

4th Street Parking Garage

Structural Condition Assessment Report

City of Bloomington

Bloomington, Indiana

Project ID: 17-165

May 25, 2018



CITY OF BLOOMINGTON



Applied
Engineering Services

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PROJECT OVERVIEW

We have completed our structural condition assessment of the 4th Street Parking Garage. This assessment involved a comprehensive field investigation, further described in the following sections of this report, to evaluate the current condition of the parking garage. All findings from this assessment are summarized within this report for the purpose of planning and budgeting for future repair and restoration projects in the upcoming years by the City of Bloomington.

Typical plans views, a 3D view, and general information for the 4th Street parking Garage are provided below.

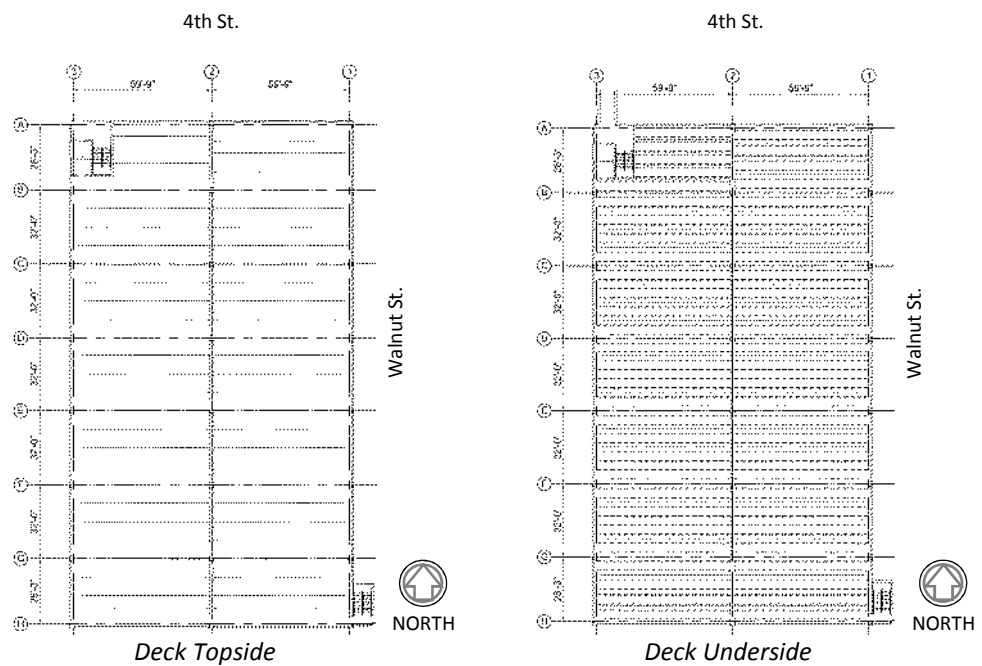


Figure 1: 4th Street Parking Garage – Typical Plan Views

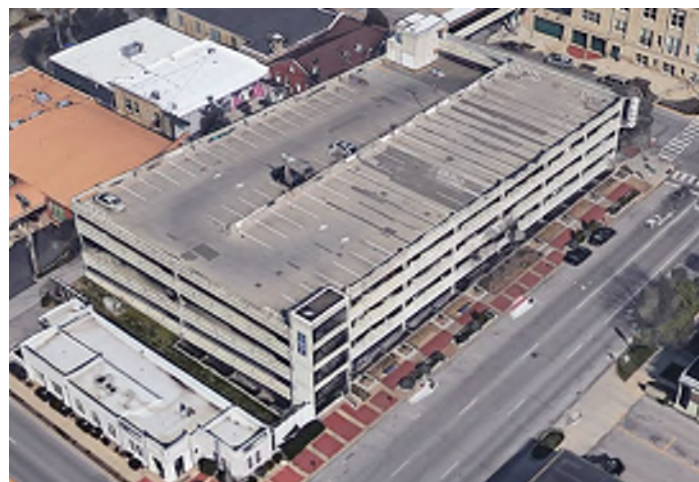


Figure 2: 4th Street Parking Garage – 3D View (looking northwest)

Table 1: 4th Street Parking Garage – General information

Year Built:	1985	Est. parking stalls	± 400
Size:	220' L x 123' W x 45' H	Vehicular Accessible from:	4 th Street
General Construction:	Basement + 4 Tiers (tier 4 partial) – Basement deck is S.O.G and below grade with concrete retaining walls, all other tiers above are precast double tees with topping slab; double tees are supported by ledger beams and precast columns. Two full stair towers and additional stair from basement to 1 st level (Ground Level) – Precast wall panels with cast in place landings and steel staircases.		

APPROACH

Our evaluation was limited to the structural elements (beams, columns, walls, slabs, and stair towers) and the water drainage system. Our evaluation did not include items such as the elevator located within the Northwest stair tower, lighting systems, or other similar items not associated with the structural or water drainage systems.

Prior to our assessment, existing drawings of the parking garage were provided to us by Charles C. Brandt Construction Co., the construction firm involved in the original parking garage construction. These drawings included the original architectural and structural contract drawings dated 1985. The original precast concrete shop drawings were not available.

DRAINAGE SYSTEM:

The drainage assessment of the parking garage was performed on April 12, 2018 by Lucas Burley, EI, of Applied Engineering. Observations and recommendations pertaining to the drainage system can be found in Appendix C of this report.

STRUCTURAL SYSTEM:

The structural assessment of the parking garage was performed between March 23rd and April 13th, 2018 by Carrie L. Walden, PE, Jessica A. Barrios, Nathan D. Boltz, EI, Mike M. Kelly, EI, and Riley M. Sears of our office. Our assessment was completed during the day while the garage was occupied by vehicles. Each day of our assessment, a different section of the parking garage was closed to parking to aid in our assessment of the parking decks.

During our assessment of the parking garage structural deficiencies, deteriorations were identified through visual examination, hammer sounding, and chain dragging. No destructive investigation, structural instrumentation, monitoring, or testing was performed. Selective photographs taken during the assessment are included in Appendix B. A summary of our findings and recommendations is provided in the following sections.

OBSERVATIONS

During our assessment of 4th Street Garage we encountered a number of deterioration types in the structural components of the garage. Below is a tabulated summary of our observations:

Table 2: Observations by structural element

STRUCTURAL ELEMENT:	ELEMENT DESCRIPTION:	GENERAL CONDITION:	OBSERVED PREVIOUS REPAIRS:	ASSESSMENT NOTES:	RELATED REPAIRS:
Elevated Parking Deck - Topside	<ul style="list-style-type: none"> 3" Cast-in-place topping slab over double tee beams <ul style="list-style-type: none"> Reinforced with 6x6 WWF Polyurethane crack control joints at 8' O.C. at double tee transitions Several drain openings throughout the garage 	<ul style="list-style-type: none"> Small delaminations detected – lower decks Large delaminations detected – top decks Cracks <ul style="list-style-type: none"> Missing control joint at transition beams at several locations Missing and mis-aligned control joints at double tee transitions at several locations Randomly distributed cracks Joint sealants severely weathered on top decks, moderately weathered on lower decks Handicap parking stall paint slightly worn and chipped on level 1 (ramp) 	<ul style="list-style-type: none"> Partial Depth Patches – predominantly on top decks <ul style="list-style-type: none"> Several patches were made without appropriate joints at double tee transitions A few patches appear to be localized topping slab replacement Routed and Sealed cracks Replaced Joint Sealants (cove joints and deck joints) A few Traffic Coating patches throughout the garage 	<ul style="list-style-type: none"> Slight accessibility restriction due to a few cars parked in stalls 	<ul style="list-style-type: none"> 9B 9C 10E-1 10E-2 15A 15B 21 22
Elevated Parking Deck – Double Tee (Underside)	<ul style="list-style-type: none"> 4'-9" to 8'-0" wide double tee beams Precast Bearing on exterior and interior ledger beam, and precast stair tower walls Typical span = 59'-9" Shear plates along joints (3 typ per span) Several drain openings throughout the garage 	<ul style="list-style-type: none"> Evidence of leaking along joints mostly on top levels Several shear plates are corroded, only few are fractured Small-medium delaminations detected – typically near flange edges, flange center (top decks), or drain pipes Exposed corroded steel from spalling concrete on double tee flanges and webs Narrow longitudinal and diagonal cracks in flanges – cracks often show signs of leakage Localized narrow vertical cracks on webs due to overload or damage Localized narrow horizontal cracks on bottom side of webs 	<ul style="list-style-type: none"> Partial/Full Depth Patches – typically near flange edges, flange center (top decks), or drain pipes <ul style="list-style-type: none"> Several previous patches did not re-establish appropriate joints at transitions Minimal crack Epoxy Injection Localized Additional Bearing Supports 	<ul style="list-style-type: none"> Visual assessment only of underside of level 2 (ramp bay) and level 1 (flat bay) due to high floor height at portion of these bays 	<ul style="list-style-type: none"> 3C 5B 7B-1 7B-2 8 10C 11B 12B 13 14 26 27
Exterior Ledger Beams	<ul style="list-style-type: none"> 8" wide x 5'-9" deep Beams are pocketed to support double tee joists webs <ul style="list-style-type: none"> 14" wide x 10 3/4" deep ledger Precast Typical span = 38'-0" Bearing on exterior column pockets 	<ul style="list-style-type: none"> Diagonal (Shear) cracks extending from the beam bearing – visible from the underside and the topside. Several locations of exposed reinforcing steel on the bottom and sides Few delaminations at special bearing condition on south east stair tower wall Small delaminations on top of the pockets and on top of the beam Few steel plate and bolt connections at columns show signs of corrosion <ul style="list-style-type: none"> Few connections with slotted holes appeared to be field modified with insufficient material beyond the enlarged hole Precast lifting inserts are exposed and corroded. 	<ul style="list-style-type: none"> Partial Depth Patches – predominantly on top face Steel plate and bolt connections Cleaned and Painted <ul style="list-style-type: none"> Some bolts have been replaced Some connections have been reinforced with additional steel plates Crack Epoxy Injection – cracks accessible from the upper portion of the beam Thin concrete Patches at precast lifting points (debonded) 	<ul style="list-style-type: none"> Visual assessment only of underside of level 2 (ramp bay) and level 1 (flat bay) due to high floor height at portion of these bays 	<ul style="list-style-type: none"> 1 2A 3A 3B 5A 7A 9A 9B 10A 10B 11A 23
Interior Ledger Beams	<ul style="list-style-type: none"> 8" wide x 5'-9" deep Beams are pocketed to support double tee joists webs <ul style="list-style-type: none"> 14" wide x 10 3/4" deep ledger Precast Typical span = 38'-0" Bearing on corbels on interior columns 	<ul style="list-style-type: none"> Exposed reinforcing steel on the bottom and sides <ul style="list-style-type: none"> Often, stirrups exposed on bottom side of transition beams Small delaminations and shear cracks at bearing <ul style="list-style-type: none"> One bearing needs to be rebuilt Small delaminations on top of the pockets and on top of the beam Few steel plate and bolt connections at columns show signs of corrosion 	<ul style="list-style-type: none"> Connection steel plates and bolts Cleaned and Painted 	<ul style="list-style-type: none"> Visual assessment only of underside of level 2 (ramp bay) and level 1 (flat bay) due to high floor height at portion of these bays 	<ul style="list-style-type: none"> 1 2A 3A 3B 5A 7A 9A 9B 10A 10B 11A 23

Table 2 (continued): Observations by structural element

STRUCTURAL ELEMENT:	ELEMENT DESCRIPTION:	GENERAL CONDITION:	OBSERVED PREVIOUS REPAIRS:	ASSESSMENT NOTES:	RELATED REPAIRS:
Columns	<ul style="list-style-type: none"> ● 24" x 24" effective area ● Exterior – with haunches (pockets) to support ledger beams ● Interior – with corbels to support ledger beams ● Precast 	<ul style="list-style-type: none"> ● Large delaminations – mostly on lower levels ● Very narrow horizontal cracks on interior faces ● Few delaminated corbels ● Several delaminations at embedded steel plates ● Several embedded steel plates show signs of corrosion ● Minimum steel exposed – typically secondary. ● Precast lifting point inserts are exposed and corroded. 	<ul style="list-style-type: none"> ● Small Partial Depth Patches <ul style="list-style-type: none"> ○ Exterior – typically near embedded plates ○ Interior – corbel ● Exposed embedded steel plates Cleaned and Painted ● Thin concrete Patches at precast lifting points (debonded) 	<ul style="list-style-type: none"> ● Visual assessment only of underside of level 2 (ramp bay) and level 1 (flat bay) due to high floor height at portion of these bays 	3D 5D 6 7D 9A 10D 11D 12A
Spandrel Wall Panels	<ul style="list-style-type: none"> ● Two types: <ul style="list-style-type: none"> ○ Type A: Panels at north and south end for garage <ul style="list-style-type: none"> - 8" thick x 5'-9" deep - Bearing on columns similar to exterior ledger beams ○ Type B: Panels along west side of the garage <ul style="list-style-type: none"> - 8" thick x height varies - Extend in-between ledger beams - bearing top of the exterior ledger beams – connected with steel plates and bolts ● Precast 	<ul style="list-style-type: none"> ● Type A: <ul style="list-style-type: none"> ○ Bearing connection to stair tower precast wall at northwest end is severely deteriorated – supplemental framing has been recommended as an urgent repair ○ Several delaminations on the top of the panels ○ Few spalls at artwork decoration connections ● Type B: <ul style="list-style-type: none"> ○ Few narrow vertical cracks ○ Few steel plate and bolt connections at columns show signs of corrosion ● Precast lifting point inserts are exposed and corroded. 	<ul style="list-style-type: none"> ● Small Partial Depth Patches – Type A ● Minimal crack Epoxy Injection – Type B ● Exposed embedded steel plates Cleaned and Painted ● Thin concrete Patches at precast lifting points (debonded) 		3F 5D 7E 9A 9B 10F 11D 23 24
Retaining Walls	<ul style="list-style-type: none"> ● 12" thick ● Cast-in-place ● Painted (aesthetically) 	<ul style="list-style-type: none"> ● One vertical crack – paint may be masking sign of leakage. 	<ul style="list-style-type: none"> ● None 	<ul style="list-style-type: none"> ● 8" thick Cast-in-place retaining walls at wells on the east side of garage were not assessed 	4 10F
Stairs Towers	<ul style="list-style-type: none"> ● Southeast tower – staircase ● Northwest tower - staircase + elevator + mechanical/storage rooms + access to pedestrian bridge ● Northeast tower – one flight staircase ● Towers are constructed of precast concrete walls extending the full height of tower, exterior walls have window glazing supported by beam like elements that span between walls ● Intermediate landings and stair flights are constructed with concrete filled composite metal decks; main landing are precast slabs and beams bearing on steel angle anchored to the walls ● Stairs are steel framed with glass fiber reinforced concrete on treads ● Walls facing the parking garage support double tee and beam bearings 	<ul style="list-style-type: none"> ● Deteriorated joint material between wall panels ● Several delaminations of concrete deck and pourstops, door headers and walls ● Few Cracks – mostly on concrete deck ● Moderate-Severe corrosion in multiple locations on steel decks and stair framing - typical near top of stair towers ● Ledger beams at the northwest towers are severely delaminated - shoring has been recommended as an urgent repair ● Exposed embedded steel plates and precast lifting points corroded. ● Handrail post severely corroded <ul style="list-style-type: none"> ○ Few posts missing caps ○ Few handrail-wall anchor bolt connections deteriorated 	<ul style="list-style-type: none"> ● Stair tread replacement ● Thin concrete Patches at precast lifting points (debonded) ● Steel surfaces Cleaned and Painted 	<ul style="list-style-type: none"> ● Upon completion of the assessment, Stair Tower restoration work independent from this study began. 	2B 3G 4 5E 7D 9A 10G 11A 15C 16 17 18 19 20

Table 2 (continued): Observations by structural element

STRUCTURAL ELEMENT:	ELEMENT DESCRIPTION:	GENERAL CONDITION:	OBSERVED PREVIOUS REPAIRS:	ASSESSMENT NOTES:	RELATED REPAIRS:
Pedestrian Walkway on Fourth Level	<ul style="list-style-type: none"> 4" Precast slab spanning 6'-0" between ledger beams 3" Cast-in-place topping slab over precast slab Ledger beams are: <ul style="list-style-type: none"> 8" thick x 5'-9" deep spanning 41'-6" bearing on northwest stair tower precast wall and interior ledger beam at level transition. 	<ul style="list-style-type: none"> Several delaminations on underside of ledger beams and precast slab – relatively large Several small delaminations on the topping slab Several structural cracks on the underside of the precast slab <ul style="list-style-type: none"> Pipe penetration patches cracked and weathered Minimal exposed steel reinforcement on the underside of the precast slab and on top of ledger beams more often present on the latter Beam bearing on the west end (bearing on steel member embedded in the stair wall) severely deteriorated Upper portion of beam steel plate and bolt connection to stair tower precast wall is severely deteriorated 	<ul style="list-style-type: none"> Partial Depth Patches – topping slab Pedestrian Traffic Coating on topping slab Steel plate and bolt connections Cleaned and Painted <ul style="list-style-type: none"> Connections have been reinforced with additional steel plates and bolts Pipe penetration patch appears different from others at different location of the underside of the garage 		<p>3C 10E-2 22</p>
Exterior	<ul style="list-style-type: none"> Limestone concrete finish Large "Garage" blade sign on the northeast corner of the garage connected to the garage elements on the second and fourth levels Decorative artwork connected to the structural elements on the second, third and fourth level elements on the north side of the garage 	<ul style="list-style-type: none"> "Garage" blade sign connection appeared inadequate per code – sign recommended to be removed as urgent repair 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> Visual assessment of Exterior only, completed at a distance (from ground level) Pedestrian bridge spanning 4th Street was not assessed and appears to be independent from the garage 	<p>25</p>

RECOMMENDATIONS

We recommend the following repairs to address the current structural concerns; please note that: (1) repair ID numbers are for reference only and are not indicative of priority level; (2) "Top of Beam" refers to the area of that element that is visible above the topping slab. Likewise, the area referred to as "Underside of Beam" is the area visible from below the deck topping slab.

Table 3: 4th Street Parking Garage – Recommended repairs




REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
1	Beam underside delamination	5 EA	Partial Depth Patch w/ shoring during repair	Ledger Beams	HIGH	
2A	Beam bearing	5 EA	Partial Depth Patch w/ shoring during repair	Ledger Beams	HIGH	
2B	Beam bearing	4 EA	Partial Depth Patch w/ shoring during repair	Stair Towers	HIGH	

Table 3 (continued): Recommended repairs


REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
3A	Exposed, corroded steel with spalled concrete on beam underside	218 LF	Clean and Coat	Ledger Beams	HIGH	
3B	Exposed, corroded steel with spalled concrete on beams tops	107 LF	Clean and Coat	Ledger Beams	LOW	
3C	Exposed, corroded steel with deteriorated concrete	205 LF	Clean and Coat	Double Tees Pedestrian Walkway (slab underside)	MED	
3D	Exposed, corroded steel with deteriorated concrete	21 LF	Clean and Coat	Columns	MED	
3E	Exposed, corroded steel with deteriorated concrete	13 LF	Clean and Coat	Wall Panels	LOW	
3F	Exposed, corroded steel with deteriorated concrete	21 LF	Clean and Coat	Stair Towers	MED	
4	Vertical cracks in walls	46 LF	Chemical Grout Injection	Retaining Walls Stair Towers	LOW	
5A	Corroded steel plates and/or bolts	44 EA	Clean and Paint	Ledger Beams	MED	
5B	Corroded steel angles	12 EA	Clean and Paint	Double Tees	HIGH	
5C	Corroded steel plates	10 EA	Clean and Paint	Columns	MED	

Table 3 (continued): Recommended repairs

REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
5D	Corroded steel plates and/or bolts	22 EA	Clean and Paint	Wall Panels	HIGH	
5E	Corroded steel plates and angles	44 EA	Clean and Paint	Stair Towers	HIGH	
6	Corbel delamination	2 EA	Partial Depth Patch w/ shoring during repair	Columns	HIGH	
7A	Structural cracks in concrete	330 LF	Epoxy Injection	Ledger Beams	HIGH	
7B-1	Structural cracks in concrete	256 LF	Epoxy Injection	Double Tees	HIGH	
7B-2	Non-structural Leaking Cracks in concrete	467 LF	Epoxy Injection	Double Tees	MED	
7C	Structural cracks in concrete	49 LF	Epoxy Injection	Columns	HIGH	
7D	Structural cracks in concrete	145 LF	Epoxy Injection	Stair Towers	HIGH	
7E	Structural cracks in concrete	34 LF	Epoxy Injection	Wall Panels	HIGH	
8	Exposed steel and concrete spalling on double tee flange edges (at joint)	782 LF	Removal of loose concrete plus Clean and Paint exposed steel	Double Tees	HIGH	

Table 3 (continued): Recommended repairs











REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
9A	Deteriorated vertical joint material between elements (on top side of deck)	497 LF	Replace vertical joint sealant	Columns Wall Panels Ledger Beams Stair Towers	MED	
9B	Deteriorated perimeter cove joint material (on top side of deck)	4,737 LF	Replace cove joint sealant	Ledger Beams Wall Panels Columns Decks	MED	
9C	Weathered control joints on deck topping slab	11,646 LF	Replace control joint sealant	Decks	HIGH	
10A	Concrete delamination on beam undersides	36 SF	Partial Depth Patch	Ledger Beams	HIGH	
10B	Concrete delamination on beam tops	26 SF	Partial Depth Patch	Ledger Beams	HIGH	
10C	Concrete delamination on double tee webs and flanges	262 SF	Partial Depth Patch	Double Tees	HIGH	
10D	Concrete delamination along columns and corbels	120 SF	Partial Depth Patch	Columns	HIGH	
10E-1	Deck topping slab delamination on lower levels (interior)	336 SF	Partial Depth Patch	Decks	MED	
10E-2	Deck topping slab delamination on upper levels (exterior)	2,091 SF	Partial Depth Patch	Decks Pedestrian Walkway	HIGH	
10F	Concrete delamination on miscellaneous location on wall elements	21 SF	Partial Depth Patch	Retaining Walls Walls Panels	HIGH	

Table 3 (continued): Recommended repairs








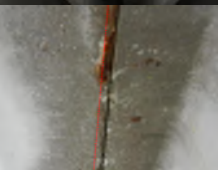









REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
10G	Concrete delamination on stair walls and landings	167 SF	Partial Depth Patch	Stair Towers	HIGH	
11A	Deep concrete delamination on beam undersides and northwest stair tower double tee ledge	60 SF	Deep Patch	Ledger Beams Stair Towers	HIGH	
11B	Deep concrete delamination on double tee	8 SF	Deep Patch	Double Tee	HIGH	
11C	Deep concrete delamination along column	6 SF	Deep Patch	Columns	HIGH	
11D	Deep concrete delamination on wall panels bearings	9 SF	Deep Patch	Wall Panels	HIGH	
12A	Excessive water Leaking through column corbel	3 SF	Apply Silane Sealer	Columns	MED	
12B	Excessive water Leaking through deteriorated double tee flange	315 SF	Apply Silane Sealer	Double Tees	MED	
13	Corroded shear transfer plate and corroded supplemental steel	55 EA	Clean and Coat (concrete demo required to inspect supplemental steel)	Double Tee	HIGH	
14	Broken shear transfer plate	8 EA	Shear Transfer Plate Replacement with "Sandwich Plates"	Double Tee	HIGH	
15A	Deck topping slab cracks on lower levels (interior)	2,339 LF	Rout cracks and Seal with Joint Sealant	Decks	MED	

Table 3 (continued): Recommended repairs

REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
15B	Deck topping slab cracks on upper levels (exterior)	1,437 LF	Rout cracks and Seal with Joint Sealant	Decks	HIGH	
15C	Landing topping slab cracks on stair landings	18 LF	Rout cracks and Seal with Joint Sealant	Stair Towers	HIGH	
16	Missing handrail post cap	3 EA	Replace Handrail Post Cap	Stair Towers	HIGH	
17	Landing topping slab pour stop delamination	3 EA	Replace Landing Pour Stop (re-pour)	Stair Towers	MED	
18	Handrail post section loss	12 EA	Supplemental Handrail Post Steel	Stair Towers	MED	
19	Stair tread nosing section loss	47 EA	Stair Tread Nosing Repair	Stair Towers	HIGH	
20	Stair tread section loss due severe corrosion	30 EA	Tread Strengthening	Stair Towers	HIGH	
21	Deck topping slab deficiency on lower levels (interior)	64,604 SF	Waterproofing <u>Option A:</u> Apply Urethane Traffic Coating System	Decks	MED	See Appendix A
			<u>Option B:</u> Apply PUMA Traffic Coating System		LOW	See Appendix A

Table 3 (continued): Recommended repairs

REPAIR ID:	DETERIORATION DESCRIPTION:	QUANTITY:	PROPOSED REPAIR:	IMPACTED ELEMENT:	PRIORITY LEVEL:	REPRESENTATIVE PHOTO:
22	Deck topping slab deficiency on upper levels (exterior)	26,150 SF	Waterproofing Option A: Apply Urethane Traffic Coating System	Decks	HIGH	See Appendix A
			Option B: Apply PUMA Traffic Coating System		MED	See Appendix A
23	Connection plate deficient holes	6 EA	Add plate material to plates with slotted holes	Ledger Beams Walls Panels	MED	
24	Corroded embedded steel at bearing	4 EA	Provide additional bearing support	Panels	HIGH	
25	Inadequate top garage sign connection	1 EA	Provide additional support	Exterior	HIGH	
26	Concrete flange delamination	15 EA	Rebuild flange	Double Tees	HIGH	
27	Concrete Bearing Delamination	1 EA	Rebuild bearing	Double Tees	HIGH	
28	Severe staircase steel corrosion (stair tower #1)	-	Clean and paint	Stair Towers	HIGH	
29	Severe staircase steel corrosion (stair tower #3)	-	Clean and paint	Stair Towers	MED	

PRIORITY LEVEL DEFINITION

The parking garage, constructed in 1985, is approximately 33 years old. Parking structures of this type and era typically have a life expectancy of up to 50 years with routine maintenance and care. Efforts to waterproof and maintain the 4th Street Parking Garage appear to have been marginal in its early lifetime. Recent efforts included repairs that did not account for movement and did not effectively stop water infiltration into key structural connections. The remaining lifespan of the garage will depend on the level of repair/funding put into the garage.

We have assigned priority levels to the repairs based on how many years the garage will remain in operation in order for the City of Bloomington to perform a cost/benefit analysis to determine the appropriate level of project/funding.

Urgent repairs are being implemented in four locations due to imminent structural integrity concerns. The localized areas of the garage were at risk of structural failure and supplemental strengthening was required immediately. These repairs are not included in the tables above nor in the priority levels below; they are currently underway.

If the garage will be taken out of operation and secure against access in 2019; no additional repairs beyond the “urgent” repairs currently underway are required.

If the garage is to remain in operation 5 years (until 2023) all HIGH priority repairs shall be performed in 2019. An additional repair project may be necessary in 2021 for repair of continuing structural deterioration.

If the garage is to remain in operation 10 years (until 2028) all HIGH + MEDIUM priority repairs shall be performed in 2019. An additional significant repair project will be necessary in 2023 for replacement of joint sealants, traffic coating, and repair of structural deterioration. A repair project may also be necessary in 2026 depending on the rate of structural deterioration.

If the garage is to remain in operation 15 years (until 2033) all HIGH + MEDIUM + LOW priority repairs shall be performed in 2019. Additional significant repair projects will be required every 3-5 years to keep the garage in operation for this extended amount of time due to the current level of deterioration.

All recommendations are based on a repair project in 2019; if the repair project is delayed beyond 2019, additional urgent repairs may need to be implemented and the lifespan of the garage will be decreased.

All repair recommendations provided in the previous section have been assigned priority levels. These priority levels are based upon our professional opinion and are briefly defined and explained in the table below:

Table 4: Priority level definitions

PRIORITY LEVEL:	DEFINITION:
HIGH	<ul style="list-style-type: none"> • Structural deficiencies within primary structural elements that will adversely impact performance of elements if not addressed • Needed repairs to waterproofing joints and application of coatings that directly help protect highly susceptible structural elements from water and deicing chemicals exposure • Structural or non-structural deficiencies that could pose falling debris hazard
MED	<ul style="list-style-type: none"> • Needed repairs to waterproofing joints and application of coatings that directly help protect structural elements from water and deicing salts exposure • Early-state structural deficiencies within primary or secondary structural elements that may adversely impact performance of elements if not addressed • Non-structural deficiencies within non-structural elements that may adversely impact performance of elements if not addressed
LOW	<ul style="list-style-type: none"> • Needed repairs to waterproofing joints and application of coatings that directly help protect structural elements from water and deicing chemicals exposure

OPINION OF PROBABLE STRUCTURAL CONSTRUCTION COST

Appendix A contains the Opinion of Probable Structural Construction Cost which contains the overall probable drainage construction cost for budgeting purposes. A detailed Opinion of Probable Drainage Construction Cost is provided in appendix C. Dollar amounts are current as of the date of the study (May 2018). If the project is delayed beyond the summer of 2019, additional deterioration may increase the anticipated construction cost.

CLOSING REMARKS

In closing, please note that our structural condition assessment of the 4th Street Parking Garage was limited strictly to those items identified in this report and to the extent noted. Should unforeseen deficiencies exist (structural or non-structural), they are beyond the scope of this structural condition assessment. Should you have any questions or wish to discuss this matter further, please do not hesitate to contact CE Solutions.



Carrie L. Walden, PE
 Senior Project Manager

**APPENDIX A – OPINION OF PROBABLE STRUCTURAL
CONSTRUCTION COST**

OPINION OF PROBABLE STRUCTURAL CONSTRUCTION COST

WORK ITEM	PRIORITY	QUANTITY	UNIT	UNIT COST	TOTAL
Cost opinion assumes garage remains operational during repair, with closures by level and as needed to facilitate the work.					
STRUCTURAL REPAIRS					
1. Ledger beam delamination Partial depth beam patch, with shoring during repair	HIGH	5	EA	\$1,250.00	\$6,250
2. Ledger beam bearing delamination – ledger beams and stair towers Partial depth patch at beam bearing, with shoring during repair	HIGH	9	EA	\$2,500.00	\$22,500
3. Exposed, corroded steel with spalled concrete – ledger beam undersides Clean and coat	HIGH	218	LF	\$25.00	\$5,450
4. Corroded steel plates, angles and bolts – double tees, wall panels, and stair towers Clean and paint	HIGH	78	EA	\$100.00	\$7,800
5. Column corbel delamination Partial depth corbel patch, with shoring during repair	HIGH	2	EA	\$1,500.00	\$3,000
6. Structural cracks in concrete – all elements Epoxy injection	HIGH	814	LF	\$125.00	\$101,750
7. Exposed steel and concrete spalling on double tee flange edges Removal of loose concrete, clean and paint exposed steel	HIGH	782	LF	\$75.00	\$58,650
8. Weathered control joints on deck topping slab Replace control joint sealant	HIGH	11,646	LF	\$4.00	\$46,584
9. Concrete delamination – ledger beam undersides, and double tees Overhead partial depth patch	HIGH	298	SF	\$200.00	\$59,600
10. Concrete delamination – ledger beam tops, columns, retaining walls, and wall panels Vertical and horizontal partial depth patch	HIGH	167	SF	\$150.00	\$25,050
11. Deck topping slab delamination – upper levels: 3 (west) and 4 Horizontal partial depth patch	HIGH	2,091	SF	\$75.00	\$156,825
12. Landing Concrete delamination – stair tower Miscellaneous partial depth patch	HIGH	167	SF	\$100.00	\$16,700
13. Concrete delamination – ledger beam undersides, double tee, column, panels Overhead/vertical deep patch, with shoring during repair	HIGH	83	SF	\$450.00	\$37,350
14. Corroded shear transfer plate and corroded supplemental steel – double tees Clean and coat, minor demo required for embedded steel inspection	HIGH	55	EA	\$250.00	\$13,750.00
15. Broken shear transfer plate – double tees Shear transfer plate replacement with "sandwich plates"	HIGH	8	EA	\$500.00	\$4,000.00
16. Deck topping slab cracks – upper levels: 3 (west) and 4 Rout cracks and seal with joint sealant	HIGH	1,437	LF	\$5.00	\$7,185.00
17. Landing topping slab cracks – stair towers Rout cracks and seal with joint sealant	HIGH	18	LF	\$5.00	\$90.00
18. Missing handrail post cap at landing – stair tower Replace handrail post cap	HIGH	3	EA	\$75.00	\$225.00
19. Corroded stair tread nosing – stair tower Stair tread nosing repair	HIGH	47	EA	\$200.00	\$9,400.00
20. Deck topping slab deterioration – upper levels: 3 (west) and 4 Apply traffic coating system – waterproofing Urethane system	HIGH	26,150	SF	\$5.00	\$130,750.00
21. Corroded Embedded steel at bearing – wall panels and stair towers Provide additional bearing support	HIGH	4	EA	\$2,000.00	\$8,000.00
22. Inadequate Top Garage Sign connection Provide additional support	HIGH	1	EA	\$4,500.00	\$4,500.00
23. Concrete Flange Delamination Rebuild double tee flange	HIGH	15	SF	\$500.00	\$7,500.00
24. Double Tee concrete Bearing Delamination Rebuild double tee bearing	HIGH	1	EA	\$1,100.00	\$1,100.00
25. Severe staircase steel corrosion – stair tower #1 Clean and paint staircase steel	HIGH	1	LS	\$8,000.00	\$8,000.00
26. Drainage Assessment – Repairs: P1 through P6³	HIGH	1	LS	\$56,650.00	\$56,650.00
27. Exposed, corroded steel with spalled concrete – double tees, pedestrian walkway, columns, and stair towers Clean and coat	MED	466	LF	\$25.00	\$11,638
28. Corroded steel plates and bolts – ledger beams and columns Clean and paint	MED	54	EA	\$100.00	\$5,400
29. Non-structural cracks in concrete – double tees Epoxy injection	MED	467	LF	\$125.00	\$58,375

WORK ITEM	PRIORITY	QUANTITY	UNIT	UNIT COST	TOTAL
30. Deteriorated vertical joint material – all elements Replace vertical joints sealant	MED	497	LF	\$10.00	\$4,970
31. Deteriorated cove joint material – all elements Replace cove joints sealant	MED	4,737	LF	\$5.00	\$23,685
32. Deck topping slab delamination – lower levels: 1 thru 3 (east) Horizontal partial depth patch	MED	336	SF	\$75.00	\$25,200
33. Excessive water Leaking through deteriorated concrete – double tees and columns corbel Silane Sealer	MED	318	SF	\$5.00	\$1,590.00
34. Deck topping slab cracks – lower levels: 1 thru 3 (east) Rout cracks and seal with joint sealant	MED	2,339	LF	\$5.00	\$11,695.00
35. Landing topping slab pour stop delamination – stair towers Replace landing pour stop (repour)	MED	3	EA	\$300.00	\$900.00
36. Landing handrail post section loss – stair towers Supplemental handrail post steel	MED	12	EA	\$400.00	\$4,800.00
37. Stair tread section loss due severe corrosion – stair tower Stair tread strengthening	MED	30	EA	\$400.00	\$12,000.00
38. Deck topping slab deterioration Apply traffic coating system – waterproofing Upper levels: 3 (west) and 4: PUMA system (cost adjusted) Lower levels: 1 thru 3 (east): Urethane system	MED	26,150 64,604	SF	\$10.00 \$5.00	\$261,500.00 \$323,020.00
39. Connection plate deficient holes Enlarge slotted plate holes	MED	6	EA	\$350.00	\$2,100.00
40. Severe staircase steel corrosion – stair tower #3 Clean and paint staircase steel	MED	1	LS	\$5,000.00	\$5,000.00
41. Exposed, corroded steel with spalled concrete – ledger beam tops, and wall panels Clean and coat	LOW	120	LF	\$25.00	\$2,988
42. Vertical cracks in retaining walls in the basement and stair towers Chemical grout injection	LOW	46	LF	\$100.00	\$4,550
43. Deck topping slab deterioration Apply traffic coating system – waterproofing Upper levels: 3 (west) and 4: PUMA system (included in medium repairs) Lower levels: 1 thru 3 (east): PUMA system (cost adjusted)	LOW	64,604	SF	\$10.00	\$646,040.00
High Priority Subtotal				\$798,659	
General Conditions	20	%		\$159,732	
Mobilization and Demobilization	10	%		\$79,865.90	
Contingency	10	%		\$79,865.90	
GRAND TOTAL - 2019 PROJECT COST FOR 5 YEAR LIFESPAN FOR GARAGE				\$1,118,123	
High Priority Subtotal				\$798,659	
Medium Priority Subtotal				\$751,873	
General Conditions	20	%		\$310,106	
Mobilization and Demobilization	10	%		\$155,053	
Contingency	10	%		\$155,053	
GRAND TOTAL - 2019 PROJECT COST FOR 10 YEAR LIFESPAN FOR GARAGE				\$2,170,744	
High Priority Subtotal				\$798,659	
Medium Priority Subtotal				\$751,873	
Low Priority Subtotal				\$653,578	
General Conditions	20	%		\$440,822	
Mobilization and Demobilization	10	%		\$220,411	
Contingency	10	%		\$220,411	
GRAND TOTAL - 2019 PROJECT COST FOR 15 YEAR LIFESPAN FOR GARAGE				\$3,085,753	
Notes:					
1. All costs are current as of the time of the report submission (May 2018)					
2. Subtotals are exclusive of contractor GC, OH&P and contingency					
3. See Appendix C for Drainage study repair recommendation summary					
4. See report for priority level descriptions and garage lifespan information; 2019 project costs are NOT total lifespan costs					

APPENDIX B – PHOTOGRAPHS



REPAIR ID - 01



REPAIR ID - 02A



REPAIR ID - 02B



REPAIR ID - 03A



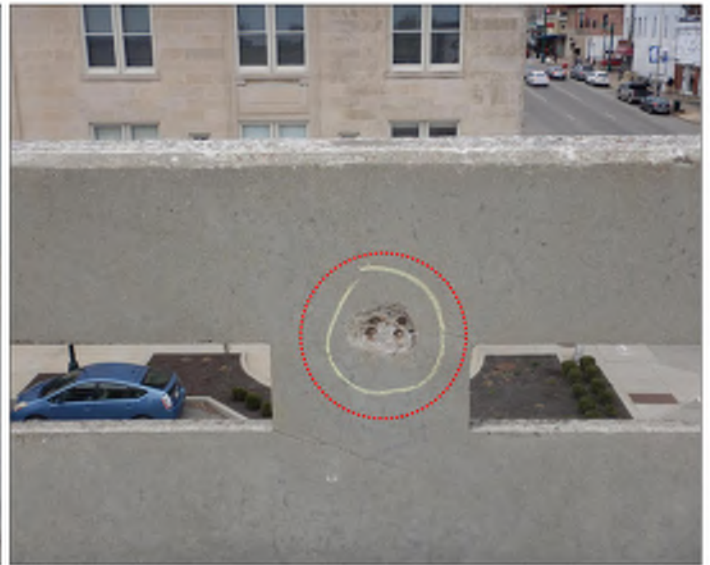
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REPAIR ID - 03C



REPAIR ID - 03D



REPAIR ID - 03E



REPAIR ID - 03F



REPAIR ID - 04



REPAIR ID - 05A



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REPAIR ID - 05C



REPAIR ID - 05D



REPAIR ID - 05E



REPAIR ID - 06



REPAIR ID - 07A



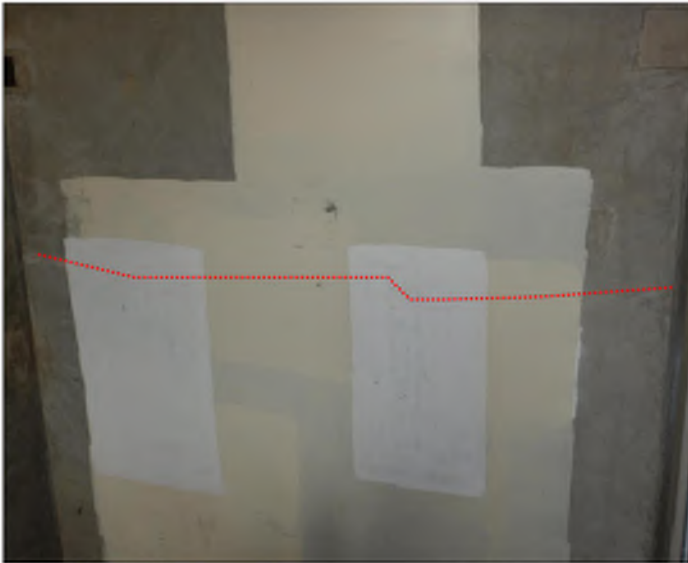
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REPAIR ID - 07B-2



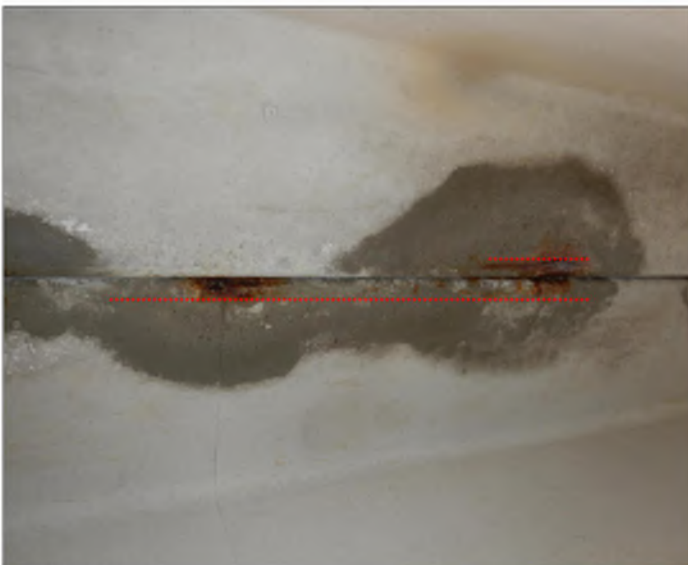
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REPAIR ID - 07D



REPAIR ID - 07E



REPAIR ID - 08



REPAIR ID - 09A



REPAIR ID - 09B



REPAIR ID - 10A



REPAIR ID - 10B



REPAIR ID - 10C



REPAIR ID - 10D



REPAIR ID - 10E-1



REPAIR ID - 10E-2



REPAIR ID - 10F



REPAIR ID - 10G



REPAIR ID - 11A



REPAIR ID - 11B



REPAIR ID - 11C



REPAIR ID - 11D



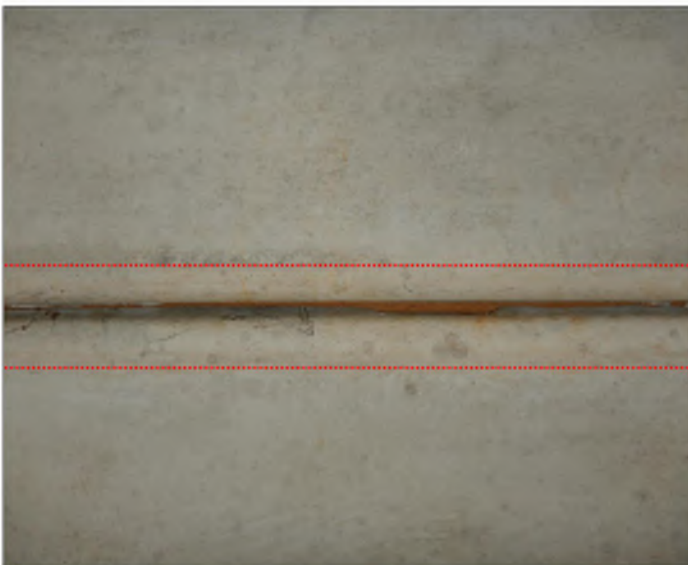
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REPAIR ID - 13



REPAIR ID - 14



REPAIR ID - 15A



REPAIR ID - 15B



REPAIR ID - 15C



REPAIR ID - 16



REPAIR ID - 17



REPAIR ID - 18



REPAIR ID - 19



REPAIR ID - 20



REPAIR ID - 23



REPAIR ID - 24



REPAIR ID - 25



REPAIR ID - 26



REPAIR ID - 27



REPAIR ID - 28



REPAIR ID - 29



REPAIR ID - 9C



GENERAL - 01



GENERAL - 02



GENERAL - 03



GENERAL - 04

**APPENDIX C – DRAINAGE ASSESSMENT AND OPINION OF PROBABLE
DRAINAGE CONSTRUCTION COST BY APPLIED ENGINEERING SERVICES**

20
YEARS STRONG

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City of Bloomington

4th Street Parking Garage Drainage Piping Study
Final Study
5-25-2018

Fourth Street Garage Drainage Piping Study

Visual Walk-Thru

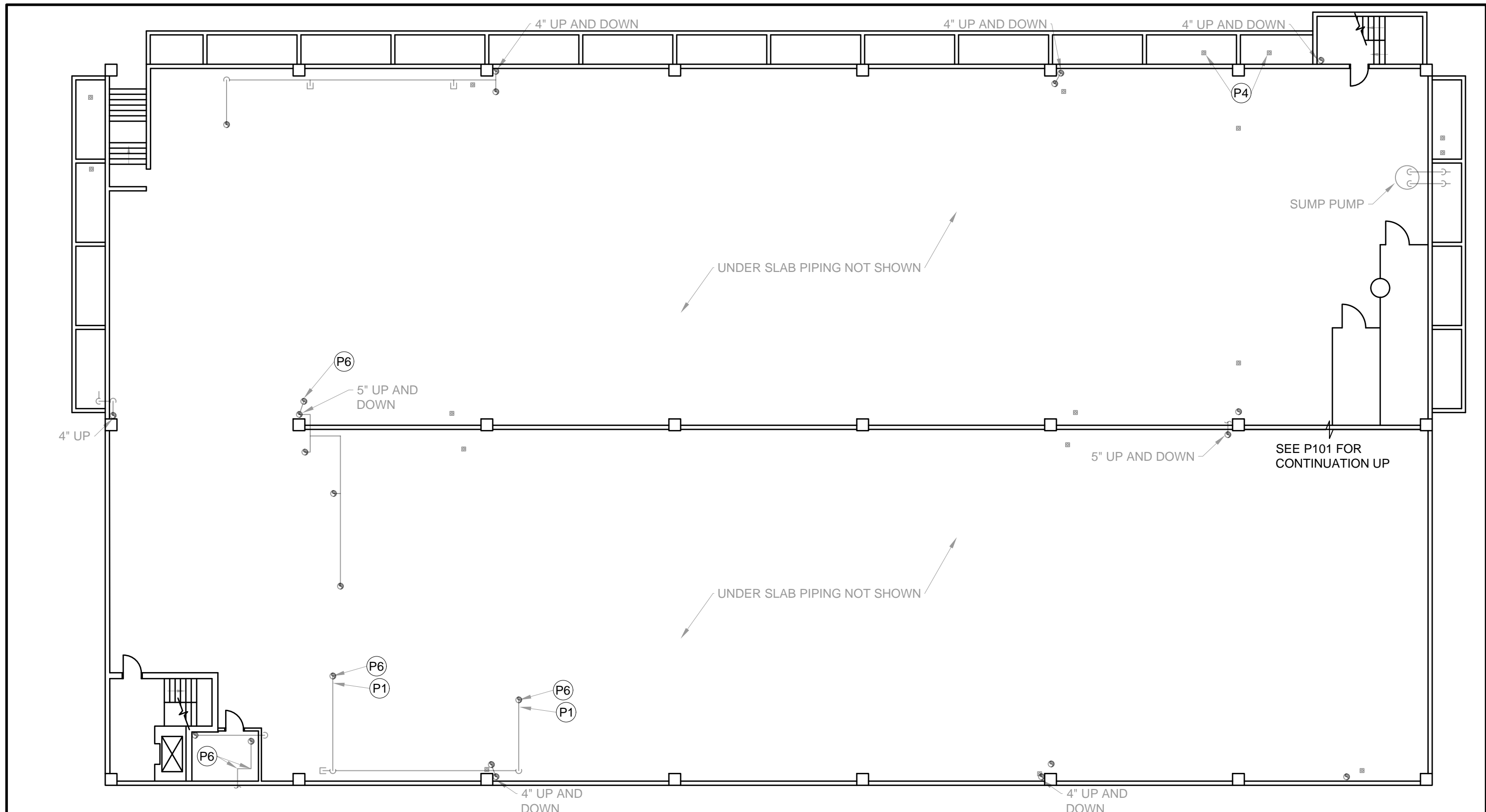
Design team performed a visual walk-thru of the Fourth Street Parking Garage on April 12th, 2018. Design Team noted and photographed problems from the initial walk-thru. Type of Repair, Location, Photograph No., Cost of Repair, Priority and Comments are given on the attached spread sheet. Photographs illustrating the problem are included.

Drainage Narrative

The storm drain system for the parking garage is comprised of primarily hubless cast iron pipe and fittings with some PVC pipe and fittings. In general, the hubless cast iron piping and fittings are deteriorating. This report calls out the fittings needing the most attention and recommends that all the laterals be replaced because various hubless couplings are failing and leaking. It is further recommended that either new hubless fittings be installed, or new PVC piping and fittings. The attached inspection summary and drawings show locals with particularly notable damage, and apparent issues based on the walk through are attached. The repair items called out all fit into the "High" priority level matching the structural assessment. These repair items appear to either be currently leaking, or if not addressed will likely fail and cause additional leaks. Due to the nature of pipe deterioration, it is difficult to identify needed repairs for the lower priority levels. It is likely additional significant repairs will be needed every 3-5 years to keep the drainage system in operation for an extended period, based on the overall condition of the existing hubless drain pipes.

Various floor drains appeared to be clogged with debris. The parking deck, drains, and lateral piping should be cleaned out and inspected to ensure there are no further blockages.

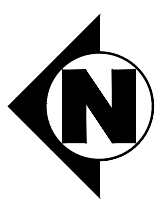
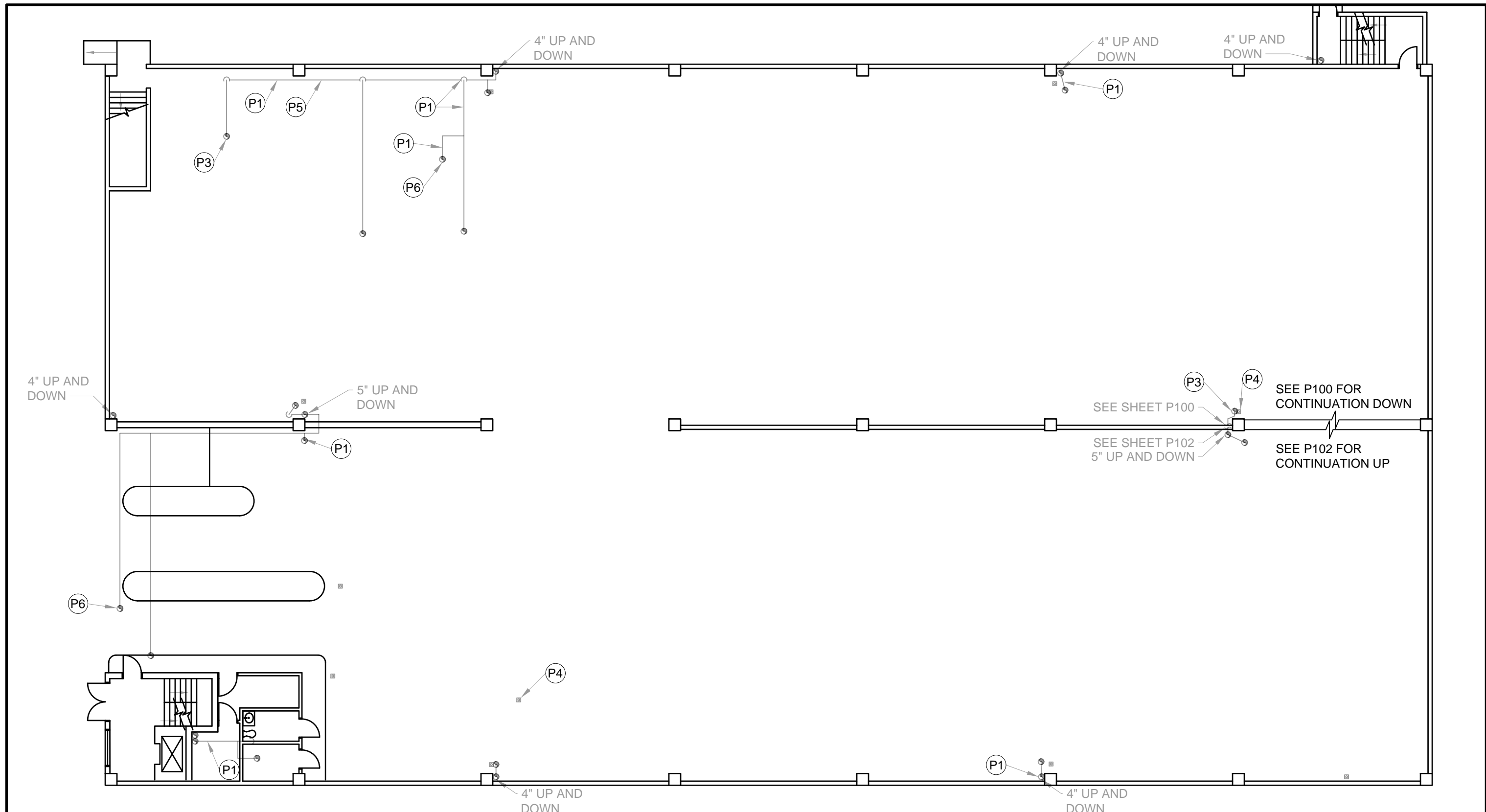
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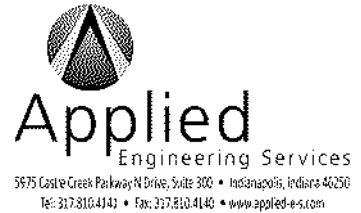



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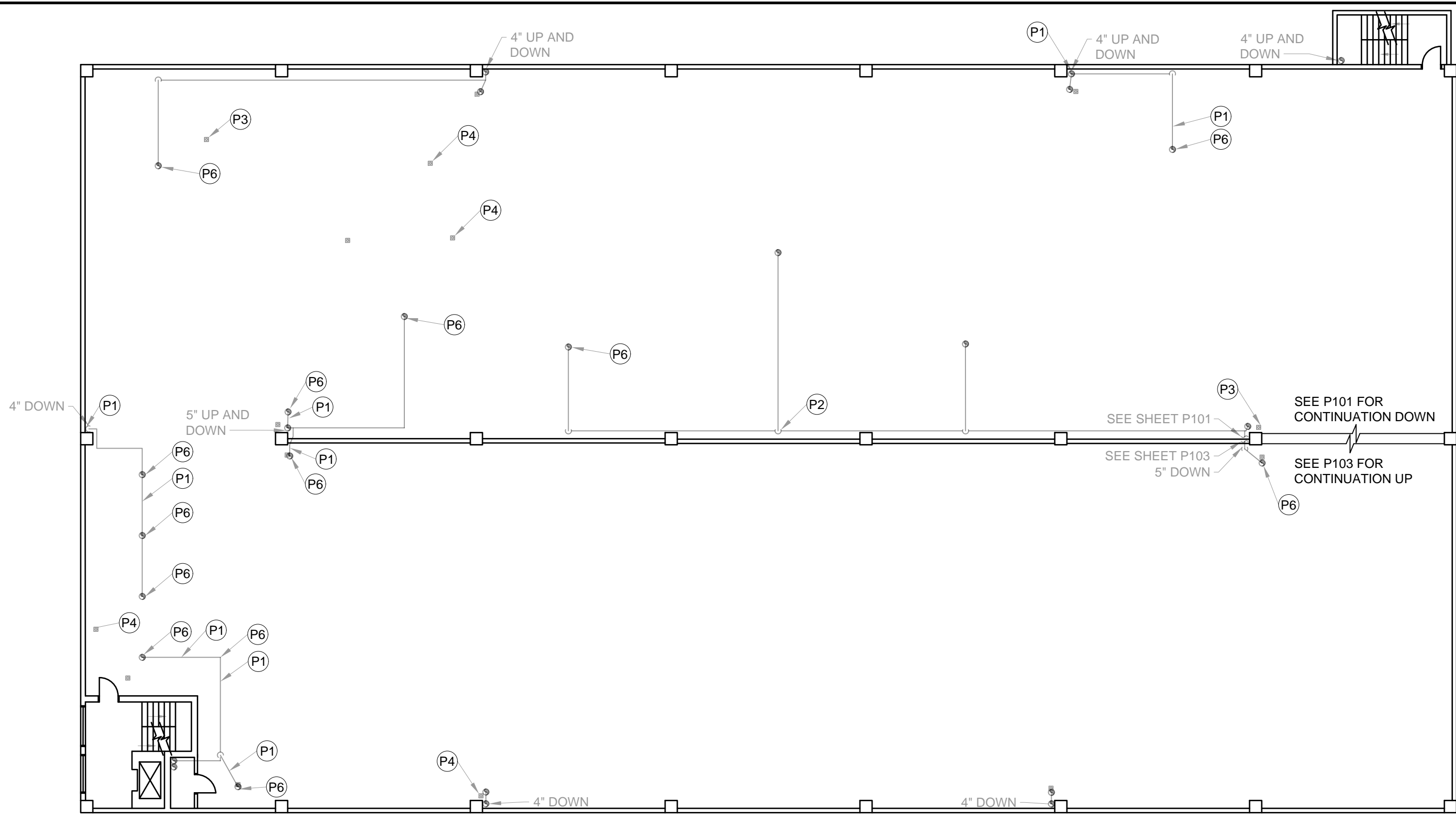
City of Bloomington 4th Street Garage Bloomington, IN			SHEET REF. P100
DRAINAGE PIPING STUDY	DESIGNED BY LMB	APPROVED BY LMB	

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	DRAINAGE PIPING STUDY	DESIGNED BY LMB	APPROVED BY LMB	PROJECT NO. 18-048
				P101

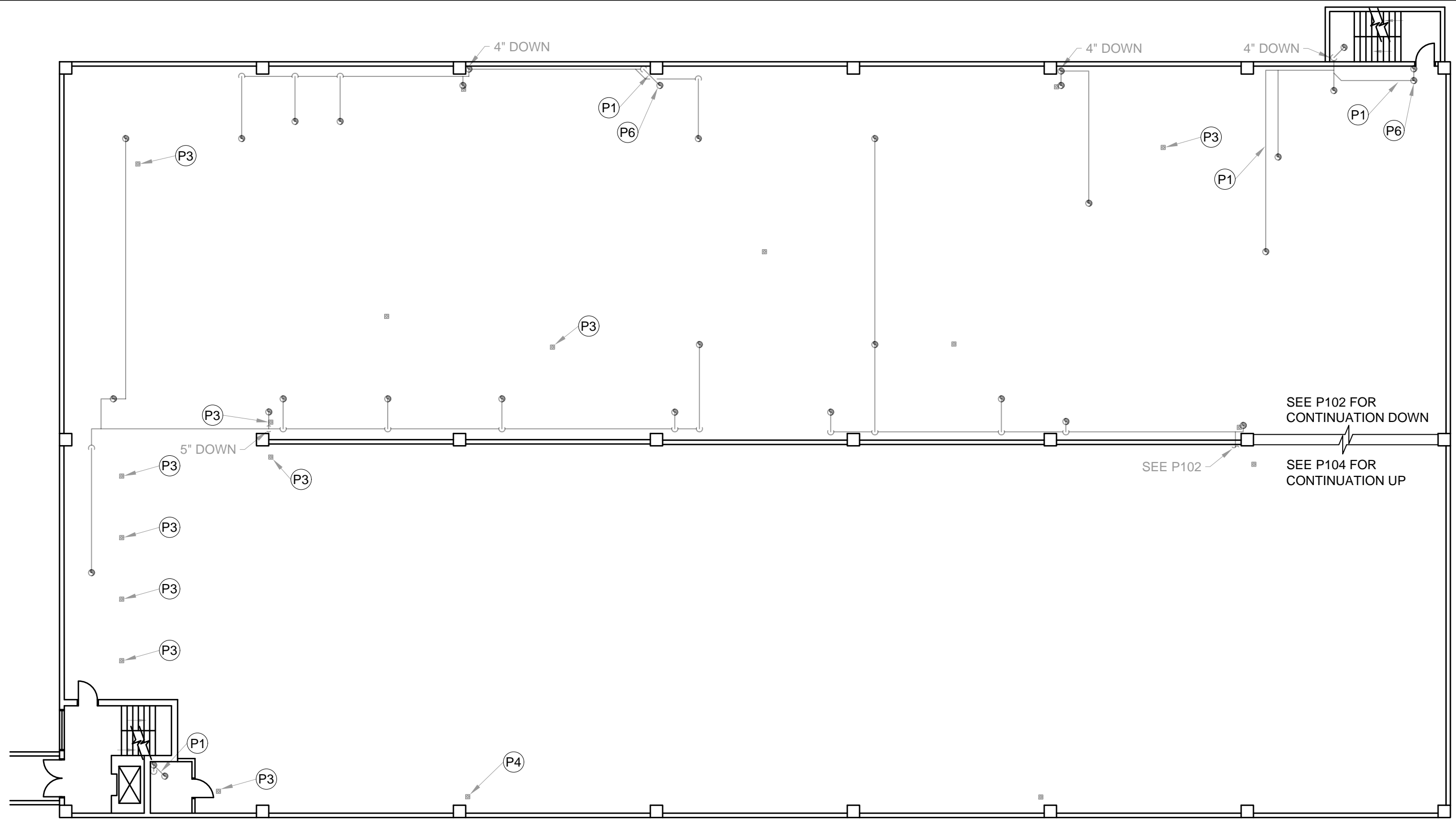
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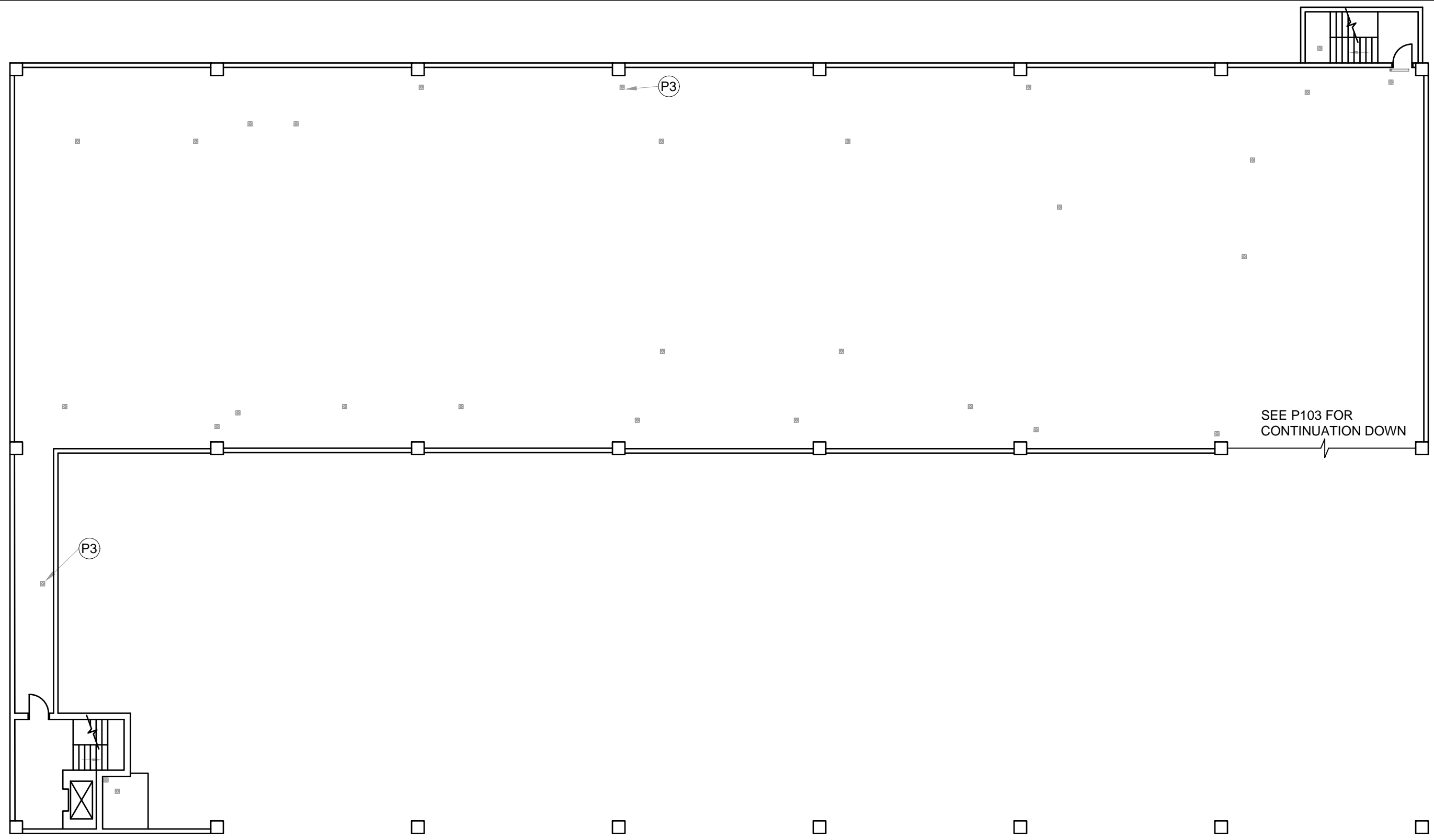
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DRAINAGE PIPING STUDY	DESIGNED BY LMB	APPROVED BY LMB	PROJECT NO. 18-048

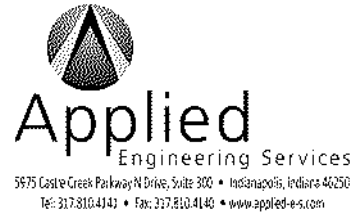
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City of Bloomington 4th Street Garage Bloomington, IN			SHEET REF. P103
DRAINAGE PIPING STUDY	DESIGNED BY LMB	APPROVED BY LMB	



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	DRAINAGE PIPING STUDY	DESIGNED BY LMB	APPROVED BY LMB	



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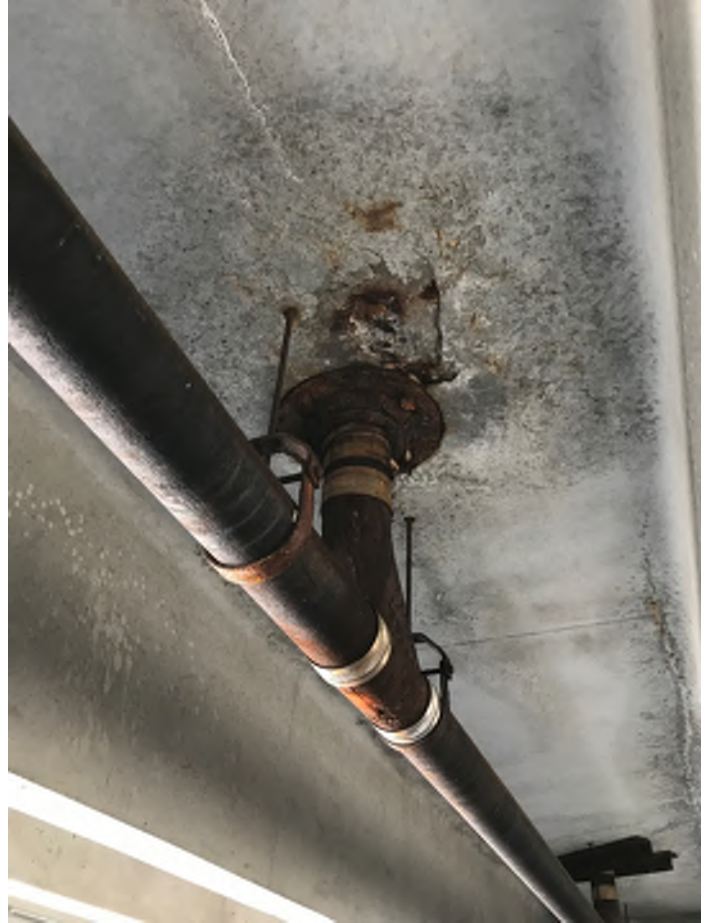
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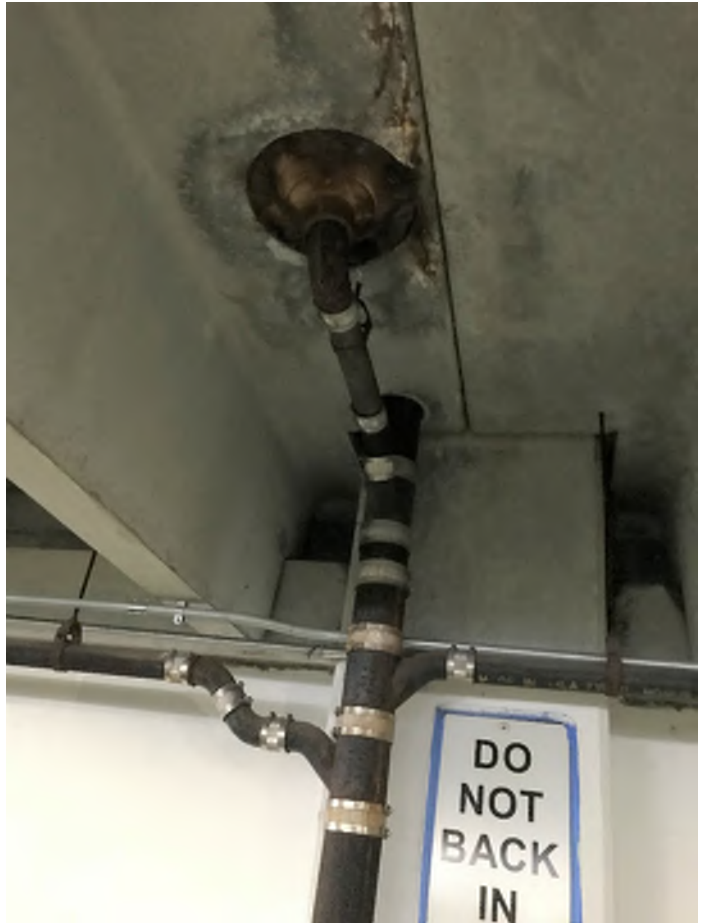
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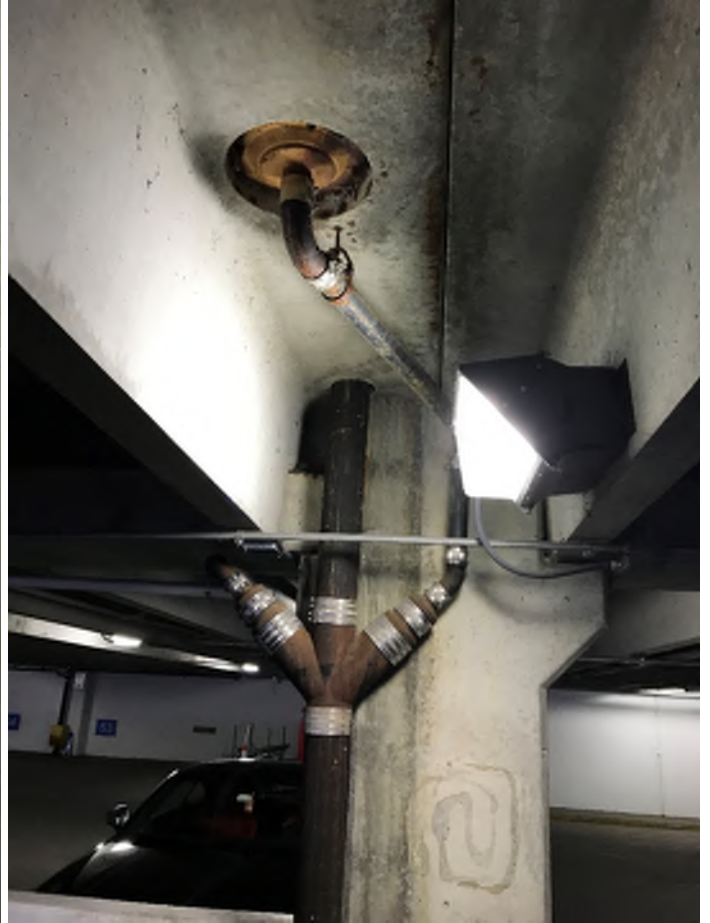
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