWN MAC CALC. BOOK 525

OREGON STATE HIGHWAY DEPARTMENT
BRIDGE DIVISION

6 STANDARD RETAINING WALLS
FRONT FACE VERTICAL
UNIFORM BEARING

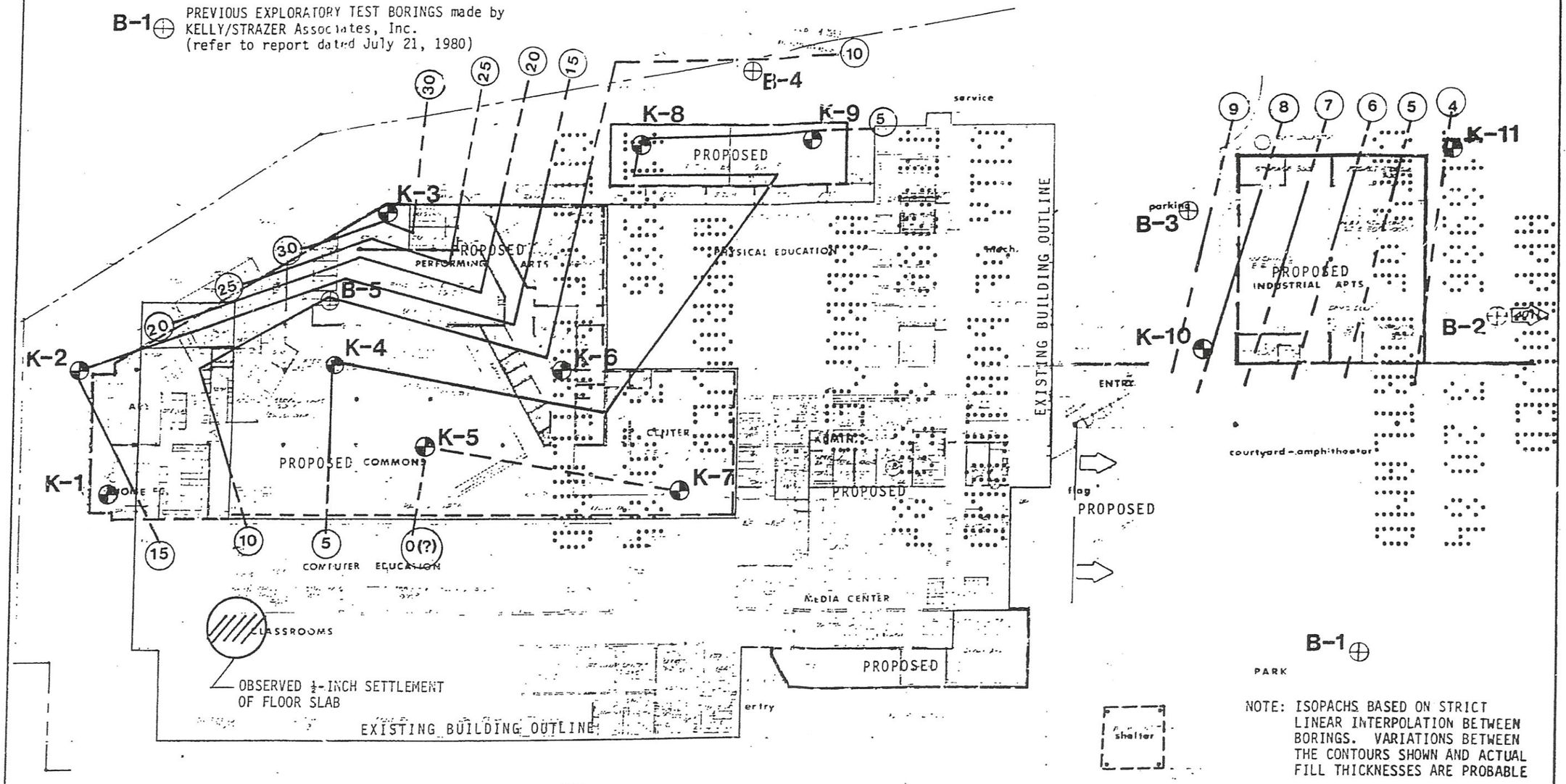
DATE 1-14-60 SHEET OF

BRIDGE NO. STANDARD DRAWING NO. 15552

LEGEND

K-1 ⊕ EXPLORATORY TEST BORINGS made by KELLY/STRAZER Associates, Inc.

B-1 ⊕ PREVIOUS EXPLORATORY TEST BORINGS made by KELLY/STRAZER Associates, Inc. (refer to report dated July 21, 1980)



NOTE: ISOPACHS BASED ON STRICT LINEAR INTERPOLATION BETWEEN BORINGS. VARIATIONS BETWEEN THE CONTOURS SHOWN AND ACTUAL FILL THICKNESSES ARE PROBABLE

Kelly/Strazer Associates Geotechnical Consultants	HARRIET TUBMAN MIDDLE SCHOOL PROJECT Portland, Oregon	FILL THICKNESS ISOPACH MAP Mar., 1983 0-192.02	FIGURE 14