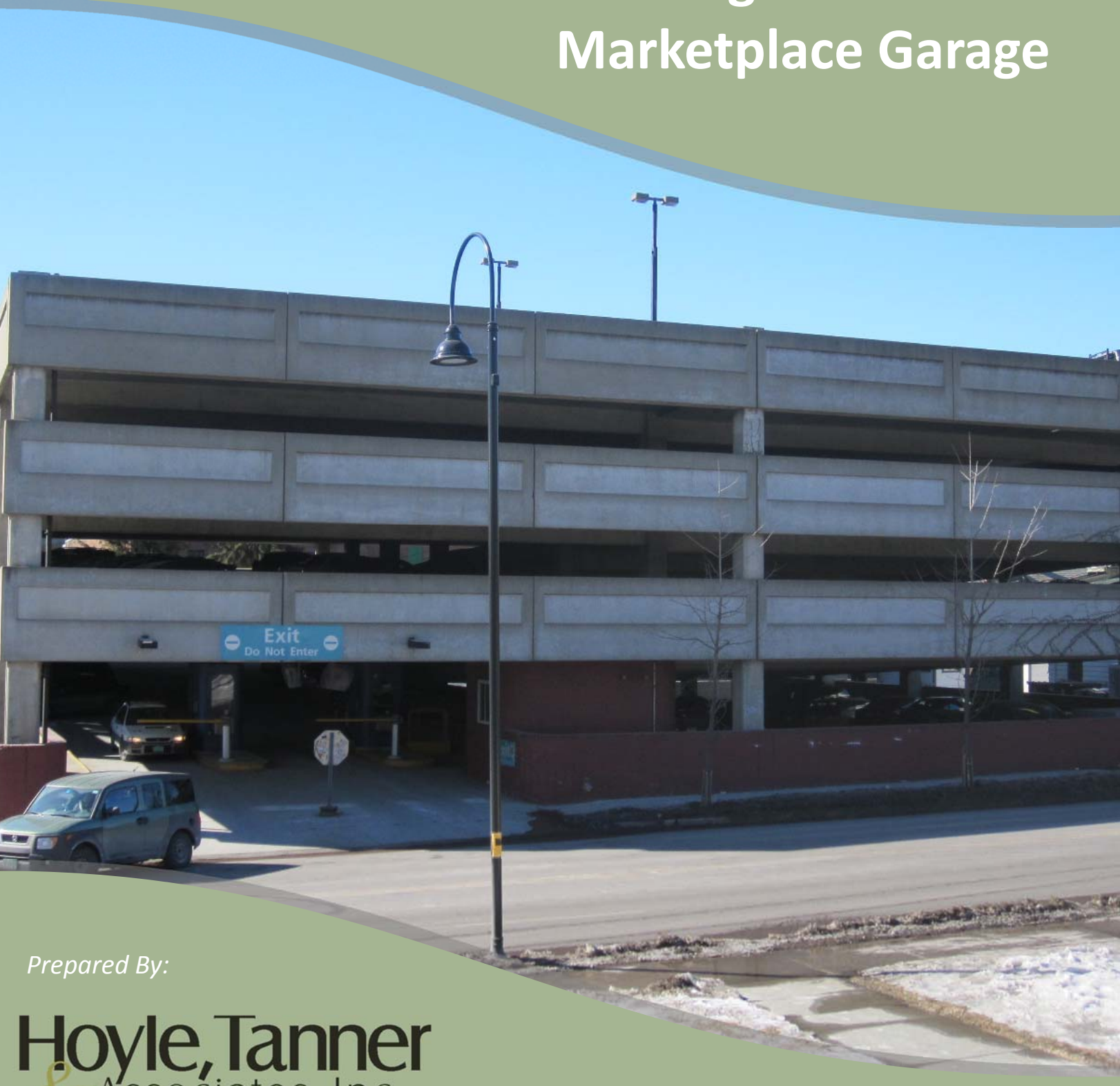
Assessment of City Parking Garage Structures
Marketplace Garage



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1 EXECUTIVE SUMMARY

The team of Hoyle, Tanner & Associates, Inc. (Hoyle, Tanner), Freeman, French, Freeman (FFF), and Kirick Engineering has been retained by the City of Burlington to perform a detailed conditions assessment with repair recommendations and budgetary considerations at the Marketplace Garage in Burlington, VT. These recommendations include immediate, short term, mid term, and long term needs as well as long term maintenance. This report summarizes our field observations, engineering opinions, and estimated costs.

The Marketplace Garage is a "modified" double helix comprised of post tensioned cast-in-place concrete slabs and beams supported by cast-in-place concrete columns. Post Tensioning (PT) systems are typically used to reduce the structural depth of the slabs and beams to minimize the overall weight of the garage and to provide a more economical design. Each helix is 114' wide by 141' long, reference Appendix B for garage floor layout plans. This 5 level structure was opened in 1976 and serves as an important public parking facility for the Church Street Marketplace as well as other downtown destinations. There are two vehicular entrances on the first level of the garage; a south entrance from Bank Street and North entrance from Cherry Street. There is one exit from the Garage on the second level that outlets onto South Winooski Avenue. Three detached stair towers provide pedestrian access into and out of the garage. These are indicated on the original garage plans alphanumerically and labeled in the garage based on street access. They are as follows; Stair Tower A (Church Street), Stair Tower B (Cherry Street) and Stair Tower C (Bank Street). Stair Tower A houses two elevators in a single shaft in addition to stairs.

In preparation of this report the following assumptions were made:

- No record drawings are available for this garage. Therefore, the exact layout including size of the post tensioning tendons is unknown. The Design Drawings provided indicated the PT system for the slab was performance specified for the Contractor to design.
- The interior of the elevator shaft was inspected for structural and architectural considerations. The elevator and associated equipment are routinely inspected and maintained under a separate contract.

There are many issues in the Marketplace Garage that require repair or replacement. Understanding the level of capital investment required for this garage, we have attempted to categorize repairs that allows for spending to be budgeted and spread over multiple years. All of the recommendations are important to the long term integrity of this garage, if they can be coordinated and completed sooner we recommend doing so. We have also included recommendations for general housekeeping and preventive maintenance schedules. Deferred capital spending will lead to more costly, more structure-critical repairs.

During our inspection we identified the following issues that should be addressed as soon as possible:

1. Remove loose overhead grout patch from the underside of the construction joint at Level 1 D-E Ramp at Beam Line 4 (JS-3: this nomenclature is used with the

report to key identified issues and is further explained in the Conditions Assessment Section of the report)
2. Patch concrete spalls with exposed reinforcing steel until more permanent floor surface repairs can be completed (CS-3)
3. Cover electrical junction boxes and patch spall locations until more permanent floor surface repairs can be completed (CS-4)

The most pressing issues at this garage stem from poor quality control during the original construction of the garage. Some structural elements, including the concrete slab and columns were constructed with inadequate concrete cover over reinforcing bars and PT strands which accelerates the rate of reinforcing corrosion and concrete deterioration.

Though there are many repairs and improvements necessary for this garage, much of the structure is still in serviceable condition. If repairs are completed within the recommended timeframe, future issues are quickly addressed, and a strong maintenance plan is adhered to this structure can be serviceable for another 15 to 20 years.

When considering alternatives at this garage location, recent average construction costs are at approximately $25,000 per parking space for new parking garage facilities. So to reconstruct a new garage at this location, matching the existing 400 parking spaces would cost approximately $10,000,000 (including engineering fees and demolitions costs).

2 INTRODUCTION

This report is based on a number of inspections performed by Hoyle, Tanner – structural components, FFF – architectural components, and Kirick Engineering – electrical components. We have reviewed existing plans to better understand the original construction and to better prepare for typical “in service” issues associated with this structure type. We have worked closely with Mr. Pat Buteau, Assistant Director of Public Works, and Mr. Brad Cummings, DPW Parking Facilities Manager. They provided a depth of historical knowledge, current needs, stakeholder considerations, and parking facility user challenges.

For the purposes of this study, our inspection was generally completed through representative sampling, with more detailed inspections occurring where visible and historical evidence warranted. Concrete was inspected for spalls utilizing hammer sounding, a laser plumb was used to verify beam and column plumbness, and a light meter was utilized to map light levels within the garage and determine the performance of the overall system and where improvements are needed.

Based on our inspections of the Marketplace garage we have not found visual evidence of PT strand damage or failure, and therefore recommended to the City the deletion of Non-Destructive Testing during this Garage Study. Visual indicators would be grease or rust staining on the undersides of slabs, transverse slab cracks, differential slab deflection at construction joints, or strand corrosion at surface spalls where strands are exposed. We did not find such indicators, alternatively, several strands were completely exposed within concrete spall areas (which appear associated with poor cover over steel reinforcing bars), and were found in relatively good condition. The repair recommendations for the slab

(necessary in the Short Term) included in this report will provide visual exposure on substantial portions of the PT strands. Should evidence of strand damage be found during this work, radiographic (x-ray) testing can be utilized at similar locations within the garage.

We understand that simultaneous to this study there are three other parking studies being conducted for the City of Burlington:

- Downtown Burlington Parking & Travel Management Plan
- City of Burlington TDM Action Plan
- Parking Study in Residential Areas

We trust the findings of this report in partnership with the above studies will aid in shaping the future of downtown parking in Burlington. Considerations should be made with regards to the mid and long term spending on this garage and the future needs in this area as determined from these studies.

3 CONDITIONS RATING SYSTEM

CI = Conditions Index: The CI rating system used for this assessment was developed specifically for this project to help understand / rate the garage element(s) inspected. There may be select repairs that are prioritized even if an element of the garage is rated favorably. The rating system is intended to score how the element as a whole within the garage (or garage level) is performing with respect to its intended functionality. It is unrelated to public safety concerns, which have been accounted for in the Recommended Repair Timeframe (see section 4 of this report). The rating is from 0 to 10, and is as follows:

0 1	Serious	Element is not performing or is not present. Extensive repairs/replacement required to nearly 100% of element.
2 3 4	Poor	Element is failing or in risk of failing. Multiple locations requiring repair. Repairs extensive in nature.
5 6 7	Moderate	Minor repairs required in select locations
8 9 10	Good	Element in good condition. Maintain preventative maintenance program.

4 REPAIR TIMEFRAME

Each repair recommendation provided in this Report provides a description of the issue along with a repair recommendation and recommend timeframe in which to complete the repair. This conditions assessment was completed with the intent to identify issues, and prioritize them with budgetary costs. Further engineering for the development of bid and construction plans is recommended for all repair projects.

IMMEDIATE	0 – 1 years	Intended for repairs/replacements that represent a public safety hazard, or need to be completed to prevent further damage from occurring within the garage.
Short Term	1 – 2 years	Intended for repairs that need to be completed as soon as possible to prevent further damage within the garage, but are able to go through a proper design-bid-build cycle. It is recommended that the design process for these repairs begin shortly after receipt of this report, and be completed within the following construction season (i.e. complete prior to December 2015)
Mid Term	2 – 5 years	Repairs required for the garage that are necessary, but do not present a current hazard to the garage performance
Long Term	5 – 10 years	Aesthetic repairs. Repairs that will improve the long term performance of the garage, but can wait for planning purposes as prioritized needs are met.

5 CONDITIONS ASSESSMENT AND REPAIR RECOMMENDATIONS

For the purposes of this report we have developed an issue identification system so they can be tracked within the description, budget, photos, and prioritization matrix sections of the report. We attempted to utilized nomenclature that matched the garage element it is closely associated with, and numbered multiple issues within that category accordingly. For instance, for Joint Sealant repairs, we used JS, and since there were two different joint sealant conditions to note, they are identified as JS-1 and JS-2.

In order to maintain photograph integrity and size we have separated photos from the report body, but have used the identification system described above and maintained the order as follows in this section. We encourage the reader to utilize the photograph appendix in concert with reviewing the below section.

Estimated quantities of each issue are provided in the cost estimate summary in Appendix A of this report.

Reference to Grid, Column, and Beam Lines are based on the existing drawings which were utilized in developing project base maps as provided in Appendix B.

5.1 Construction Joint Sealant

Levels 1 - 3: CI = 5 Portions of joint material have failed.

Levels 4 - 5: CI = 3 Significant lengths of joint material have failed.

Observations:

Construction joints for cast-in-place concrete structures are locations where one concrete placement ends and another begins. In this garage, construction joints are found on each level although the location and number of joints per level varies. A point to note for the Marketplace Garage is that the construction joints on the elevated slabs do not fall above the beam lines. Rather, they fall between beam lines creating cantilevered portions of the slab. This is important to note because the cantilevered portion of the slab relies on the post tensioning force to adequately transfer live load stressed across the construction joint. A joint sealant is used to prevent water from infiltrating this joint and corroding the tendon. Properly functioning joint sealant should have the following characteristics;

- Maintain elasticity to resist differential movements.
- No tears or ruptures within the sealant.
- Adhesion to concrete surfaces to resist water and debris infiltration.

Failed sections of joint sealant were observed to have lost elasticity and have debonded from the concrete surface. Condition of the construction joint sealant in the Marketplace Garage is heavily dependent on its location within the garage. Sealant at the fourth and fifth level with direct exposure to sunlight was found to be in poor condition and show more extensive deterioration than sealant in the lower levels. The construction joint at beam line E3 – F3 was observed to be leaking during the inspection indicating that the sealant had failed. The majority of sealant in floors 1-3 was found in fair condition and could be replaced in 2-5 year (Mid Term) repair window. However, based on the amount of work required on the fourth and fifth levels, we recommend that levels 1-3 be replaced in the short term along with levels 4-5 to improve cost efficiency.

The construction joint in the first level D-E ramp at beam line 4 was observed to be patched from below with grout. This grout is not a structural repair and was not observed at any other construction joint. In this orientation, the grout patch presents a liability issue and with time, the grout will delaminate from the slab and fall onto the level below. This grout should be removed from the joint immediately.

JS-1	Issue:	Joint Sealant Failures at Level 4 and Level 5.
	Cause:	Service Life Expired, Direct Exposure to Sunlight.
	Effect/Consequence:	Surface water travels through the construction joint, increasing the potential for slab and beam damage and post tensioning tendon corrosion.
	Repair Recommendation:	Replace the full length of all joint sealant at these levels. Remove and repair spalled concrete to create uniform joint edge and remove patches that cross the construction joint (see spalled concrete patching under concrete slab section of this report). Clean and prepare bonding surface prior to installation.
	Repair Timeframe:	**Short Term**

JS-2	Issue:	Joint Sealant Failure at Levels 1, 2 and 3.
	Cause:	Service Life Expired.
	Effect/Consequence:	See JS-1.
	Repair Recommendation:	See JS-1.
	Repair Timeframe:	**Short Term**

JS-3	Issue:	Grout Patch Below Construction Joint at Level 1 D-E Ramp at Beam Line 4.
	Cause:	Improper use of grout patch, no structural need.
	Effect/Consequence:	Future delamination and spalling causing sections to fall onto level below (liability concern).
	Repair Recommendation:	Remove grout.
	Repair Timeframe:	**IMMEDIATE**

5.2 Expansion Joints

Levels 1 - 5: CI = 3 Expansion joints are failing in all existing locations.

Observations:

Expansion joints are used to control water infiltration while allowing for limited amounts of lateral movement due to thermal expansion and contraction of the structure. The expansion joints used in this garage consist of an open cell neoprene modular joint. Expansion joints are found at the interface of column lines C9-D at the cross over location for levels 1 through 5 as well as transitions from slabs-on-grade to elevated slabs. These locations are column line E10 – E8 on the first level and column line B9 – C11 on the second level. Expansion joints are also found at the garage ends of roof level stair tower ramps at all three stair towers.

In general, the expansion joints are at the end of their useful service life and all were found to be in poor condition with many joints having tears or breaks. Additionally, debris was observed to be collecting on top of the expansion joints which collects and holds water and corrosive salts. At a minimum, all expansion joints should be replaced in kind. Alternatively, the joints can be modified to accept an open cell joint modular joint with asphaltic concrete nosing to better connect the joint to the concrete and protect against water infiltration. This alternative repair will require modification to the existing joints as the concrete surface will need to be ground approximately ¾" to create a block out that will accommodate an asphaltic concrete nosing. This alternative creates a completely waterproof joint. Once the expansion joints are repaired, periodic maintenance including cleaning the joints of debris will be required to maintain the joints in good condition.

EJ-1	Issue:	Expansion Joint Failure at Cross Over (Column Line C9-D)
	Cause:	Age, Debris Buildup.
	Effect/Consequence:	Water penetration causing damage to structural elements below.
	Repair Recommendation:	Remove and repair all unsound concrete at joint location and replace all expansion joints (all levels) in kind. Alternatively, replace with in-kind joint that includes asphaltic concrete seal. This involves grinding the concrete surface to create a block out that will accommodate an asphaltic concrete nosing.
	Repair Timeframe:	**Short Term**

EJ-2	Issue:	Expansion Joint Failure at Transition Between Slab on Grade and Elevated Slab Sections (Column Line E10 – E8 on the first level and B9 – C11 on the second level).
	Cause:	Age, Debris Buildup.
	Effect/Consequence:	See EJ-1.
	Repair Recommendation:	See EJ-1.
	Repair Timeframe:	**Short Term**

EJ-3	Issue:	Expansion Joint Failure at Transition Between Stair Tower Ramps and Parking Garage at All Three Stair Towers
	Cause:	Age, Debris Buildup.
	Effect/Consequence:	See EJ-1.
	Repair Recommendation:	See EJ-1.
	Repair Timeframe:	**Short Term**

5.3 Precast Spandrel Beams

Stair Ramp Support Spandrel **CI = 3** Significant damage at majority of locations.
Typical Spandrel **CI = 7** Moderate condition with minor aging issues.

Observations:

Precast spandrel beams and their connections located around the perimeter of each garage level are generally in good condition. Issues exist at spandrel beams supporting stair ramps where joint failure and water damage have caused spandrel beam reinforcement corrosion, and associated concrete cracking. Several of these beams have experienced significant damage and are in need of replacement.

PC-1	Issue:	Precast beam cracking
	Cause:	Water damage due to joint failure above
	Effect/Consequence:	Beam damage, long term - potential reduced capacity
	Repair Recommendation:	Patch Spall locations, epoxy inject cracks
	Repair Timeframe:	**Short Term**

PC-2	Issue:	Spandrel beam at North Stair Tower – serious integrity loss
	Cause:	Ramp bearing does not allow thermal movement – forces transferred into spandrel beam cause cracking and water infiltration has caused section loss.
	Effect/Consequence:	Eventual beam failure
	Repair Recommendation:	Replace beam (shore ramp during replacement). Install new ramp bearings
	Repair Timeframe:	**Short Term**

5.4 Cast-in-Place Concrete

As was previously stated, the structural elements in the Marketplace garage are comprised of cast-in-place (CIP) Concrete. Elements including slabs, beams, and columns have been included in this report in their respective sections as follows:

- 5.4.1 Concrete Slabs
- 5.4.2 Concrete Beams
- 5.4.3 Concrete Columns

5.4.1 Concrete Slabs

Lower Tier and Level 1 Slab-On-Grade: CI = 7 Minor cracking in slab.

Level 1 (D-E Ramp) and 2 (E-F Ramp) and Slabs at Entrances: CI = 3 Significant potholing, and spalling. Exposed rebar and post tensioning tendons.

Levels 2-3 Slabs: CI = 5 Moderate condition with specific repair areas.

Levels 4-5 Slabs: CI = 7 Moderate condition with specific repair areas.

Observations:

Two types of slabs are present in the garage. The lower levels are comprised of slabs-on-grade and upper elevated levels are comprised of post tensioned slabs supported by beams at each grid line. As is typical of most elements in the Marketplace Garage, the condition of the slabs is highly dependent on its location relative to entrances of the garage. Slabs near these entrances are in a significantly more deteriorated state than the slabs further away.

Slabs-on-grade were observed to be in good to moderate condition. Minor cracking in the slabs was observed especially at reentrant corners such as at the base of columns. These cracks have previously been routed and sealed with a silicone based sealant. These repairs seem to be functioning properly. Any additional cracking should have the same repair. The slab-on-grade at grid A-C, 7-9 and at grid D-E, 8-10 on the first floor was observed to be in poor condition with large amounts of cracking present. This section of slab connects the Cherry Street and Bank Street entrances with one-way up ramp helix section of the garage and is therefore subject to heavy traffic loading including corrosive salts and water carried into the garage.

CIP-1	Issue:	Slab-On-Grade Surface Cracks
	Cause:	Differential settlement of the slabs and natural concrete aging processes such as shrinkage and creep.
	Effect/Consequence:	Susceptibility for water infiltration and reinforcing corrosion.
	Repair Recommendation:	Route cracks to a v-notch shape and seal with a silicone based joint sealant.
	Repair Timeframe:	**Mid Term** (unsealed cracks) **Long Term** (sealed cracks)

CIP-2	Issue:	Surface Cracks at Entrances
	Cause:	Differential settlement of the slabs and natural concrete aging processes such as shrinkage and creep. Heavy Traffic and corrosive salts.
	Effect/Consequence:	Susceptibility for water infiltration and reinforcing corrosion.
	Repair Recommendation:	Grind protruding edges of slabs to decrease elevation difference, route cracks to a v-notch shape and seal with a silicone based joint sealant. Long term should consider more extension portions of slab replacement.
	Repair Timeframe:	**Short Term**

Elevated slabs are continuous over the beams and the post tensioning tendons are draped through the slab. This means that the location of the stand relative to the top or bottom of the slab changes along the length of the slab to compress areas subject to flexural tension.

Every elevated level has sections of concrete spalling and many of these spalls have been patched with a grout material. These patch repairs have performed with varying degrees of success, and some of the patches extend over the construction joints in the slabs which is poor detailing. Heavy spalling was observed on the lower ramps due to higher vehicular traffic and salt exposure. During our inspection of the elevated slabs, it became apparent that quality control was an issue during the original construction of the garage. Most of the exposed reinforcing steel had less concrete cover than what is indicated on the original plans and what is recommended for structures of this type. Similarly, some of the post tensioning tendons passing over the beam lines were protruding from the top of the slab indicating the same issue.

Post tensioning tendons were visible in several locations including on the top and bottom of the concrete slab. Exposed tendons are usually a result of poor quality control or spalls caused by corrosion of the mild steel reinforcing. Exposed tendons are of concern since the most common mechanism for post tensioning tendon failure is pitting corrosion caused when the tendon is exposed to air was well as chloride ions. The post tensioning strands in the Marketplace garage are protected in a greased plastic sheathing. This barrier helps to prevent moisture from coming into contact with the tendon, however once the sheath is compromised the tendon can begin to corrode due to atmospheric exposure as well as water that infiltrates between the sheath and the strand, collecting at the low points of the harped tendons.

Conduits that house the electrical wiring for the interior lights were cast into the elevated slabs. Junction boxes are located in the cross over portions of the garage. An approximately 1' diameter surface spall was observed above most of the junction boxes. This spall allows for water to come into contact with electrical components compromising the system.

CIP-3	Issue:	Concrete Spalls With Exposed Reinforcing Steel.
	Cause:	Typically associated with rebar corrosion / expansion.
	Effect/Consequence:	Water can penetrate into the slab to cause more extensive beam damage to reinforcing and post tensioning stands. Over time, these spalls compromise the structural integrity of the slab. Spalls also present a hazard to pedestrians and vehicles.
	Repair Recommendation:	Fill spalls with asphalt cold patch prior to completing short term repairs (see CS-5 and CS-6) to limit the ingress of water and prevent further damage to reinforcing and post tensioning tendons.
	Repair Timeframe:	**IMMEDIATE**

CIP-4	Issue:	Junction Box Spalls at Cross Overs.
	Cause:	Freeze, thaw cycles.
	Effect/Consequence:	Water can penetrate into the electrical system causing damage.
	Repair Recommendation:	Plate over junction box and fill spalls with asphalt cold patch prior to completing short term repairs (see CS-5 and CS-6) to limit the ingress of water and prevent further damage the electrical system.
	Repair Timeframe:	**IMMEDIATE**

CIP-5	Issue:	Level 1 D-E Ramp, Level 1-2 Crossover and Level 2 E-F Ramp Spalls.
	Cause:	Typically associated with rebar corrosion / expansion.
	Effect/Consequence:	Water can penetrate into the slab to cause more extensive beam damage which over time will compromise the structural integrity of the slab.
	Repair Recommendation:	Removal all patches, chip out all surface concrete to a depth of 1"-2" over a width of 30' centered on the ramp and re-pour the concrete surface. Note: Contractor to take caution during slab removal and protect embedded electrical service and PT strands
	Repair Timeframe:	**Short Term**

CIP-6	Issue:	Remaining elevated ramps and cross over spalls.
	Cause:	Typically associated with rebar corrosion / expansion.
	Effect/Consequence:	Water can penetrate into the slab to cause more extensive beam damage which over time will compromise the structural integrity of the slab.
	Repair Recommendation:	Remove all patches, chip out all deteriorated concrete, as identified by hammer sounding and chain dragging, surface concrete to a depth of 1"-2" and re-pour the concrete surface using a high strength concrete patching material.
	Repair Timeframe:	**Short Term**

Note: Due to the presence of electrical conduit in the slab, extreme caution should be made when chipping out concrete in the slab. The exact location or depth to the conduit is unknown. Similarly, based on the observed variable depth of the post tensioning slab as well as the harped configuration of the stand, no concrete shall be removed from beneath the strands, this will result in a loss of post tensioning force.

CIP-7	Issue:	Longitudinal and Transverse Cracking of Elevated Slabs.
	Cause:	Potential causes: natural aging of concrete including shrinkage and creep, quality control issues during original construction
	Effect/Consequence:	Water can penetrate into the slab to cause more extensive slab damage which over time will compromise the structural integrity of the slab.
	Repair Recommendation:	Route cracks to a v-notch shape and seal with a silicone based joint sealant.
	Repair Timeframe:	**Short Term**

CIP-8	Issue:	Concrete Spall and Exposed Post Tensioning Tendon at Bottom Face of Slab at B7 – B9 on the Second Level.
	Cause:	Concrete cracking above has allowed water to infiltrate the slab and corrode the reinforcing steel.
	Effect/Consequence:	Spalling of the slab and eventual corrosion of the post tensioning strands.
	Repair Recommendation:	From Above: Route cracks to a v-notch shape and seal with a silicone based joint sealant above. From Below: Chip out deteriorated concrete, install headed screws into slab form up a 6" deep repair "beam" and inject self-consolidating concrete (SCC) into cored ports through the existing slab (include vent locations as well).
	Repair Timeframe:	**Short Term**

5.4.2 Concrete Beams

CI = 5 Majority of beams are in good conditions, several beams exhibit issues such as delaminated concrete, reinforcing steel corrosion, longitudinal cracking.

Observations:

Post tensioned cast-in-place concrete beams transfer the load carried from the elevated slabs into the columns. Similar to the elevated post tensioned slabs, the beams have draped post tensioning tendons used in the beam's flexural capacity. The ends of each beam are rigidly framed into the columns creating a moment connection. Hairline cracks were observed in multiple beams. Cracking in post tensioned beams can be a point of concern, however, due to the size, vertical orientation, spacing and repeating occurrences from beam to beam, we concluded that these cracks are not detrimental to the capacity of the beam and are a consequence of the natural aging of the concrete.

As was observed for the cast-in-place slabs, there is evidence of poor quality control during construction. The clearance as measured from the bottom of the beams to the slab varies and several beams show signs of impact damage. Similarly, several beams exhibit a "belly" where the concrete form deflected during the concrete placement.

There are multiple locations in the garage where beams have significant reinforcing corrosion and associated concrete spalling. The cause for this beam deterioration in the Marketplace Garage can be traced to water leakage above the beams. Solutions to help prevent water leakage are described in other sections of this report. The following is a summary of the issues in the beams identified in the beginning of this section.

CB-1	Issue:	Delaminated Concrete, Reinforcing Steel Corrosion at Level 1 Grid E-F Beams 6 and 8
	Cause:	Failed expansion joint above, high vehicular traffic, slab deterioration above.
	Effect/Consequence:	Reduced beam capacity.
	Repair Recommendation:	Remove sections of delaminated concrete. Wire brush and coat reinforcing steel, patch repair area with a high strength concrete patching material, wrap beam with fiber reinforced polymer to increase beam capacity.
	Repair Timeframe:	**Short Term**

CB-2	Issue:	Longitudinal Crack at Midspan of the Beam at Level 2 Grid E-F Beam 10
	Cause:	Failed joint at interface between stair ramp and garage above causing water leakage.
	Effect/Consequence:	See CB-1.
	Repair Recommendation:	See CB-1.
	Repair Timeframe:	**Short Term**

CB-3	Issue:	Concrete Spalls and Reinforcing Steel Corrosion at the End of the Beam, at Level 2 Grid A-B Beam 9
	Cause:	Water leakage from roof drainage (See SD-3)
	Effect/Consequence:	See CB-1.
	Repair Recommendation:	See CB-1.
	Repair Timeframe:	**Short Term**

CB-4	Issue:	Concrete Delamination and Reinforcing Steel Corrosion Along Length of the Beam at Level 5 Grid C9-D Beams
	Cause:	Leaking Expansion joint above.
	Effect/Consequence:	See CB-1.
	Repair Recommendation:	See CB-1.
	Repair Timeframe:	**Short Term**

5.4.3 Concrete Columns

CI = 6 Majority of columns are in good to moderate conditions. Several columns require spall or crack repair.

Observations:

Cast-In-Place concrete columns carry load from the beams into the foundation. The garage was constructed using typical “bottom up” sequence meaning that there is a construction joint in the columns below and above each beam. Due to this construction technique

concrete had to be dropped into the forms from a height equal to the level above. During our inspection, we observed many corner spalls at the interface of the column and the slab due to segregation of the concrete at the time of placement. In total, we observed 11 instances of this spalling at the base of the columns.

CC-1	Issue:	Column Spalls at Interface of Slab and Column on Interior (Slab Side) of Spandrel Beam.
	Cause:	Poor quality control during construction and exposure to surface water.
	Effect/Consequence:	Reinforcing corrosion, reduction of column capacity
	Repair Recommendation:	Chip out deteriorated concrete, patch repair area with a high strength concrete patching material, taper concrete patch to shed water away from the base of the column, apply water proofing membrane wrapping 6" up column face.
	Repair Timeframe:	**Short Term**

Poor quality control during construction appears to be an issue for damage at multiple columns. There are many instances of minimal, or even zero, concrete cover over the confinement steel in the columns. This has resulted in minor corrosion of the exposed reinforcing steel, and if left unrepaired could lead to more substantial structural damage.

CC-2	Issue:	Exposed Reinforcing Steel Due to Shallow Concrete Cover.
	Cause:	Poor quality control during construction.
	Effect/Consequence:	Reinforcing corrosion.
	Repair Recommendation:	Wire brush the steel to remove surface rust. Coat the reinforcing steel in a corrosion resistant epoxy paint (color grey).
	Repair Timeframe:	**Mid Term**

Representatives from Hoyle, Tanner investigated the columns to see if there were signs of differential settlement, racking, or other issues that would cause the columns to be out of plumb. Using a laser level, measurements were taken at each floor level and compared to a reference line. Although we did record offsets from the reference line as large as ¾", there was no correlation in column shape even when considering adjacent columns. Therefore, we concluded that these were construction tolerance issues rather than structural movement issues.

CC-3	Issue:	Column Spalls at Construction Joint on Exterior Side of Structure Beams.
	Cause:	See CC-1.
	Effect/Consequence:	See CC-1.
	Repair Recommendation:	Chip out deteriorated concrete, patch repair area with a high strength concrete patching material.
	Repair Timeframe:	**Mid Term**

Levels 5 and Open Air Level 4 Column Tops CI = 6

CC-4	Issue:	Surface Cracking at Top of Columns.
	Cause:	Exposure to temperature fluctuation, water and snow/ice.
	Effect/Consequence:	Increased water infiltration that could cause issues over the length of the column.
	Repair Recommendation:	Inject epoxy repair filler in cracks larger than 1/16". Apply water repellant sealer (silane/siloxane) to all tops of columns. Consider metal cap to act as flashing for the tops of columns
	Repair Timeframe:	**Mid Term**

5.5 Miscellaneous Steel

Observations:

The majority of this garage is constructed of precast and cast-in-place concrete. There are however, metal guardrails at each level along grids 1, 7, 10, and 16. These railings and their connections appear in good condition. Routine cleaning and painting should be maintained; this is accounted for in the maintenance section of this report.

There are steel pipe rails located in front of each stair tower ramp. Several of these have become disconnected and should be reattached to the floor slab. Ground Penetrating Radar (GPR) should be used prior drilling new bolt holes in order to locate and avoid slab reinforcing and PT strands. Routine cleaning and painting should be maintained; this is accounted for in the maintenance section of this report.

MS-1	Issue:	Reconnect Steel Pipe Rails
	Cause:	Age, connection failures
	Effect/Consequence:	Lack of protection for stair tower ramps
	Repair Recommendation:	Drill and bolt to slab.
	Repair Timeframe:	**Short Term**

Cable guardrails are located at interior parking spaces. Many of these have become detached, loosened, or replaced with a non-structural chain link. These cable guardrails should be replaced and retensioned to their original installed condition. Cable guardrails are required at these locations per the original design and per the Life Safety Code (2012 NFPA 101). They shall have a maximum 4" spacing up to a height of 34" above the floor slab elevation.

MS-2	Issue:	Cable Guardrail Issues
	Cause:	Age, connection failures
	Effect/Consequence:	Safety hazard
	Repair Recommendation:	Install new lengths of cable where missing or cable is damaged. Retension existing cable
	Repair Timeframe:	**Short Term**

5.6 Electrical and Lighting Systems

The garage was built in 1976 and it appears that very little additional electrical infrastructure was added or replaced since this initial construction (with the exception of replacement of the lighting fixtures within garage interior floor levels). As a result, much of the electrical equipment is near or at the end of its useful life. A complete assessment of the electrical infrastructure for this garage was completed between May 20th and June 11th, 2014. The following conditions were field observed:

5.6.1 Service Equipment

CI – 3 Existing panels are rusted and in need of replacement

Observations:

The main service size is very robust at 1200 amps, 208/120 volt, three phase, and terminates at main panel MDP in the electrical room on the main level; however, when this service was installed (3) sets of parallel 500 KCMIL cables were used for the 1200 amp service. At the time this was a code compliant design. Since then the NEC has changed and today would require 600 KCMIL cables to be used. This is due to the fact that 500 KCMIL cables are only rated for 380 amps, and 3 x 380 = 1140 amps, which is shy of the full 1200 amp service.

Generally, this equipment is in barely usable condition. The years of being in a damp environment has pitted this gear with rust in many locations, including the main panel as well as associated subpanels and wireways in this space. The make of MDP and associated sub-panels is Federal Pacific (FPE), which is a manufacturer that no longer is in business, so replacement circuit breakers and parts will be increasingly hard to come by, and presently requires after-market reconditioned or salvaged parts for servicing, which is costly and much less reliable than using new hardware. Circuit breakers also degrade over time, becoming less sensitive to over-current conditions, if they arise. This is due to fatigue of mechanical parts (especially in damp environments) and the years of accumulated transient voltage surges that naturally occur from utility connection voltage spikes and local lightning strike surges.

The main panel also includes what appears to be a subsection that is fed from a tap on the main incoming service line and backed-up by batteries and inverters so as to provide for emergency egress lighting if normal power to the facility is lost. According to personnel interviewed, this equipment has never been serviced since its installation, and is unreliable at best at this time. Observation of this equipment does appear to indicate that this is the original installed system and does not appear to have been modified or replaced since its install in 1976. Batteries typically have a bout a 10 -15 year useful life in best conditions, and would be expected to have a continuing degree of degradation after that. Staff has confirmed that under some recent power outages, the emergency lights have not come fully on, and in some locations has not come on at all.

Initial panel schedules indicated that expected demand loads, with the originally intended lighting and venting systems, would be around 200 kW, which would translate to 555 amps at 208/120 volt, 3 phase; well within the 1200 amp service capacity. If more efficient equipment is installed as part of renovations to this facility, then the existing service size would still be adequate to serve the building.

ES-1	Issue:	Rusting service equipment and sub-panels and made by manufacturer no longer in business. Age and condition of equipment also makes it possibly unreliable. Failure of emergency section.
	Cause:	High humidity levels and old age.
	Effect/Consequence:	Lack of emergency power to facility. Unreliable
	Repair Recommendation:	Replace service distribution and sub-panels and installation of a reliable emergency power system. A central battery inverter system or a generator based system recommended (if space allows) for emergency power needs.
	Repair Timeframe:	**Mid Term**

5.6.2 Distribution Equipment

CI – 3 Horizontal lengths of conduit and wiring heavily corroded.

Observations:

In the main electric room there are several sub-panels, combination starter-disconnects for fans (or other motor loads), and several smaller branch circuit panels. Small sub-panels have also been installed in the office and toll booths as part of the original equipment provisioning. All these panels are original vintage, except for one newer panel installed in the electric room, and as such are near the end of their useful life (newer panel excepted).

As for the distributed branch circuits, most of the visible, vertical, mid-to-upper floor conduit systems look to be in fairly good condition. The exception being the lower floor, where water seepage has partially rusted wireways and conduits, and ceiling lighting circuits on the upper floor (just below the roof-top parking level), where water seepage through the upper deck has corroded many of the original concrete embedded recessed lighting circuit conduits. It appears that in these cases, the original circuit and associated light fixtures have been abandoned and replaced with newer lighting and seal-tite (waterproof) circuiting. Some PVC conduit installations were also observed as more recently installed circuits. These are still in adequate condition but represent only a small minority of circuits installed.

ED-1	Issue:	Highly corroded conduit and wiring.
	Cause:	Water infiltration to facility.
	Effect/Consequence:	Eventual imminent circuit failures. Danger to occupants.
	Repair Recommendation:	Replace sub-panels and conduit and wiring for all active branch circuits on all upper floors where water damaged.
	Repair Timeframe:	**Short Term**

5.6.3 General Lighting

CI – 6

Observations:

The original lighting systems were a combination of mercury vapor based HID fixtures, T12 fluorescent fixtures, and incandescent fixtures. None or very few of these lighting systems would be used in a new parking garage design, due to vastly improved and much more energy efficient systems available today. Most of the original lights have been replaced at least once; however, there remains a mixture of different lighting styles and lamp types throughout the facility. This makes for a very non-uniform looking mash-up of lighting levels and colors as one moves through the structure.

Generally, the National Parking Association (NPA) in association with the Illumination Engineering Society of North America (IESNA) recommend 2.0 footcandles (FC) average for general parking areas, with 20 FC in stairwells and at stair entrances, and 6 FC at ramps and a minimum of 1 FC maintained at floor throughout. Higher FC levels at entrance areas are also recommended for daytime use when exterior daylight could be quite bright and entering a (relatively) dark parking garage needs to have a transitional zone so that eyes have a chance to adjust to the lower internal levels. Egress pathways are required by code to have a minimum of 1 FC average for path and 10 FC minimum for egress stairs. For this facility the following field lighting levels were measured:

20-30 FC at Bank and Cherry Street entrances
10-20 FC at College Street exit
10-20 FC at major walkway accesses between stair and elevator towers
3-6 FC down center of drive path
3-16 FC in stair towers (but as high as 90 FC in places where replacement metal halide fixtures were installed)
20-30 FC in elevator tower landings but as low as 3 FC at the top level of tower. Very inconsistent lighting levels throughout.
0.1- 2.0 FC at rooftop level with mostly below 0.5 FC

Generally, where lighting was fully operational the light levels were adequate; however, numerous fixtures were inoperative, either due to total failure or in need of lamp replacement. This made for very uneven lighting throughout the facility. Different lamp types were used and this results in interior color variations from blue-white to cream-white, to yellowish. Lighting levels also varied extremely through the facility due to mis-matching replacement fixtures and lamps. Due to the age of currently installed bulbs it is anticipated that many will need replacement within the next several years. This cost has been accounted for in the maintenance section of this report.

Pole fixtures on the upper deck are rusting and lighting is so low in places that even readings of 0.1 FC could not be measured, especially around the exterior perimeter line of parking spaces.

Ambient lighting sensors were also observed, so as to control (turn off) unneeded perimeter lighting at open walls where daylighting can contribute useful levels of light. It was not confirmed if this system is operational or if observed fixtures were off due to failure.

EL-1	Issue:	Low light levels on Roof Level (4/5) and stairwells
	Cause:	Aging fixtures
	Effect/Consequence:	Reduced security and comfort of patrons, higher energy bills than need be.
	Repair Recommendation:	Replace roof level and stairwell lighting fixtures with a fully integrated lighting scheme, using high-efficiency lighting systems such LED or induction based. Replace poles and base anchorage with fixture replacements.
	Repair Timeframe:	**Mid Term**

5.6.4 Required Lighting Systems

CI - 2

Observations:

Life-safety systems consist of two elements: the emergency egress lighting system, and the fire alarm system. Both of these systems have deficiencies and operational problems. Details of each of the critical elements were inspected and findings are described below -

Egress Lighting – Emergency egress lighting consists of two components, exit signage marking and auxiliary power backed-up pathway illumination. Exit signage must be either internally or externally illuminated and be placed along egress routes so that at no location along the egress path is the distance greater than 100 feet. Also, generally building inspectors like to have two different exit signs visible from any given location so that if one pathway is blocked by a hazardous condition during an emergency the viewer can opt to take the alternate path to safety.

In general, many locations within the Marketplace structure have adequate placement and quantities of exit signage; however, there are locations in the lower structure that will need supplemental signs. This garage has a unique style of exit sign, which is wedge shaped, allowing for the two-faced sign to be visible from a much wider angle than traditional blade shaped signs. The only drawback to the existing signs is that they have incandescent based lamps. An LED based unit would be much better from an energy use and maintenance lamp replacement stand. KEA would recommend retrofitting these units, if possible, and continue their use, while supplementing with newer units as required.
As for emergency lighting operations, the existing system as designed is not functioning. There is an emergency battery set and associated inverters designed into the main switchgear of the facility. This emergency section of the gear has not been maintained by personnel and they may not even be aware of its make-up or how to maintain it. There is no record of any replacement of batteries being installed, nor regular testing of this system. When recent power outages have occurred, the main facility parking areas remained dark. Only the central elevator tower had some emergency backup lighting,

which was derived from additional stand-alone emergency battery pack units that are installed in these spaces.

Fire Alarm- For parking structures over 100,000 square feet (SF) in size, a manual or automatic fire alarm system is required (unless sprinkler protected). The Marketplace garage is larger than 100,000 SF, does not contain a fire suppression system, therefore at a minimum, a manual fire alarm system is required throughout. In addition, this structure has an elevator, which also has requirements for automatic smoke and heat detection for its associated spaces.

Presently, this structure has a nominal fire alarm system associated with the elevator tower only. It appears that the requirements for smoke and heat detection for the elevator and machine room have been met; however, the associated manual pull stations alarm notification is minimal, only installed in and on the elevator tower and not beyond. There should be manual pull stations at all stairwell exits from floors, at all ground floor exits from the structure, and all accessible locations in the structure must be within 100 feet from a pull station. Additional pull stations must be added to meet these criteria.

As for annunciation appliances (audible/visual units), occupants must be able to be notified of an alarm condition within the facility. Generally, occupants must be able to see and hear fire alarm strobe/horn units from any given location. As mentioned above only the elevator tower has any notification appliances. The rest of the building is lacking in these critical alarm notification devices.

Generator System: There is no generator system for this facility. Emergency circuits for lighting only are provided by a battery set that is installed as part of the main panel (see service equipment above) and some supplemental battery pack based emergency lights in the elevator tower. (See ES-1)

ELS-1	Issue:	Fire alarm system deficiencies.
	Cause:	Old partially installed system, with many missing components to system.
	Effect/Consequence:	Reduced security and safety of patrons, and lack of code compliance.
	Repair Recommendation:	Provide an expanded and properly designed manual fire alarm system and associated general area annunciation horn/strobe appliances
	Repair Timeframe:	**Short Term**

ELS-2	Issue:	Exit signage deficiencies.
	Cause:	Initial building design deficiencies.
	Effect/Consequence:	Reduced security and comfort of patrons.
	Repair Recommendation:	Add exit signage as required.
	Repair Timeframe:	**Short Term**

5.6.5 Other Electrical Systems Observed

Telephone: Telephone service is basic and appears adequate for the use of the facility.

Computer/Data: There is a local network for a minimal number of workstations associated with the office and adjoining toll booths. CAT5e cabling is fairly new and in good condition. System is adequate for its function.

Communications/PA: The initial building had a public address (PA) system installed but it has not been used as long as personnel can remember and is not currently in operation. Such a system would be recommended to serve as a mass notification system if needed during emergency events.

CATV: There is some coaxial cable present in the building but its use is not known. On the first floor an associated junction box near the first floor level (Winooski St side) was damaged and needs replacement (or removal if not in service).

Security: Recently, some security monitoring cameras have been installed at the main toll exit ramp. This is an IP based system (not a recorder based system) and is connected to Burlington DPW for remote monitoring of facility as needed. Mostly designed for reading license plates as they exit the facility.

5.7 Openings (Windows, Doors and Storefronts)

CI = 6 Some deficiencies in functionality.

Observations:

Doors and hardware are in generally fair condition; some rust and broken or poorly functioning hardware were observed in each stairwell.

Skylights: Observed 10 pane, double slope, full vented skylight (Stair A: 9'-8" N/S x 9'-2" E/W) and two fixed 3 pane single sloped skylights (Stair B: 5'-10"x 3'-4" & Stair C: 6'-8' x 4'-2"). All skylights appear to be in adequate condition.

There are openings that exceed the allowable opening width of 4" in the guard (solid CIP wall) on the uppermost level.

5.8 Stair and Elevator Towers

Joints at Slab to Garage Interface	**CI = 2**	Replace all joints.
Stair Tower Nosings	**CI = 2**	Multiple nosings are in serious condition and need replacement/reattachment

Observations:

The three freestanding stair towers are comprised of concrete masonry unit (CMU) blocks with a brick façade are connected to the main garage with bridging walkways. Representatives from Hoyle, Tanner investigated the towers to see if there were signs of differential settlement, racking, tilting or other issues that would bring the towers out of plumb. Using a laser level, measurements were taken at each floor level and compared to a reference line. Based on the results of the measurements, differences between readings and the reference line did not indicate any issues with the towers beyond construction tolerance of the brick façade.

At each level, an elevated concrete slab (referred to as stair tower ramp) connects the stair towers to the garage. The joint material at every joint location between the interface of the stair tower slab and the garage has reached its useful service life and requires replacement. Due to the current condition, many of these joints have failed and allow water to infiltrate into the lower levels of the garage. These ramps were designed to be fixed to stair towers and allowed to move (for thermal expansion/contraction) at parking garage bearing locations. It appears that at several ramp locations this movement was restricted and has caused cracking issues in the spandrel beams and/or adjacent brick façade. The ramp bearing locations at the garage structure need to allow horizontal movement of the ramps

Stairs and railings are generally in mixed conditions, with code compliance deficiencies throughout. **Tread nosing inserts are loose and pose an immediate public safety risk**; railings exhibit a substantial amount of rust in some locations but are not loose or broken; stair rise/run as well as railing height and gaps do not meet current life safety code standards. Handrails measure less than 32” above stair nosings; guardrails measure 42” above stair nosings.

ST-1	Issue:	Worn or Detached Stair Nosings
	Cause:	Poor Installation, Age
	Effect/Consequence:	Many treads are loose, causing a potential tripping hazard.
	Repair Recommendation:	Replace stair tower treads. Fasten with stainless steel fasteners. Use epoxy adhesive on the underside of stair treads prior to screwing down. This will remove the noise issues as treads bounce currently bounce on the concrete.
	Repair Timeframe:	**Short Term**

ST-2	Issue:	Repair Ramp Bearings at Garage Structure
	Cause:	Corrosion, water infiltration
	Effect/Consequence:	Potential structural issues for ramps and spandrel support beams
	Repair Recommendation:	Elastomeric bearing pad with seismic anchor (allows for thermal movement but prevents horizontal displacement under a seismic event)
	Repair Timeframe:	**Short Term**

ST-3	Issue:	Cracks on Stair Treads and Landings
	Cause:	Corrosion, water infiltration leading to reinforcing corrosion and expansion
	Effect/Consequence:	Long term damage to structural capacity
	Repair Recommendation:	Epoxy inject cracks
	Repair Timeframe:	**Short Term**

ST-4	Issue:	Stair 4 – Missing Guardrail on Stair Run
	Cause:	Original Construction
	Effect/Consequence:	Code/Safety Issue
	Repair Recommendation:	Add guardrail
	Repair Timeframe:	**Short Term**

ST-5	Issue:	Railing and stair code deficiencies
	Cause:	Spacing between horizontal bars in guardrails at stair tower ramps is greater than 4” clear. Handrails in all stair towers are below 32” as measured from stair nosing.
	Effect/Consequence:	Code deficiency
	Repair Recommendation:	Replace rails with code compliant handrail/guardrail combination at interior stair runs. Replace guardrails at stair tower ramps with code compliant guardrails.
	Repair Timeframe:	**Short Term**

5.9 Elevator Shafts

Observations:

There are two, 5 stop Schindler 2500 elevators with inside clear dimensions of 6’-9”x 4’-3”.

Elevator Car #1 (Left) was temporarily out of service during observation period. (Door was pried open by firemen and damaged). The floor finish of Car 1 has extensive damage and warping of the subfloor. Car 1 Cab glass had hole in the lower left panel. Door threshold damage causing door opening issues (Not in scope).

Both elevator cars and shafts exhibited conditions characteristic of water damage. BPW staff indicated this was a result of a poorly executed cleaning incident (pressure washing) that occurred in the recent past.

Elevator Machine room (below grade) seems to have moisture seeping in through CIP walls.

5.10 Roofing Membranes

CI = 9 No visual indication on underside of roof indication membrane issues above

Roof membranes were observed from aerial photographs, adjacent roofs and from conditions below. The roof systems are assumed to be the original 1976 ballasted built up roof with 1½" insulation minimum on cast-in-place roof slab. Parapets are 12" Rowlock Brick on top of through wall cap flashing on three courses of CMU.

Generally membranes exceed expected life span of roof system which is 15-20 years (this roof system is assumed to be about 40 years old).

Total area of roof membranes (not including skylights or vent) = approximately 506 sq. ft. The replacement of roof membranes has been accounted for in the Maintenance section of this report.

Roof Membrane Location	Date of Installation / Replacement	Date of Repairs / Patching	Age
SE Stair Tower	2005	-	9 yrs
Center Stair Tower	2005	-	9 yrs
NW Stair Tower	2005	-	9 yrs

5.11 Striping and Deck Markings

CI = 6 Striping has low to moderate visibility in many locations.

Observations:

The striping of stalls and other traffic control lines were observed to be in fair condition. There are several areas where the striping is fading or has detached from the concrete surface. All levels should be restriped in kind, including arrows, parking stalls, and curbs.

5.12 Mechanical / Utility Rooms

There is a fan unit on the lower level of the garage. It was noted during the site visit that air flow is poor at this levels and moist floor/wall areas take a very long time to dry. This has a deleterious effect on structural, mechanical, and electrical garage components, as well as contributing to poor air quality. It appears to have been the design intent for this unit to circulate air at the lower level, and it is recommended to replace this unit (it is anticipated that the existing fan unit is no longer operable, and efficiency technology improvements warrant mechanical replacement).

The utility / staff room on Level 1 was found in generally good condition. It was noted that there is a leak in the Southeast corner of the room during rain event. This is due to an expansion joint failure above which is noted for repair/replacement in the Expansion Joint section of this report.

ME-1	Issue:	Poor Air Flow at Lower Level
	Cause:	Majority of levels is underground – limited fresh air exposure
	Effect/Consequence:	Poor air quality, moisture related issues on structural, mechanical, and electrical components
	Repair Recommendation:	Install new fan unit
	Repair Timeframe:	**Long Term**

5.13 Occupied Spaces

There are two storage rooms located on the Lower Level of the Garage. Generally these occupied spaces are in adequate condition. However, there are some repairs that are required on the slab and beams above that will require partial relocation and temporary removal of partition walls.

The first floor office by the South Winooski exit is in good condition with no known issues. However, above the office there is a high concentration of pigeons roosting in the space between the garage floor above and the roof of the office. These pigeons need to be relocated, this space needs to be cleaned, and the wire netting enclosing this space needs to be reattached. Pigeon droppings (guano) represent a health hazard.

5.14 Brick Walls

Levels 1	**CI = 5**	Multiple repairs needed
Stair Tower Façade	**CI = 8**	Generally good condition
Grid 6 Façade at Ctr Stair	**CI = 5**	Spot repairs needed at stair tower ramps

The perimeter of the first level of this garage is surrounded by a Concrete Masonry Unit (CMU) wall with clay brick façade. Mortar Joints, brick attachment, and joint sealants are all in need of significant repair.

Stair tower facades observed were in generally good condition.

The façade that extends up the face of Grid 6 adjacent to the Center Stair Tower required brick reattachment at each stair tower ramp.

FA-1	Issue:	Brick Façade Detached
	Cause:	Impact, thermal movement, water damage
	Effect/Consequence:	Long Term potential for dislodging and falling bricks
	Repair Recommendation:	Remove bricks, install new clips, and reset bricks
	Repair Timeframe:	**Mid Term**

FA-2	Issue:	Mortar Failure
	Cause:	Water damage
	Effect/Consequence:	Water infiltration into CMU and Brick Walls
	Repair Recommendation:	Repoint mortar
	Repair Timeframe:	**Mid Term**

5.15 Surface (Floor) Drainage

Levels 1-5 CI = 6 Minor corrosion and concrete spalling, ponding due to heavy debris build-up.

Cherry Street Trench Drain CL = 2 Local slab deterioration. Trench Drain failure

Observations:

Surface Drainage in the Marketplace garage is comprised of two cast iron drains at the base of each ramp and a trench drain at the Cherry Street entrance. There is additional roof drainage on top of the three stair towers.

In general, the structural condition of the floor drains in the garage are in moderate condition. The slabs were cast with a cross slope peaked at the slab centerline to a wash at the edges of the slabs which channels surface flow into the drainage system. Rain on June 17th into June 18th allowed for our team to identify areas of poor drainage and ponding in the garage. Minor section loss was observed on some of the drains and there are some concrete spalls around the perimeter of the drains that compromise the seal between the drain and the slab. Multiple floor drains were found plugged by debris. Plugged drains can be greatly detrimental to the long term condition of the garage as it does not allow the drainage system to remove the water.

SD-1	Issue:	Plugged Drains
	Cause:	Debris build-up.
	Effect/Consequence:	Pooled water undergoes freeze/thaw cycles, causing damage to the structural elements.
	Repair Recommendation:	Clean out all floor drains. Clean debris out of garage. Pressure was garage thoroughly. Flush drainage system at each drain location.
	Repair Timeframe:	**Short Term**

The trench drain at the Cherry Street entrance was observed to be in poor condition. Stagnant water was present in the drain indicating that the drain outlet is plugged and not functioning properly. This condition does not appear to be a recent issue as surrounding areas of the cast-in-place concrete slab are in poor condition with large cracks and with a portion missing exposing the subsurface below.

SD-2	Issue:	Replace Trench Drain
	Cause:	Age, installation
	Effect/Consequence:	Drain collapse causing travel way issues at Cherry Street Entrance
	Repair Recommendation:	Remove and replace trench drain, clean outfall pipe, chip out and replace section of CIP slab that has cracked.
	Repair Timeframe:	**Short Term**

The roof drainage at stair tower B (column line A between beams 9 and 11) outlets through the brick façade of the stair tower onto the ramp between the stair tower and the fifth level of the garage. The outfall consists of a PVC pipe that is broken allowing water to discharge on the stair tower ramp and infiltrate to levels below. This water path has led to multiple structural issues below in the spandrel beams, PT beams, slabs, and drain pipes

SD-3	Issue:	Water Infiltration at the Joint Between the Ramp and Garage Slab at Stair Tower B (Level 4).
	Cause:	Broken PVC outfall pipe
	Effect/Consequence:	Deterioration of structural elements below.
	Repair Recommendation:	Re-route the pipe to the underside of the Level 4 Ramp (this will require coring through the stair landing and out the stair wall below the ramp). Maintain continuous pipe on the underside of the ramp to the garage, where it should tie directly into the downspout of the drainage piping system
	Repair Timeframe:	**Short Term**

5.16 Drainage System

CI = 3 Repairs required at each level.

Observations:

Storm water is conveyed out of the garage through a closed drainage system consisting of cast iron piping. Lengths of storm drainage piping at Levels 1 through 5 show signs of failure, either having cracked, or showing severe section loss due to corrosion of the cast iron pipe. This was typically observed in the short horizontal pipe lengths between floor drains and vertical drain pipes

Based on observations of the existing building plans and our inspection, the system is comprised mainly of 6" diameter cast iron piping. The drainage system outlets to drainage

structures adjacent to the garage (one located at column line B-16, and one located between column lines D-6 and E-6.). The drainage structures have outfall pipes that ties into the City stormwater collection system. It was observed during the site visit that the drainage structure in the alley adjacent to D-6 ponds during rain events. This catch basin needs to be cleaned out and the outfall pipe size should be evaluated to determine if it is sized appropriately to carry flow from the garage drainage system (this is outside the parking garage limits but impacts garage drainage system performance)

DS-1	Issue:	Piping Has Failed – Cracked or Rusted Through.
	Cause:	Cracked pipes appear to have failed from the freezing of water trapped inside the pipe. This could have occurred as a result of a plug within the pipe, having noted the debris issues within the garage.
	Effect/Consequence:	Water escapes the drainage system and causes structural issues to areas of the garage not intended for stormwater exposure.
	Repair Recommendation:	Replace lengths of failed stormwater piping to match existing size and type (consider non-ferrous piping alternatives with replacement – coordinate with code requirements for material selection). Where possible improve pipe pitch during replacement.
	Repair Timeframe:	**Short Term**

DS-2	Issue:	Corrosion on Elbow Joints Below Surface Drains.
	Cause:	Water ponding above due to debris collection and water leaking between the perimeter of the drain and the slab.
	Effect/Consequence:	Section loss of the elbow joints.
	Repair Recommendation:	Replace heavily corroded elbow joints to match existing size and type (consider non-ferrous piping alternatives with replacement – coordinate with code requirements for material selection).
	Repair Timeframe:	**Mid Term**

5.17 Foundation

We performed inspection of columns and walls considering potential for foundation issues. Based on our inspection, we did not find indications of foundation related issues such as differential settlement or wall movement.

5.18 Americans with Disabilities (ADA) Standards (including Parking and Deck Striping)

CI = 7 Garage generally meets 2010 ADA standards

Observations:

Wheelchair accessible entry to the garage is from the Church Street and South Winooski Ave. entrances. Pedestrian entries from Cherry Street and Bank Street are not wheelchair accessible.

Inside the garage, (10) accessible parking spaces are provided; all accessible spaces are located on Levels 1-3 of the southern half of the garage structure. No accessible parking spaces were noted at Level 4 and the Roof Level. The garage has 401 spaces. Per ADA Table 208.2 this number of spaces requires 9 ADA accessible spaces, for every 6 or fraction of 6 ADA spaces at least one shall be accessible Van Parking. Therefore the required number of spaces to meet ADA requirements is (7 Accessible parking spaces + 2 Van Spaces = 9 spaces).

In general, Accessible parking spaces themselves are of adequate size but do not include adjacent clear space for wheelchair loading and unloading. Signage and/or painting depicting the universal symbol of accessibility are provided. A 36" wide travel lane is provided at the east and west sides of the southern half of the garage structure, identified with painted stripes.

At stairwells, access is poor in places due to damaged, cracked, and loose concrete at door approaches. Door hardware is in poor repair, requiring greater than allowable effort to operate doors.

5.19 Miscellaneous Housekeeping:

Several areas in the garage were identified during our field investigation that are not directly related to the overall facility integrity and performance. These were observed to be areas of litter and debris collection that detrimentally impact the air quality, aesthetics, and user experience of the garage.

MI-1	Issue:	Debris in Maintenance Storage Area Holding Moisture (Lower Tier).
	Cause:	Stockpiling of materials including parking garage records
	Effect/Consequence:	Degradation of air quality, potential for mold growth, and general aesthetics
	Repair Recommendation:	Remove all unnecessary items from the storage area. All necessary items should be maintained in a dry environment preferably off of the concrete.
	Repair Timeframe:	**Short Term**

MI-2	Issue:	Debris and Garbage Collection between Spandrel Walls and Garage Fascia on Ground Levels.
	Cause:	Littering from pedestrians.
	Effect/Consequence:	Same as MI-1
	Repair Recommendation:	Clean debris. Consider capping or sealing the gaps that are harder to clean on a periodic period such as at Beam line 10 between D and F on the first level.
	Repair Timeframe:	**Short Term**

5.20 General Recommended Improvements

In addition to the necessary repairs and preventative maintenance proposed in this report there are several features that could be added which would greatly benefit the overall function and appearance of the garage. They are as follows:

- **Additional Security Cameras:** Security at Parking Facilities could benefit from additional cameras in stair towers, general floor level locations, and operational cameras in elevators.

- **Public Address System:** Public Address (PA) systems provide an opportunity for mass notification throughout the facility in the event of an emergency.

- **Electric Vehicle (EV) Charging Stations**: During the course of this study BED has installed a Level 3 (fast charging) Chargepoint charging system. This is a charge card based system allowing for charging activation based upon a swiped credit or debit card. KEA does not know the details of the business model used for this new convenience. KEA recommends that additional charging stations be planned for when doing any electrical system upgrades. This added customer convenience could be set up as a free service as a loss leader for incentivizing vehicles to the downtown area, or as a charged service for revenue enhancement.

- **Solar PV Panel Installation**: Though this garage could greatly benefit from the significant power generation of a rooftop PV system, the remaining projected lifespan of the structure and level of necessary short term investment does not warrant the installation of PV Panels at this time. Future city garage structures should consider these benefits during their design.

- **WiFi or WiMax**: With the already installed data network, the parking garage already has internet access capabilities to deploy a Wifi or WiMax internet access point(s) for the facility. Again, this could be used as a customer draw to the downtown area. Arrangements could be made with several downtown merchants to creatively deliver special sales or coupon offers via this service platform to further entice users to the garage(s). Similar to the EV charging stations, this system could be used as a free amenity to patrons or possibly used as a revenue stream with area merchants who return a negotiated fee for every customer that makes store purchases as a result of using this parking garage service.

- **Replace Elevator**: According to DPW staff and elevator subcontractor the elevators in this facility should be replaced within the next 5 to 10 years. Though not part of this study we have accounted for elevator costs (see EV-1 below and maintenance budget estimate).

EV-1	Issue:	Elevator Replacement
	Cause:	Age
	Effect/Consequence:	Elevator Function
	Repair Recommendation:	Replace Elevators
	Repair Timeframe:	**Mid Term**

- **Replace Attendant Booths:** Per DPW staff, attendant booths have poor heating and ventilation as well as wiring and general condition issues and are in need of replacement.

BO-1	Issue:	Attendant Booth Replacement
	Cause:	Age
	Effect/Consequence:	Poor quality for attendant staff
	Repair Recommendation:	Replace Attendant Booths
	Repair Timeframe:	**Mid Term**

- **Windows in Stairs:** This has been a general public request in the past.

- **Incorporate Storefront Space on Street Level:** This may only be possible on South Winooski. The floor is ramped to the Lower Level along Bank Street

- **Promote Proper Public Space Usage:** The garage has seen past issues with improper public space usage. Consider deterrents in future design / repair projects.

5.21 Maintenance:

Parking garages require more housekeeping and preventative maintenance than most structures. Owners can see significant long term savings by following best practices for routine garage upkeep. The Precast Concrete Institute (PCI) provides a detailed Maintenance Manual for Precast Parking Structures that includes recommendations for daily, weekly, monthly, quarterly, semi-annually, annually, and as required housekeeping, preventative maintenance, and inspection schedules. Although this parking garage is comprised of cast-in-place elements, the recommended maintenance is not specific to precast concrete structures. Reference Appendix D for excerpts from this manual: Table A – Housekeeping Schedule, and Table B – Preventative Maintenance Schedule. Capital planning efforts should account for these routine activities.

Due to the amount of debris currently in the Marketplace garage we have included several maintenance activities in the Short Term repairs. These items are beyond standard housekeeping costs and should be coordinated with repair projects.

MA-1	Issue:	Concrete cleanliness
	Cause:	Salts and chemical buildup tracked in from vehicular traffic
	Effect/Consequence:	Potential corrosion of reinforcing and damage to concrete members
	Repair Recommendation:	Complete a large scale pressure wash of entire garage both surface level and underside of floors and framing members.
	Repair Timeframe:	**Short Term**

Preventative Maintenance: Many Components of the garage require frequent cleaning, repair, and replacement. Elements such as paint, joint sealants, waterproofing membranes, roofing membranes, and concrete sealer degrade over time and have a dependable life expectancy as supplied by the manufacturer and industry standards. We have calculated for a garage of this size and type the City should appropriate an annual **Preventative Maintenance and Housekeeping Budget of $100,000 to $110,000**. This accounts for work to be completed each year as well as routine repair/replacement items. A breakdown of this estimate has been provided in Appendix A of this report.

6 SUMMARY

The Marketplace Garage is in generally fair condition, however many elements are in poor condition. Many structural repairs need to be made in the near future, as they represent a public safety or structural integrity hazard. In order to assist with completing the most pressing projects and developing funding for future projects we have summarized the above described issues into the following prioritization matrix (in order of highest priority to lowest):

Report Designation	Description	Cost	Recommended Timeframe
JS-3	Remove Grout Patch on Underside of Construction Joint at Level 1 D-E Ramp at Beam Line 4.	$1,411	**IMMEDIATE**
CIP-3	Patch Concrete Spalls With Exposed Reinforcing Steel	$7,920	
CIP-4	Cover and Patch Junction Box Spalls at Cross Overs	$6,600	
EJ-1	Replace Expansion Joint at Cross Over (Column Line C9-D) (all levels)	$49,005	**Short Term**
EJ-2	Replace Expansion Joint at Transition Between SOG and Elevated Slabs	$28,512	
ST-1	Reattach Stair Treads (all). Replace damaged treads in kind	$37,125	
PC-2	Replace Spandrel Beams at North Stair Tower	$49,500	
JS-1	Replace Joint Sealant at Level 4 and 5	$5,643	
JS-2	Replace Joint Sealant at Levels 1-3	$6,237	
EJ-3	Replace Expansion Joints at Stair	$29,700	

Report Designation	Description	Cost	Recommended Timeframe
	Tower Ramps		
CIP-2	Repair Surface Cracks at Entrances	$9,900	
CIP-5	Resurface Level 1 D-E Ramp, Level 1-2 Cross Over and Level 2 E-F Ramp	$1,584,000	
CIP-7	Repair Longitudinal and Transverse Cracking of Elevated Slabs.	$17,325	
CB-1	Repair Concrete Beams with Delaminated Concrete, Reinforcing Steel Corrosion.	$10,692	
CB-2	Repair Concrete Beams with Longitudinal Cracking	$8,910	
CB-3	Repair Concrete Beams with Concrete Spalls and Reinforcing Steel Corrosion at the End of the Beam	$6,237	
CB-4	Repair Concrete Beams with Concrete Delamination and Reinforcing Steel Corrosion Along Length of the Beam	$17,820	
PC-1	Repair Cracking in Precast Spandrel Beams	$33,000	
CC-1	Repair Column Spalls at Interface of Slab and Column on Interior (Slab Side) of Spandrel Beam	$17,325	
CIP-6	Repair Remaining Ramp Spalls (See CS-5)	$49,500	
CIP-8	Repair Concrete Spall and Exposed Post Tensioning Tendon at Bottom Face of Slab At Grid B-7, B-9 on the Second Level	$6,600	
MA-1	Pressure Wash Garage	$148,500	
SD-1	Flush Plugged Drains	$8,250	
SD-2	Replace Trench Drain	$8,250	
SD-3	Repipe Roof Drain at Stair Tower B (Level 4).	$4,125	
DS-1	Replace Lengths of Failed Drainage Pipe	$15,015	
ST-3	Repair Cracks on Stair Treads and Landings	$49,500	
ST-2	Repair Stair Tower Ramp Bearings at Garage Structure	$16,500	
ST-4	Install Guardrail at Stair 4	$4,950	
ST-5	Replace Stair Rails with Code Compliant Handrail/Guardrail (at Stairs and on Ramps)	$6,600	
ED-1	Replace sub-panels, conduit, and	$247,500	

Report Designation	Description	Cost	Recommended Timeframe
	wiring where water damaged		
ELS-1	Upgrade Fire Alarm System	$198,000	
ELS-2	Add Exit Signage	$16,500	
MS-1	Reconnect Steel Pipe Rails at Stair Tower Ramps	$8,250	
MS-2	Retension/Replace/Install Cable Guardrail	$20,790	
MI-1	Remove Debris in Maintenance Storage Area Holding Moisture (Lower Tier).	$8,250	
MI-2	Remove Debris and Garbage Collection between Spandrel Walls and Garage Fascia on Ground Levels.	$8,250	
CC-2	Repair Exposed Reinforcing Steel in Concrete Columns	$1,980	Mid Term
CC-3	Repair Column Spalls at Construction Joint on Exterior Side of PT Beam	$6,930	
CC-4	Repair Cracking at Top of Columns	$8,044	
DS-2	Replace Elbow Joints Below Surface Drains	$7,920	
EV-1	Replace Elevators	$627,000	
BO-1	Replace Attendant Booths	$66,000	
EL-1	Replace Lighting Fixtures	$123,750	
ES-1	Electrical Service Panel	$123,750	
FA-1	Reattach Brick Façade	$33,000	
FA-2	Repoint CMU and Brick Mortar Joints	$49,500	
CIP-1a	Repair Slab-On-Grade Surface Cracks (Unsealed Cracks)	$990	
CIP-1b	Repair Slab-On-Grade Surface Cracks (Sealed Cracks)	$2,475	Long Term
ME-1	Install new Fan Unit at Lower Level	$82,500	

- Note: Individual costs shown above account for Project Management and Engineering Fees

Completing repairs in this garage will require significant coordination with the Church Street Marketplace and downtown businesses. Although traffic counts were not part of the scope for this report, the Marketplace garage sees heavy daily traffic and near continuous turnover due to its central downtown proximity. The garage's unique layout and multiple entrances allows for traffic control or staged construction options. Further discussion is necessary with DPW and invested stakeholders to determine the optimum construction operation hours for repair work and long term routine maintenance work at this garage.

The budget estimates for repair work have assumed staged efforts to maintain garage access. Each unit price includes an additional 20% to account for Traffic Control and added Mobilization costs.

Engineering, Resident Engineering, and Project Management fees have been estimated for each group of repairs based on a percentage of the total construction costs. These fees are for budgetary purposes and may be higher or lower depending on the grouping of repairs to be completed.

As stated earlier in this report, housekeeping and preventative maintenance need to occur at their recommended schedule (reference Appendix D), coordinated but independent of repair schedules. It is likely that there are structural issues which haven't presented yet. Routine inspections should be completed by parking garage staff, with bi-annual structural inspections by a professional engineer.

APPENDIX A

Budgetary Estimates

Hoyle, Tanner & Associates, Inc.

Calc. By:	JCR	Date:	7/1/2014
Chck. By:	JAO	Date:	7/10/2014
Chck. By:		Date:	
Chck. By:		Date:	

Marketplace Parking Garage Assessment
Budgetary Estimate of Probable Repair/Replacement Costs
Hoyle, Tanner Project No. 909040

		Quantity		Cost	
		Unit	Amount	Unit Price	Total
IMMEDIATE Recommendations					
JS-3	Removal of Delaminated Grout Patch Below Construction Joint at Level 1 D-E Ramp at Beam Line 4	LF	57	$15.00	$ 855.00
CIP-3	Temporary Patch Concrete Spalls With Exposed Reinforcing Steel	SF	120	$40.00	$ 4,800.00
CIP-4	Cover and Patch Junction Box Spalls at Cross Overs	SF	40	$100.00	$ 4,000.00

CONSTRUCTION SUBTOTAL	**$9,655.00**
20% CONSTRUCTION CONTINGENCY	**$1,931.00**
ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$1,931.00**
RESIDENT ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$1,931.00**
PROJECT MANAGEMENT COSTS (5% OF CONSTRUCTION, INTERNAL TO CITY)	**$482.75**
TOTAL COST =	**$16,000**

This Engineers Estimate of Probable Construction Costs is based on the anticipated scope of work, as well as Hoyle, Tanner's experience with similar projects and understanding of current industry trends. It should be noted that changes in material or labor costs in the construction industry could impact the project cost in either direction.

PROJECTED COSTS (ESTIMATED INFLATION AT 3%)	2015	2016	2017	2018
	$16,000	$16,480	$16,980	$17,490

Hoyle, Tanner & Associates, Inc.

Calc. By:	JCR	Date:	7/1/2014
Chck. By:	JAO	Date:	7/10/2014
Chck. By:		Date:	
Chck. By:		Date:	

Marketplace Parking Garage Assessment
Budgetary Estimate of Probable Repair/Replacement Costs
Hoyle, Tanner Project No. 909040

		Quantity		Cost	
		Unit	Amount	Unit Price	Total
Short-Term Recommendations					
EJ-1	Replace Expansion Joint (Column Line C9-D, All Levels)	LF	165	$180.00	$ 29,700.00
EJ-2	Replace Expansion Joint at Transition Between Slab-On-Grade and Elevated Slabs	LF	96	$180.00	$ 17,280.00
EJ-3	Replace Expansion Joint at Stair Tower Ramps (all levels)	LF	100	$180.00	$ 18,000.00
JS-1	Replace Joint Sealant at Level 4 and 5	LF	285	$12.00	$ 3,420.00
JS-2	Replace Joint Sealant at Levels 1-3	LF	315	$12.00	$ 3,780.00
PC-1	Precast Spandrel Beam Crack Repair	LF	100	$200.00	$ 20,000.00
PC-2	Precast Spandrel Beam Replacement	EA	2	$15,000.00	$ 30,000.00
CIP-2	Repair Surface Cracks at Entrances	LF	200	$30.00	$ 6,000.00
CIP-5	Resurface Level 1 D-E Ramp, Level 1-2 Cross Over and Level 2 E-F Ramp	SF	16,000	$60.00	$ 960,000.00
CIP-6	Repair Ramp Spalls	SF	500	$60.00	$ 30,000.00
CIP-7	Repair Longitudinal and Transverse Cracking of Elevated Slabs	LF	700	$15.00	$ 10,500.00
CIP-8	Repair Concrete Spall and Exposed Post Tensioning Tendon at Bottom Face of Slab At Grid B-7, B-9 on the	LS	1	$4,000.00	$ 4,000.00
CB-1	Repair Delaminated Concrete, Reinforcing Steel Corrosion	SF	36	$180.00	$ 6,480.00
CB-2	Repair Longitudinal Crack at Midspan of the Beam	SF	18	$300.00	$ 5,400.00
CB-3	Repair Concrete Spalls and Reinforcing Steel Corrosion at the End of the Beam	SF	21	$180.00	$ 3,780.00
CB-4	Repair Concrete Delamination and Reinforcing Steel Corrosion Along Length of the Beam	SF	60	$180.00	$ 10,800.00
CC-1	Repair Column Spalls at Interface of Slab and Column on Interior (Slab Side) of Spandrel Beam	EA	15	$700.00	$ 10,500.00
MS-1	Reconnect Steel Pipe Rails	EA	10	$500.00	$ 5,000.00
MS-2	Replace Cable Guardrails	LF	840	$15.00	$ 12,600.00
ED-1	Replace Subpanels, Conduit and Wiring	LS	1	$150,000.00	$ 150,000.00
ELS-1	Install Missing Fire Alarm System Components	LS	1	$120,000.00	$ 120,000.00
ELS-2	Add Exit Signage	LS	1	$10,000.00	$ 10,000.00
SD-1	Clean out Plugged Drains	LS	1	$5,000.00	$ 5,000.00
SD-2	Replace Trench Drain	LS	1	$5,000.00	$ 5,000.00
SD-3	Repipe Roof Drain at Stair Tower B (Level 4)	LF	50	$50.00	$ 2,500.00
DS-1	Replace Lengths of Failed Drainage Pipe	LF	130	$70.00	$ 9,100.00
ST-1	Replace/Reattach Stair Treads	EA	300	$75.00	$ 22,500.00
ST-2	Repair Stair Tower Ramp Bearings	LF	100	$100.00	$ 10,000.00
ST-3	Repair Stair Tread Cracks	LF	150	$200.00	$ 30,000.00
ST-4	Install Missing Guardrail at Stair Run	EA	1	$3,000.00	$ 3,000.00
ST-5	Replace Rails with Code Compliant System	LS	1	$4,000.00	$ 4,000.00
MI-1	Remove Debris in Maintenance Storage Area Holding Moisture (Lower Tier)	LS	1	$5,000.00	$ 5,000.00
MI-2	Remove Debris and Garbage Collection between Spandrel Walls and Garage Fascia on Ground Levels.	LS	1	$5,000.00	$ 5,000.00
MA-1	Pressure Wash Garage	LS	1	$90,000.00	$ 90,000.00

CONSTRUCTION SUBTOTAL	**$1,658,340.00**
20% CONSTRUCTION CONTINGENCY	**$331,668.00**
ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$331,668.00**
RESIDENT ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$331,668.00**
PROJECT MANAGEMENT COSTS (5% OF CONSTRUCTION, INTERNAL TO CITY)	**$82,917.00**
TOTAL COST =	**$2,736,300**

PROJECTED COSTS (ESTIMATED INFLATION AT 3%)	2015	2016	2017	2018
	$2,736,300	$2,818,390	$2,902,950	$2,990,040

Hoyle, Tanner & Associates, Inc.

Calc. By:	JCR	Date:	7/1/2014
Chck. By:	JAO	Date:	7/10/2014
Chck. By:		Date:	
Chck. By:		Date:	

Marketplace Parking Garage Assessment
Budgetary Estimate of Probable Repair/Replacement Costs
Hoyle, Tanner Project No. 909040

		Quantity		Cost	
		Unit	Amount	Unit Price	Total
Mid-Term Recommendations					
CIP-1a	Repair Slab-On-Grade Surface Cracks (Unsealed Cracks)	LF	40	$15.00	$ 600.00
CC-2	Repair Exposed Reinforcing Steel in Concrete Columns	SF	40	$30.00	$ 1,200.00
CC-3	Repair Column Spalls at Construction Joint on Exterior Side of PT Beam	EA	6	$700.00	$ 4,200.00
CC-4	Repair Surface Cracking at Top of Columns	EA	15	$325.00	$ 4,875.00
ES-1	Replace Service Distribution and Sub-panels and Emergency Power System	LS	1	$75,000.00	$ 75,000.00
EL-1	Replace Roof Level and Stairwell Light Fixtures	LS	1	$75,000.00	$ 75,000.00
FA-1	Remove and Reset Brick Façade	SF	400	$50.00	$ 20,000.00
FA-2	Repoint Damaged CMU and Brick Mortar Joints	LS	1	$30,000.00	$ 30,000.00
DS-2	Replace Elbow Joints Below Surface Drains	EA	24	$200.00	$ 4,800.00
EV-1	Replace Elevators	EA	2	$190,000.00	$ 380,000.00
BO-1	Replace Attendant Booths	EA	2	$20,000.00	$ 40,000.00

CONSTRUCTION SUBTOTAL	**$635,675.00**
20% CONSTRUCTION CONTINGENCY	**$127,135.00**
ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$127,135.00**
RESIDENT ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$127,135.00**
PROJECT MANAGEMENT COSTS (5% OF CONSTRUCTION, INTERNAL TO CITY)	**$31,783.75**
TOTAL COST =	**$1,048,900**

PROJECTED COSTS (ESTIMATED INFLATION AT 3%)	2015	2016	2017	2018
	$1,048,900	$1,080,370	$1,112,790	$1,146,180

Hoyle, Tanner & Associates, Inc.

Calc. By:	JCR	Date:	7/1/2014
Chck. By:	JAO	Date:	7/10/2014
Chck. By:		Date:	
Chck. By:		Date:	

Marketplace Parking Garage Assessment
Budgetary Estimate of Probable Repair/Replacement Costs
Hoyle, Tanner Project No. 909040

		Quantity		Cost	
		Unit	Amount	Unit Price	Total
Long-Term Recommendations					
CIP-1b	Repair Slab-On-Grade Surface Cracks (Sealed Cracks)	LF	100	$15.00	$ 1,500.00
ME-1	Install New Fan Unit	EA	1	$50,000.00	$ 50,000.00

CONSTRUCTION SUBTOTAL	**$51,500.00**
20% CONSTRUCTION CONTINGENCY	**$10,300.00**
ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$10,300.00**
RESIDENT ENGINEERING COSTS (ESTIMATED AT 20% OF CONSTRUCTION)	**$10,300.00**
PROJECT MANAGEMENT COSTS (5% OF CONSTRUCTION, INTERNAL TO CITY)	**$2,575.00**
TOTAL COST =	**$85,000**

PROJECTED COSTS (ESTIMATED INFLATION AT 3%)	2015	2016	2017	2018
	$85,000	$87,550	$90,180	$92,890

Hoyle, Tanner & Associates, Inc.

Calc. By:	JAO	Date:	7/8/2014
Chck. By:		Date:	
Chck. By:		Date:	
Chck. By:		Date:	

Marketplace Parking Garage Assessment
Budgetary Estimate of Preventative Maintenance Costs
Hoyle, Tanner Project No. 909040

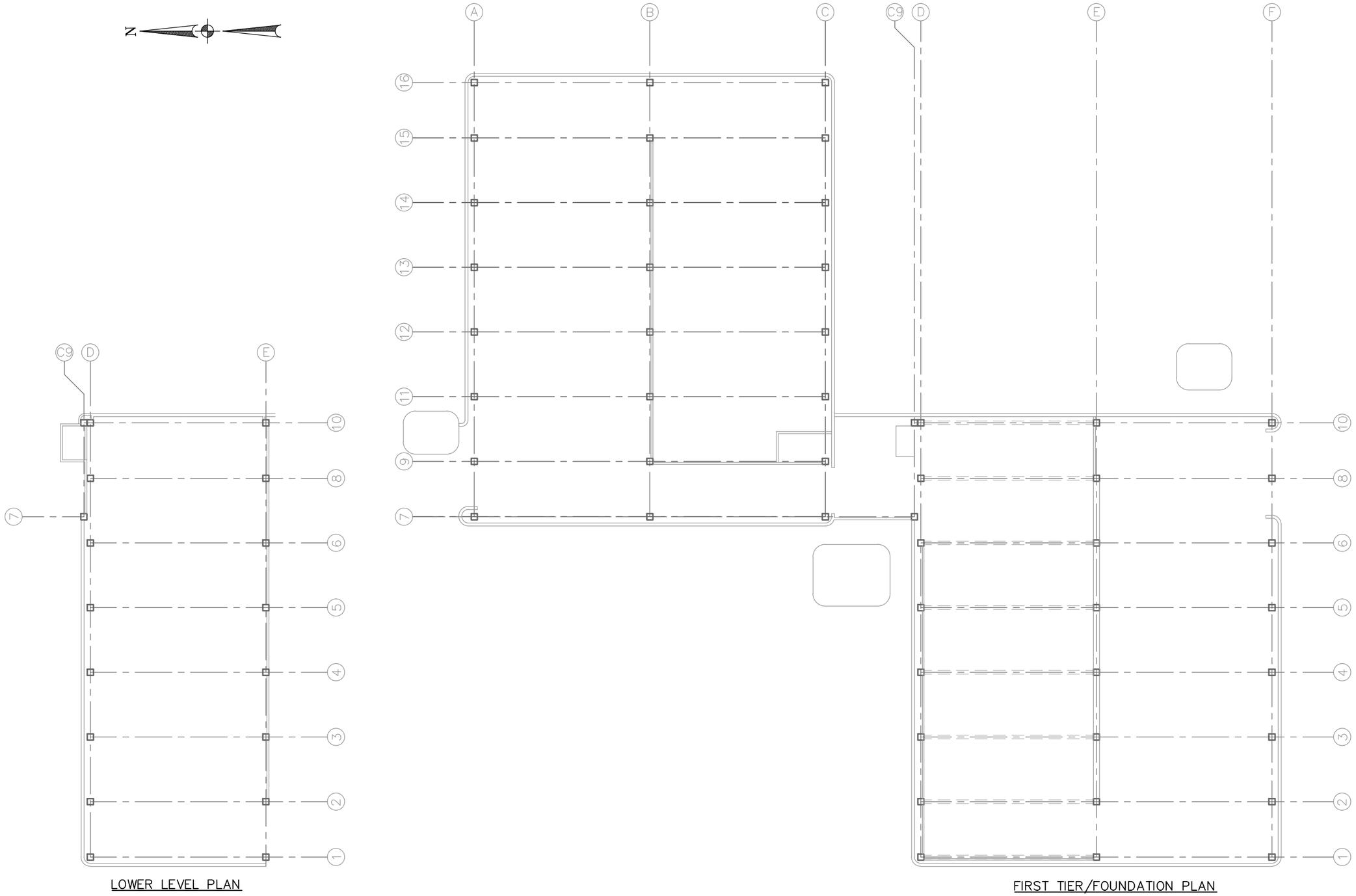
	Cost	Estimated Frequency	Adjusted Annual Frequency	Adjusted Annual Cost
Maintenance Cost				
Floor Washdowns	$10,000.00	twice/yr	2.00	$ 20,000.00
Silane Concrete Sealer	$145,200.00	every 5 yrs	0.20	$ 29,040.00
Paint Misc Steel	$10,000.00	every 5 yrs	0.20	$ 2,000.00
Striping & Markings	$19,200.00	every 2 yrs	0.50	$ 9,600.00
General Concrete Sealant Replacement	$5,000.00	every 10 yrs	0.10	$ 500.00
Expansion Joint Replacement	$65,000.00	every 10 yrs	0.10	$ 6,500.00
Roofing Membranes	$2,000.00	every 20 yrs	0.05	$ 100.00
HVAC Equipment Maintenance	n/a			
Annual Elevator Maintenance Contract Costs	$4,400.00	annual	1.00	$ 4,400.00
Elevator Repair Costs	$30,000.00	every 7 yrs	0.20	$ 6,000.00
Misc. Repairs	$5,000.00	annual	1.00	$ 5,000.00

CONSTRUCTION SUBTOTAL	**$83,140.00**
10% INFLATION COSTS	**$16,628.00**
TOTAL COST =	**$100,000**

Note: Budgeted Costs shown do not include standard operating costs which acount for staff salaries, utility costs, basic routine housekeeping, and general garage software systems and licenses. Nor do items shown above reflect all housekeeping and preventative maintenance efforts. The intent of this is to assit with budget planning and should be updated as routine maintenance costs are standardized for this garage.

APPENDIX B

Garage Plans



LOWER LEVEL PLAN

FIRST TIER/FOUNDATION PLAN

ENGINEER

REV.	DESCRIPTION	DRW BY	CHKD BY	DATE

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MAY 2014

DESIGN BY: JAO

DRAWN BY: AAS

CHKD. BY: JAO

SCALE: AS SHOWN

Hoyle, Tanner & Associates, Inc.
125 College St, Burlington VT 05401
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Webpage: www.hoyletanner.com

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CITY OF BURLINGTON
BURLINGTON, VERMONT

MARKETPLACE PARKING GARAGE

LEVEL 1 PLAN

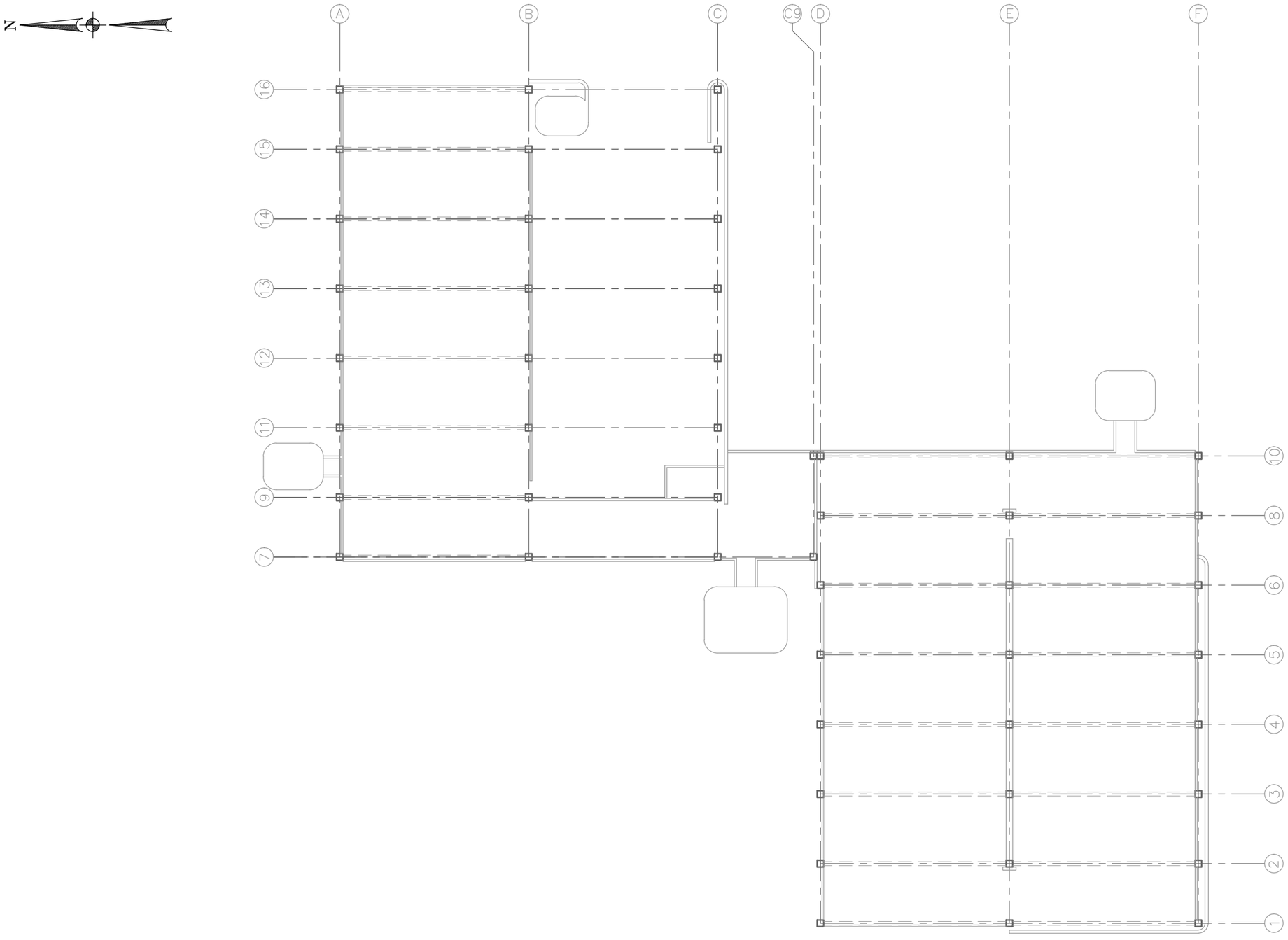
PROJECT NO.: 909040

FILE NAME: PLAN LAYOUT

SHEET NO.

I-1

SHEET 1 OF 5



SECOND TIER/FRAMING PLAN

ENGINEER

REV.	DESCRIPTION	DRW BY	CHKD BY	DATE

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MAY 2014

DESIGN BY: JAO

DRAWN BY: AAS

CHKD. BY: JAO

SCALE: AS SHOWN

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CITY OF BURLINGTON
BURLINGTON, VERMONT

MARKETPLACE PARKING GARAGE

LEVEL 2 PLAN

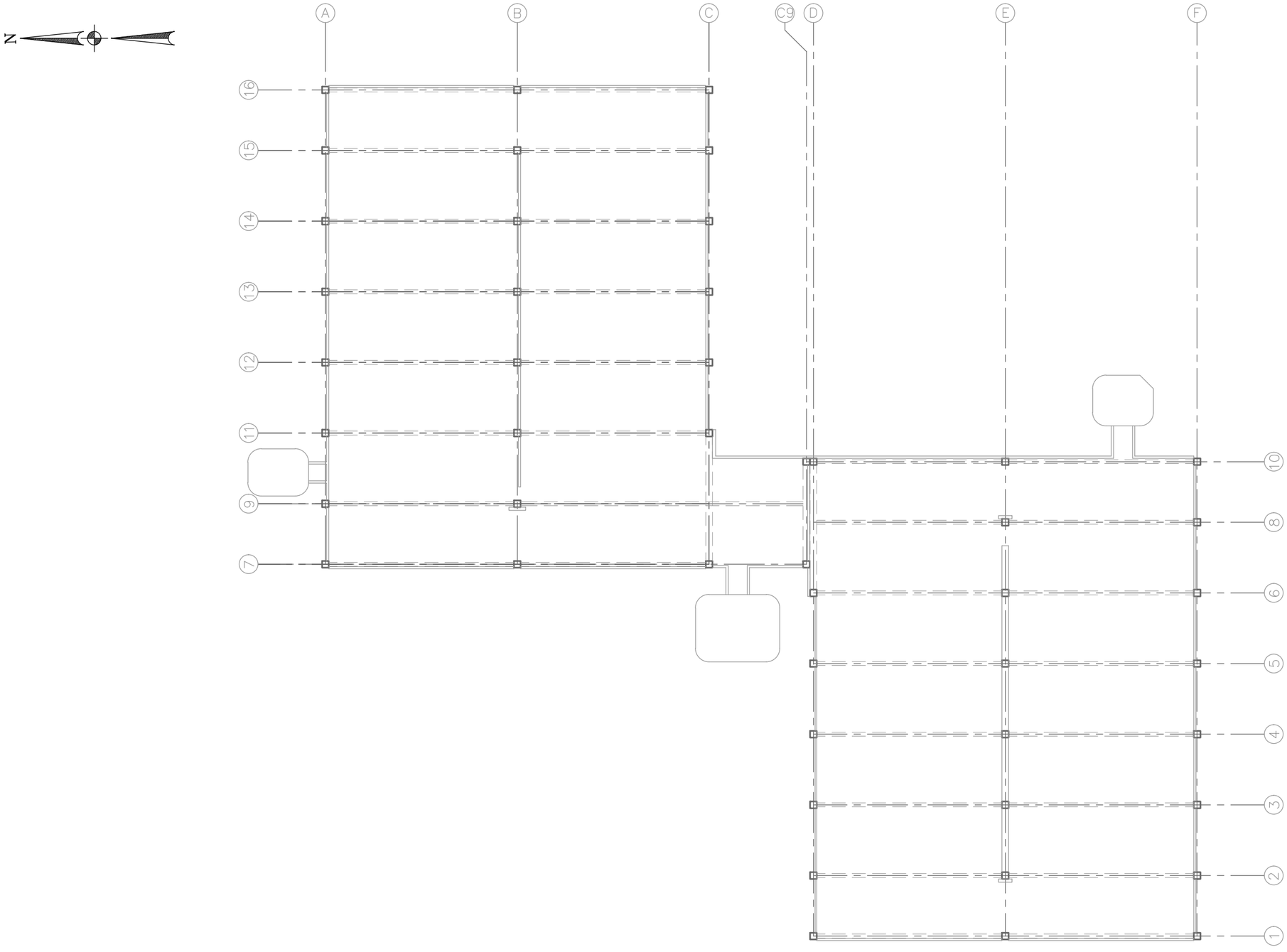
PROJECT NO.: 909040

FILE NAME: PLAN LAYOUT

SHEET NO.

I-2

SHEET 2 OF 5



THIRD TIER FRAMING PLAN

ENGINEER

REV.	DESCRIPTION	DRW BY	CHKD BY	DATE

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MAY 2014

DESIGN BY: JAO

DRAWN BY: AAS

CHKD. BY: JAO

SCALE: AS SHOWN

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CITY OF BURLINGTON
BURLINGTON, VERMONT

MARKETPLACE PARKING GARAGE

LEVEL 3 PLAN

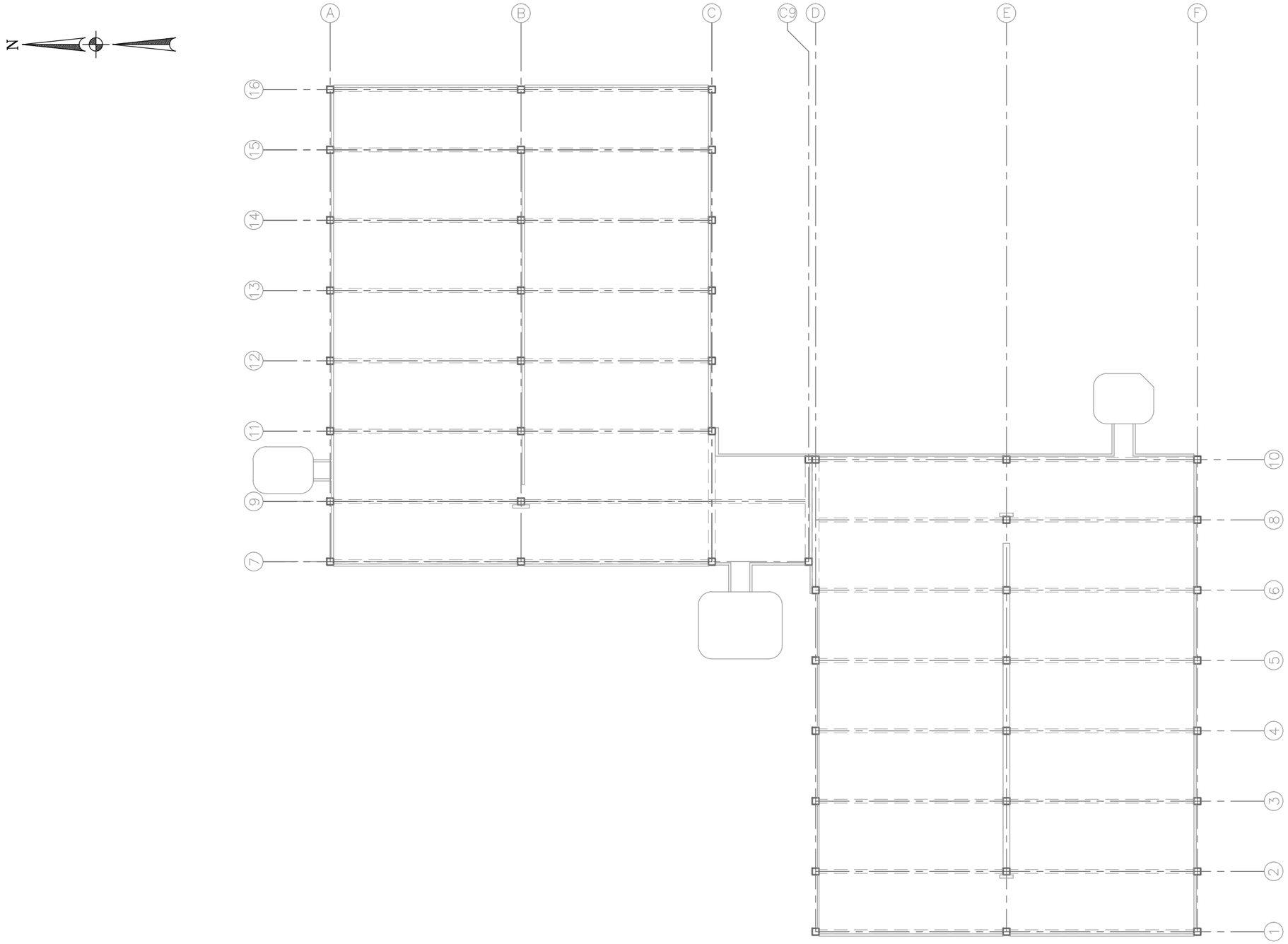
PROJECT NO.: 909040

FILE NAME: PLAN LAYOUT

SHEET NO.

I-3

SHEET 3 OF 5



FOURTH TIER FRAMING PLAN

ENGINEER

REV.	DESCRIPTION	DRW BY	CHKD BY	DATE

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MAY 2014

DESIGN BY: JAO

DRAWN BY: AAS

CHKD. BY: JAO

SCALE: AS SHOWN

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CITY OF BURLINGTON
BURLINGTON, VERMONT

MARKETPLACE PARKING GARAGE

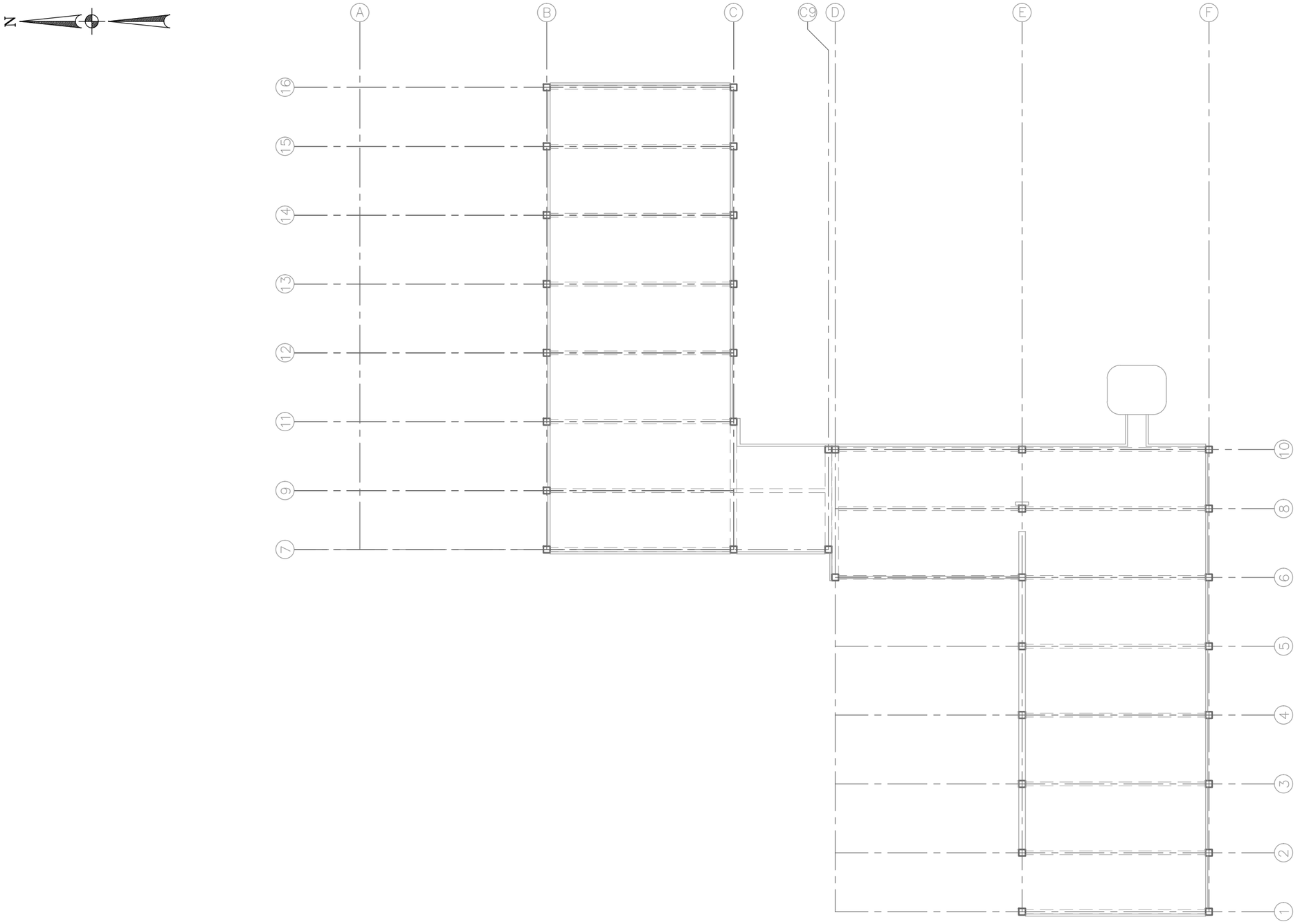
LEVEL 4 PLAN

PROJECT NO.: 909040

FILE NAME: PLAN LAYOUT

SHEET NO.

I-4



TOP TIER FRAMING PLAN

ENGINEER

REV.	DESCRIPTION	DRW. BY	CHKD. BY	DATE

MAY 2014

DESIGN BY: JAO

DRAWN BY: AAS

CHKD. BY: JAO

SCALE: AS SHOWN

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CITY OF BURLINGTON
BURLINGTON, VERMONT

MARKETPLACE PARKING GARAGE

LEVEL 5 PLAN

PROJECT NO.: 909040

FILE NAME: PLAN LAYOUT

SHEET NO.

I-5

SHEET 5 OF 5

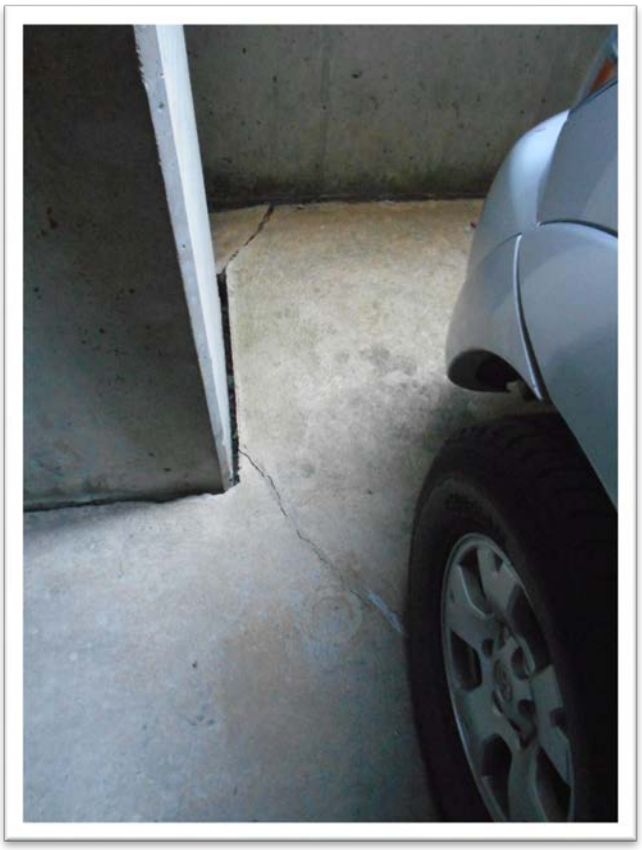
APPENDIX C

Photograph Log

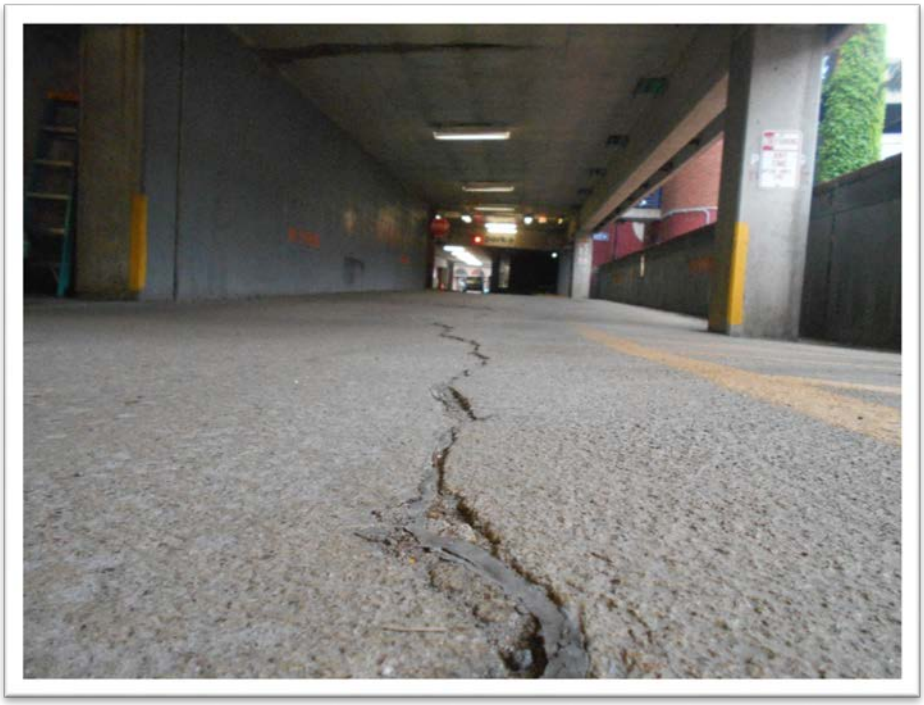
JS-2: Construction Joint Sealant Failure

EJ-1: Expansion Joint Failure at Level 5

EJ-2: Expansion Joint Failure at Transition to Elevated Slab



CIP-1: Slab on Grade Cracks



CIP-2: Surface Cracks at Cherry Street Entrance

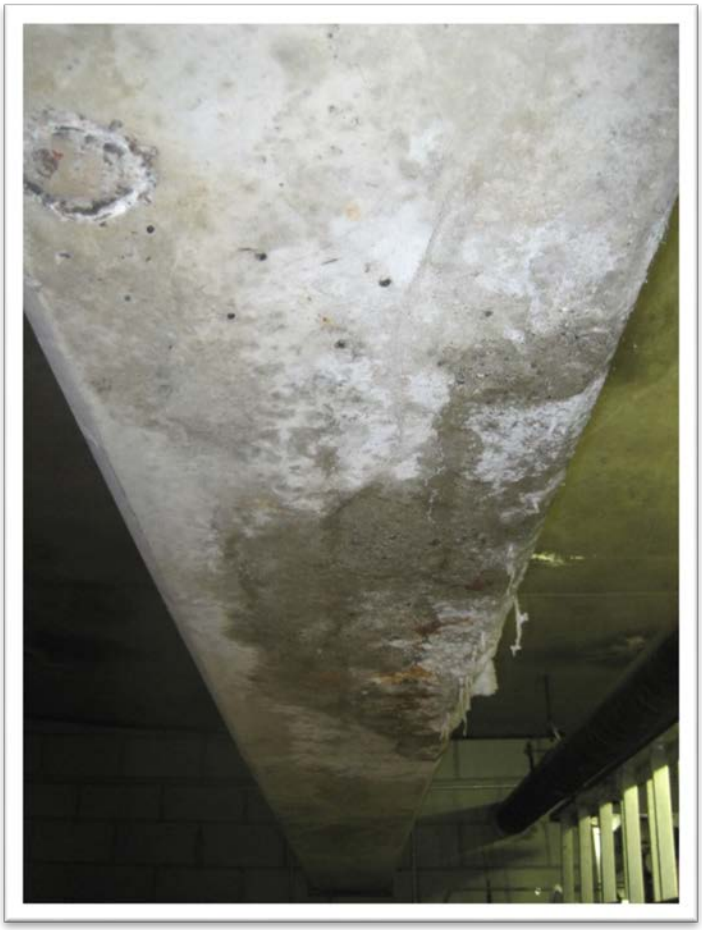
CIP-3: Concrete Spall with Exposed Rebar (Level 1, D_E Ramp)

CIP-3: Level 1 D-E Ramp Spalls and Patching

CIP-5: Typical Elevated Ramp Spalls over Beam Line

CIP-7: Cracking at 4th Level at Column Line B

CIP-8: Exposed Post Tensioning Strand



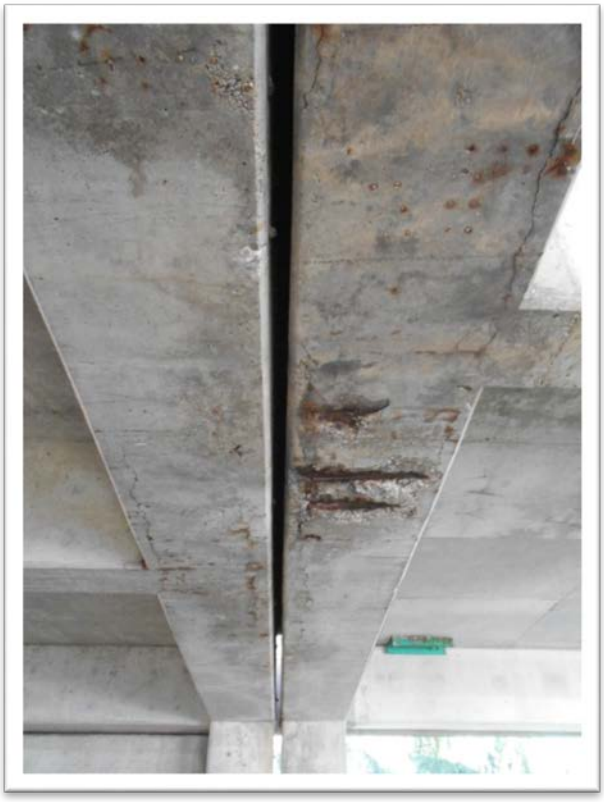
CB-1: Level 1 Beam E-F 8

CB-1a: Level 1 Beam E-F 8

CB-2: Longitudinal Crack in Level 2 Beam E-F 10

CB-3: Concrete Spall and Reinforcing Steel Corrosion at End of Beam (2nd Level Beam at A-9)

CB-4a: Concrete Spalls and Corrosion at 5th Floor Expansion Joint



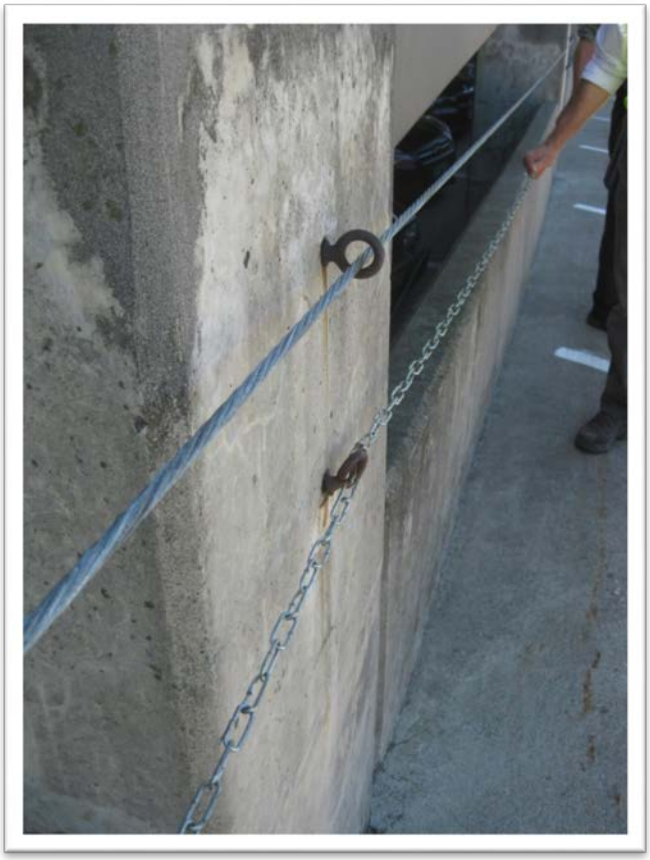
CB-4b: Concrete Spalls and Corrosion at 5th Floor Expansion Joint

CC-1: Typical Column Spall at Slab Interface

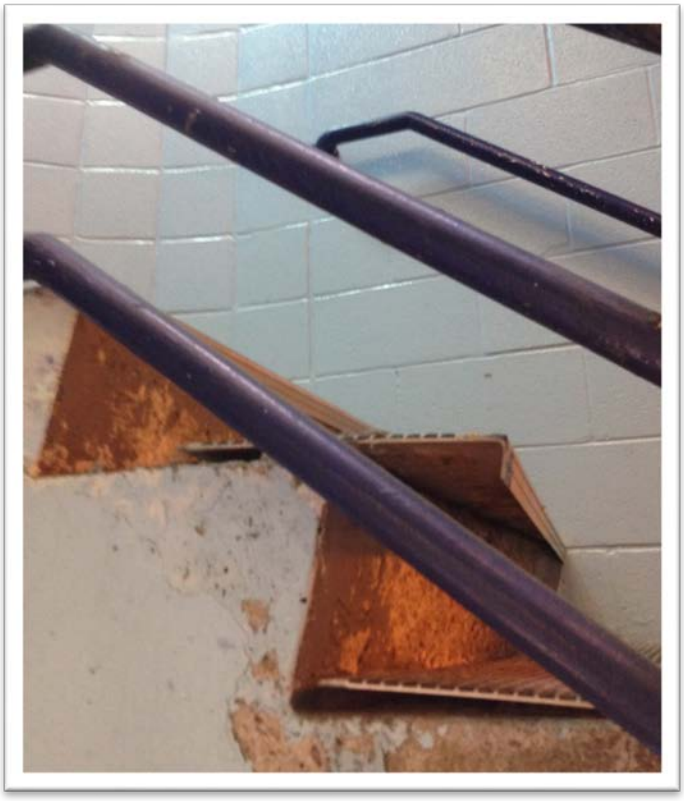
CC-2: Exposed Reinforcing Steel (3rd Level Column C-16)

CC-3: Concrete Spalls at Construction Joint (2nd Level Column E-4)

CC-4: Typical Top of Column Cracking

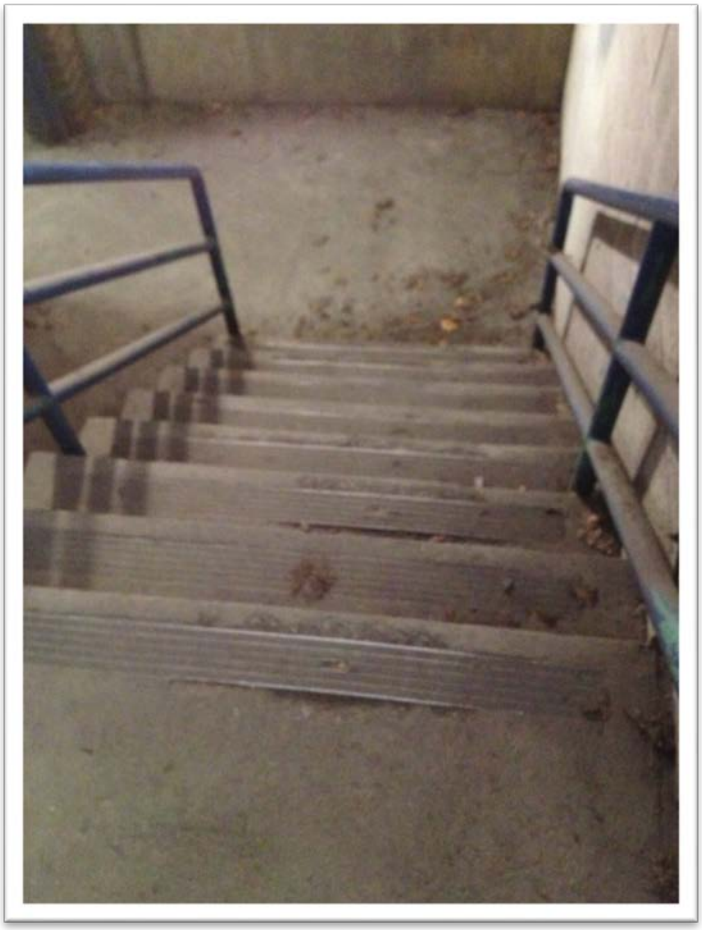


MS-2: Roof to Level 4 Chain Guardrail at North Structure Broken



ST-1: All stairwells (Particularly Stair “A”) – Loose Treads

ST-4: No Guardrail on Stair “D”



ST-5: Spacing between horizontal bars in guardrails

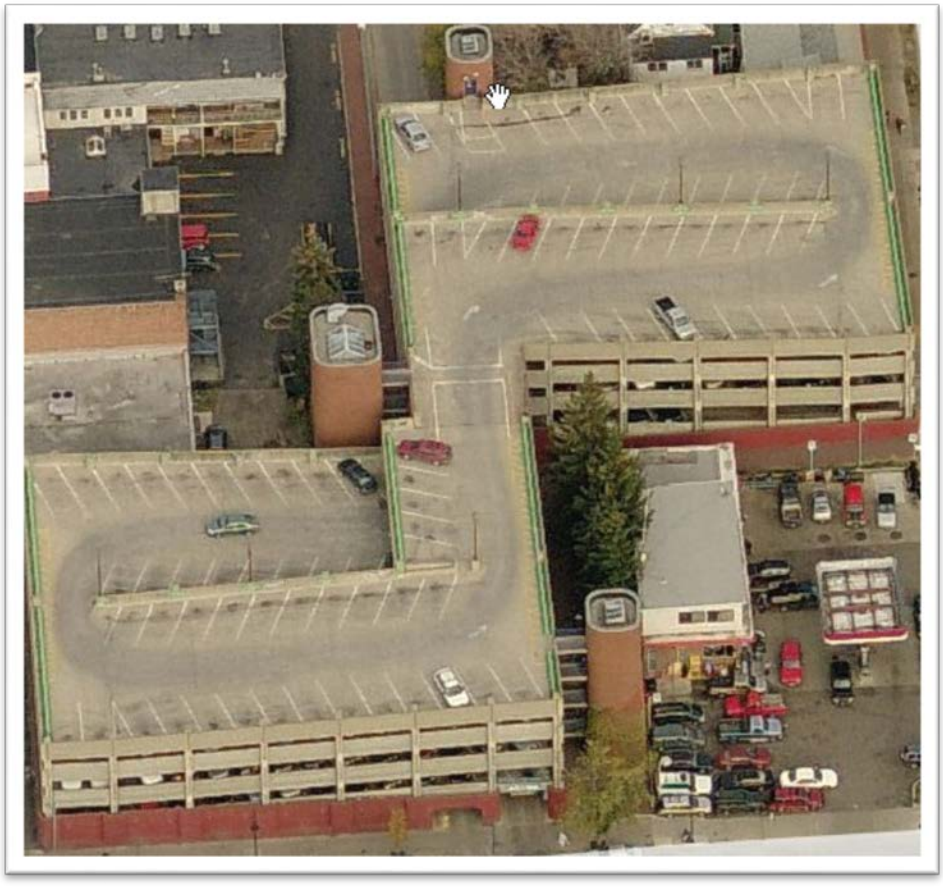
SD-1: Typical Plugged Floor Drain

SD-2: Trench Drain at Cherry Street Entrance

SD-3: Broken Drain Pipe at Cherry Street (Stair Tower A) 4th Level

DS-1: Typical Failed Drain Pipe

DS-1a & DS-2: Drain Pipe Failure with Elbow Corrosion



RM- 1: Exceeds Expected Life Span of Room System.

APPENDIX D

Excerpts from PCI Parking Garage Maintenance Manual

TABLE A Housekeeping Schedule	Daily		Weekly		Monthly		Quarterly		Semi Annually		Annually		As Required		Other
Sweeping															
Localized	*														
Overall			*												
Trash Pickup	*														
Control Joint Cleaning									*						
Expansion Joint Cleaning			*												
Elevator Cleaning	*														
Elevator Maintenance											*				
Window Cleaning									*						
Stain Cleaning			*												
Parking Space Restriping					O								*		
Remove Oil Stains	O												*		
Relamping	O		*												
Check Light Fixtures and Exposed Conduit and Repair					O								*		
Light Fixture Cleaning											*				
Floor Drain Cleaning			O						*						
Lavatory, Office, Waiting Room, Janitorial Service, Cashier Booths	*														
Graffiti Removal			*												
Graphics Cleaning											*				
Graphics Repair & Maintenance															
Non-Illuminated							O						*		
Illuminated	O												*		
Parking Equipment Maintenance	O												*		
Security System Check	*														
Landscaping			*												
Doors & Hardware	*														
Ventilation	O														
Snow Removal	*												*		
Ice Removal	O												*		
Safety checks	O												*		
Carbon Monoxide Monitor	O												*		(3)
Exit Lights	O												*		
Emergency Lights	O												*		
Tripping Hazards	O												*		
Handrails & Guardrails			O										*		
Control Joint Cleaning									*						

O = Inspect
* = Perform Operation

EXCERPT FROM PCI MAINTENANCE MANUAL FOR PRECAST PARKING STRUCTURES

TABLE B Preventive Maintenance Schedule Inspect and Repair as Necessary	Daily		Weekly		Monthly		Quarterly		Semi Annually		Annually		As Required		Other
Floor Washdowns									*						(1)
Floor Potholes & Cracking			O						*						
Scaling			O						*						
Expansion Joints									*						
Joint Sealants											*				
Bearing Pads											O		*		
Rust (Exposed Steel)							O				*				
Repaint					O								*		
Drain Water Systems for Winter											O				
Floor Surface Sealer															(2)
Stair Repair	O												*		
Plumbing			O								*				
HVAC Equipment					O								*		(3)
Fire Protection Systems					O								*		
Floor Drains			O						*						
Check Sanitary Facilities Operation	*														
Roofing & Flashing					O						*				
Floor Membranes					O								*		
Check for Water Leakage			O												
Check for Rusting Concrete Reinforcement			O												
Inspect Mortar Joints and Repair											O		*		
Inspect and Repair Concrete Cracks									O				*		

O = Inspect
* = Perform Operation

Notes:
(1) Minimum twice, per year (spring and fall) in snow or coastal regions, otherwise minimum once per year.
(2) Surface sealer (three to five years), Penetrating sealer (seven to ten years more often in abrasive areas).
(3) Daily enclosed garage (warning to management office recommended).
(4) For additional notes, see text.
(5) Tables utilize information in part from the National Parking Association Consultants Council "Parking Garage Maintenance Manual."

EXCERPT FROM PCI MAINTENANCE MANUAL FOR PRECAST PARKING STRUCTURES

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