# City of Guelph

## Structural Audit for
## Victoria Road Recreation Centre
## 151 Victoria Road North
## Guelph, Ontario

**Structural Audit Report**

**Project Number**
11099

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**Date Submitted**
June, 2012

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June 12, 2012

Ms. Samantha Jansen
Project Manager - Facilities
Corporate Building Maintenance
Community Services
City of Guelph
1 Carden Street
Guelph, ON N1H 3A1

Re: Project No. 11099 Victoria Road Recreation Centre
Guelph, Ontario
**Structural Audit**

Dear Ms. Jansen:

Please find enclosed herewith, our report on Victoria Road Recreation Centre, 151 Victoria Road North, Guelph, Ontario.

We have completed our site reviews and our limited structural analysis. The observations from our site reviews have been examined and analysed. The results of our structural analysis have been studied. Deficient conditions are detailed.

Since our conclusions are based on our visual examinations and our limited structural analysis, we cannot guarantee the total extent of deficiencies have been determined. However, our recommendations are based on the results of our limited analysis and our observations, as well as our considerable experience in the assessment of these types of building structures.

We trust this report is self-explanatory and meets with your requirements. If there are any questions regarding the content of this report, please contact the writer.

Sincerely,

E. H. Chapman, P. Eng.
Senior Structural Project Manager

/nh

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## *1.0 INTRODUCTION*

**Exp** was retained by the City of Guelph to complete a structural audit on Victoria Road Recreation Centre, 151 Victoria Road North, Guelph, Ontario.

The purpose of the audit is to determine the following:

- Condition of the building structural members
- Adequacy of the building structural members
- Deficient members and/or members requiring repair/replacement

The review was visual. No testing of existing materials or structural members was completed.

Not all areas of the building were visually reviewed and, not all structural members were visually reviewed, due to location and/or wall and ceiling finishes in place. Our recommendations and comments are based on this limited visual review and our limited structural analysis, as well as our experience in the assessment of pool and arena buildings. We cannot guarantee the total extent of structural deficiencies have been determined.

The on-site reviews were completed August 24, 2011 and January 27, 2012. A previous preliminary on-site review was completed May 27, 2010.

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## *2.0 BACKGROUND*

Victoria Road Recreation Centre includes a single ice pad, two pools and community rooms. These areas are constructed on three different levels.

The recreation centre was designed by Briestensky Architect, Guelph, Ontario in 1974. The structural design of the centre was completed by Walter Fedy McCargar Hachborn, Consulting Engineers, Kitchener. Building construction was complete in 1975.

Modifications and structural reinforcement was completed by Fenco in 1987 and 1991.

Envelope modifications were completed in 2008 by Garwood-Jones & Hanham Architects.

A list of drawings available for review is provided in Appendix 'A'.

The original floor plan drawings, Drawings A2, A3 A4 and A5 and the typical cross-section, Drawing A8, are included in Appendix 'B'.

In addition to the drawings of the Recreation Centre, the City of Guelph provided the following documents:

.1 Building Condition Assessment and Preventative Maintenance Plan, Victoria Road Community Complex, Guelph, Ontario, The Stonewell Group Inc. (Draft Copy), July 2005

.2 Hazardous Materials Assessment, Victoria Road Recreation Centre, 151 Victoria Road North, Guelph, Ontario LEX Scientific Inc., Project #01050118, March 13, 2006

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## *3.0 DESIGN & CONSTRUCTION DOCUMENTS*

The only project material specifications available to review are on the design drawings. The technical specifications noted are as follows:

.1 Original structural design drawings - Walter Fedy McCargar Hachborn

- Footing bearing capacity - 6000 psf
- All concrete (strength) - 3000 psi
- Concrete beams (various locations) - 5000 psi
- Concrete reinforcing steel (yield stress) - 60,000 psi

.2 Reinforcement design drawings - Fenco (1987)

- Steel - rolled shapes 300W
  - HSS 350W Class H
  - plates - 300W
- Bolts - A325
- Grout - Sternson M-Bed, 3000 psi
- Concrete - 3000 psi
- Pipe - A53, Fy = 241 MPa

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## *4.0 EXISTING BUILDING DESCRIPTION*

**Foundations**

- Reinforced concrete strip and spread footings
- Reinforced concrete foundation walls
- Typical concrete slab-on-grade, 4" thick, reinforced with welded wire fabric or #4 bars at 12" centres (typ)

**Level Two**

- 6" cast-in-place one-way concrete slab
- Concrete slab supported by concrete beams which frame between concrete piers, concrete and masonry columns, masonry walls and concrete foundation walls
- Additional columns placed below Level 2 along line 6
- Bleachers are detailed reinforced with additional columns added parallel and adjacent line 6 between lines C and J below Level 2

**Exit (east end)**

- Roof - steel deck supported by cold rolled channels (Photograph No. 1)
- Channels frame to steel beams
- Beams supported by masonry walls

**Level Three**

- 6" cast-in-place one way concrete slab
- Concrete slab supported by concrete beams which frame between concrete and masonry columns and masonry walls.
- Additional columns placed below Level 3 on line 6 and line 8 (Photographs No. 2 and 3)
- HSS braces added below Level 3 on line 6 (Photograph No. 2)
- Bleachers were reinforced under Level 3 (Photograph No. 4)

**Ramp**

- 6" cast-in-place one way concrete slab
- Concrete ramp slabs supported by masonry or concrete walls (Photograph No. 5)

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**Entrance Canopy Roof**

- Steel deck supported by cold rolled steel channels
- Channels frame to steel beams
- Steel beams supported by masonry wall, concrete and steel columns (Photograph No. 6)

**Natatorium Roof**

- Cold rolled steel purlins spanning to welded wide flange steel beams
- Steel beams frame full width of natatorium supported by concrete walls and concrete and masonry piers
- Roof over the training pool is similar (Photograph No. 7)
- Additional struts from roof beams were added at east wall (Photograph No. 8)
- Additional roof reinforcement (purlins) and bracing added (Photographs No. 7 and 9)

**Roof Over Ramp**

- Steel deck supported by cold rolled channels
- Cold rolled channel purlins spanning between masonry walls (Photograph No. 10)
- Additional struts were added below roof level (Photograph No. 10)

**Mechanical Room Floor**

- 2-1/2" concrete on 1-1/2" steel deck
- Deck supported by 18" open web steel joists (OWSJ)
- Joists supported by concrete wall and concrete beams
- Joists were reinforced according to Fenco drawings

**Roof Over Level Three**

- 1-1/2" steel deck supported by 18" OWSJ
- Joists span to concrete wall and/or concrete beams (Photograph No. 11)
- HSS braces added below low roof level on line 8 (Photograph No. 3)
- Joists were reinforced according to Fenco drawings

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**Arena Roof**

- Steel deck supported by 4" cold rolled channel purlins
- Purlins span to 60" long span steel joists (LSSJ)
- LSSJ's span full width of arena and are supported by concrete walls (Photograph No. 12)
- Additional struts were added at east wall from LSSJ's (Photograph No. 13)

**Low Roof at West End**

- Steel deck supported by cold rolled channel purlins (Photograph No. 14)
- Channels bear on masonry walls
- Additional bridging added to underside of purlins (Photograph No. 14)

**Mechanical Room Roof**

- Insulated roof panel supported by cold-rolled channel purlins which span between open web steel joists (Photograph No. 15)
- Joists span to concrete walls

**East Stairwell Roof**

- Steel deck supported by cold-rolled 'Z' purlins supported by masonry walls

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## *5.0 OBSERVATIONS*

### *5.1 Arena*

- Cracks in concrete wall, north and east sides (Photograph No. 16)
- Cracks in control joints of north side concrete wall (Photograph No. 17)
- Masonry wall above the concrete wall on the north side is running bond. On the east and west sides the masonry walls are stack pattern (Photographs No. 18 and 19)
- Mortar missing in vertical joint of west masonry wall (Photograph No. 19 and 20)
- Cracks in masonry wall, south side below the bleachers
- Some minor cracks in underside of concrete bleachers
- Crack in joint between interior and exterior masonry walls in the Electrical Room
- Damaged block where bridging passes through wall in the Zamboni Room (Photograph No. 14)
- Crack in joint between interior and exterior masonry walls and damage in masonry wall at bridging in the Refrigeration Room (Photograph No. 21)
- Some cracks in masonry walls within Changerooms (Photograph No. 22)
- Number of 4" masonry privacy walls within Changerooms (Photograph No. 23)
- X-bracing in roof joist space at east end appears to have buckled in one location (Photograph No. 24)

### *5.2 Natatorium*

- There was a small amount of corrosion on various roof beams. This has been painted over (Photographs No. 9 and 25)
- Cracks in masonry wall, east end at pilaster (Photograph No. 26)
- Crack in underside of concrete slab in Fitness Room (Photograph No. 27)
- Lintel for exterior door, south side, is corroding (Photograph No. 28)
- Crack in the concrete wall, north side, of the Men's Changeroom
- Missing mortar in masonry wall in Women's Changeroom (Photograph No. 29)
- Cracks in underside of concrete slab in the Pool Lobby (Photographs No. 30 and 31)

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### *5.3 Level Two - Natatorium*

- Crack in masonry wall (Photograph No. 32)
- Crack in underside of concrete slab above Level 3 (Photograph No. 33)
- Crack in concrete slab (Photograph No. 34)
- Glass guard at bleacher edge (Photograph No. 35)

### *5.4 Level Three - Arena*

- Exposed steel deck (above) is corroding (Photograph No. 36)
- Crack in masonry wall at joist location (Photograph No. 37)
- Crack in masonry wall of display case

### *5.5 East Stairwell*

- Upper masonry walls are stack pattern, lower masonry walls are running bond (Photograph No. 38)
- Beam is corroding (Photograph No. 39)

### *5.6 Exterior*

- Crack in foundation wall, south side (Photograph No. 40)
- Corroding steel beams and deck, east side (Photographs No. 1 and 41)
- Deteriorating concrete block from water damage (Photograph No. 42)
- Cracks in concrete wall, north side (Photograph No. 43)
- Cracks in control joints in concrete wall, north side (Photographs No. 44 and 45)
- Exposed and corroding reinforcing in concrete wall, north side (Photograph No. 46)

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## *6.0 ASSOCIATED DOCUMENTS*

The Building Condition Assessment and Preventative Maintenance Plan prepared by the Stonewell Group Inc., in July, 2005, documented the condition of various structural and non-structural elements.

A summary of relevant areas of the Report and our comments are as follows. Numbering below follows the Stonewall Group Inc. Report.

### *6.3 Foundation Walls*

"For the most part the foundation walls are not visible. The north wall of the arena is a reinforced concrete wall below grade. Staff provided a Simon-Carver Fenco report from 1998, which reference two cracks in this wall and indicated they should be monitored. The cracks are still visible however based on the photographs in the Simon-Carver Fenco Report there does not appear to be any change in the cracks. They are not any wider; the wall does not appear to have shifted in any direction. It is possible that these are shrinkage cracks as the wall is about 60 metres long."

The Simon-Carver Fenco Report was not made available for our review.

### *6.4 Shear Walls*

"Not applicable. Note that there were a number of studies completed on this building in the 1980 and significant structural repairs were completed in 1988."

The above noted studies were not made available for our review. Drawings of the repairs completed in 1988 were reviewed.

### *6.5 Floor Slabs*

"In service areas where the floor slabs were visible there were no unusual cracks or settlements."

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### *7.1 Roofing Systems*

"The roof system for this building has had problems from shortly after construction. The original building had a 4 ply built-up roof over the small section east and west of the mechanical rooftop penthouse. The roof over the pool and the ice rink were originally prefinished steel. There were problems with leaks at many of the roof penetrations. There were leaks at the mitered cut edges where the steel panel on the roof met the steel panel on the side wall. There were problems with the bolts securing the panels backing out of the purlins below. There were condensation problems on the underside of the arena roof. In 1987 a second roof was constructed over the original steel roof above the arena. On the arena side rigid insulation was laid on top of the original steel roof, a plywood deck was installed over the undulations and a 2 ply modified bitumen was place on the deck."

No details of the above noted roofing change over the Arena were made available.

### *7.5 Exterior Walls*

“The exterior walls are fluted concrete block. The block is generally in good condition with the exception of places where water damage from the roof has caused the block to be repeatedly wetted. The worst section of the wall is the lowest three courses of block along the south side of the teaching pool and the pool mechanical rooms. There is the largest amount of the water runoff at this point and there is no eave trough so the water runs off the roof and hits the paved ground and the back splash thoroughly wets the lowest courses of block. Other areas of damage include inside corners where water over shooting the roof wets the adjacent sidewall such as the inside corner by the chlorination room and the edges of the roof by the canopy at the east stairwell. There is also damage at selected spots along the south wall. This usually occurs where there is a minor flaw in the flashing at the bottom edge of the steel siding. This flaw tends to concentrate the water draining down the siding at specific points. There are two sections of eaves trough on the building; at the front entrance and at the northwest corner of the building however in both cases the downspouts do not effectively carry the water away from the building and damage has occurred to the block. The block along the edge of the teaching pool and some of the other locations must be replaced; most of the other damage could be halted if eaves troughs and downspouts were installed. As indicated above in the roofing section some care should be given to the design and installation of the eaves trough to ensure it is sized properly and well attached."

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## 7.0 DISCUSSION

### 7.1 Design Loads

The design loads listed on the original design drawings are as follows:

**S-4 Roof Framing Plan**

| | | |
|---|---|---|
| Live Load | - | 48 psf |
| | - | Snow build-up according to N. B. C. |
| Roof purlins | - | w = 60 psf |

**S-5 Roof Framing Plan**

| | | |
|---|---|---|
| Live Load | - | 48 psf |
| | - | Snow build-up according to N. B. C. |
| LSSJ | - | w = 60 psf |
| Roof purlins | - | w = 55 psf |

No design loads are listed for the cast-in-place concrete floors and ramps.

No design loads are noted on the reinforcing drawings prepared by Fenco.

Current design data for Guelph is as follows:

| | | |
|---|---|---|
| Snow Load | Ss | - 1.9 kPa |
| | Sr | - 0.4 kPa |
| Wind 1/10 return | | - 0.25 kPa |
| Wind 1/50 return | | - 0.33 kPa |
| Seismic | Sa(0.2) | - 0.210 |
| | Sa(0.5) | - 0.100 |
| | Sa(1.0) | - 0.049 |
| | Sa(2.0) | - 0.013 |
| | PGA | - 0.130 |

Roof snow design load based on the current code is 1.92 kPa (40.1 psf).

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Snow accumulation for various areas is detailed in Appendix 'D'. Current snow accumulation requirements are compared to the original snow accumulation loads shown on the original design drawings.

Current snow load is less than the original design live load and the current snow accumulations are typically less than the design snow accumulations.

Wind design loads based on the 1970, 1987 Codes and the current Code are as follows:

| Code | Roof (end zone) | Roof (middle) | Walls (end zone) | Walls (middle zone) |
|---|---|---|---|---|
| 1970 | 6.9/3.5 psf | 6.9/3.5 psf | 4.9/3.5 psf | 4.9/3.5 psf |
| 1987 | 13.8/9.0 psf | 9.0/6.2 psf | 10.3/8.3 psf | 6.9/5.5 psf |
| 2006 | 10.5/6.8 psf | 6.8/4.7 psf | 7.9/6.3 psf | 5.2/4.2 psf |

Current wind loads are greater than the 1970 design wind loads but less than the 1987 wind loads used for structure reinforcing.

Seismic loads cannot be calculated without the soil classification for the current Code and the foundation factor for the 1970 Code.

The roof and floor dead loads used in our analysis are as follows:

| | | |
|---|---|---|
| Flat roof (4 ply) | - | 1.07 kPa (22 psf) |
| Arena (modified Type 1) | - | 0.8 kPa (17 psf) |
| Type 2 | - | 0.68 kPa (14 psf) |
| Type 3 | - | 0.67 kPa (14 psf) |
| Type 3 (modified) | - | 0.92 kPa (19 psf) |
| Type 3 (Mechanical Room) | - | 0.87 kPa (18 psf) |
| Type 4 | - | 0.1 kPa (2 psf) |

The roof Type relates to the designation on the original design drawings.

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### *7.2 Fenco Reinforcement*

The original Victoria Road Recreation Centre was reinforced in 1987. The reinforcing detailed on the Fenco drawings is as follows:

.1 Existing masonry piers on Line L within the Arena (4 locations). Struts from joist to wall added at underside of joist to reduce masonry wall vertical unbraced height.

.2 Existing masonry piers on Line L within the Natatorium (2 locations). Struts added to reduce vertical unbraced height of masonry wall.

.3 Horizontal wall brace and struts along Line Ax.

.4 Line 6 - new columns at Level 1, steel and concrete
- new steel columns and HSS struts at Level 2

.5 Line 8 - additional channel supports at Level 2
- new columns at Level 3, complete with HSS struts, various locations

.6 New struts between roof purlins at low roof, west end of Arena.

.7 New struts below roof purlins in area bounded by Lines 5 to 6 and Lines D to G in the Natatorium.

.8 Reinforcing of mechanical penthouse floor joists.

.9 Reinforcing of roof joists between Lines 6 and 8.

.10 Addition of cross-bracing in roof of Natatorium between Lines 2 and 3 and between Lines A to L.

.11 New buttresses at Lines D-2 and F-2.

.12 Addition of steel beams and columns below Level 3 bleachers in Arena.

.13 Addition of concrete beam and columns below Level 2 bleachers in Natatorium.

The exact reason for the reinforcing of these various areas and members is not known. The noted Simon-Carver Fenco Report would most likely detail reinforcing requirements. Roof areas would appear to be reinforced for snow loads. Bleachers reinforcement is most likely due to imposed load and the original design. The struts, bracing and buttresses appear to be required for lateral loads (wind, seismic).

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### *7.3 Floor and Roof Analysis*

*.1 Roof*

The current design snow load for the roofs is 1.92 kPa (40.0 psf). The original design snow load is noted as 48 psf on the design drawings. Other than areas of snow accumulation, if the roof structure was properly designed to support the 48 psf snow load then the roof structure is adequate to support the current snow load of 1.92 kPa (40 psf).

The design snow accumulation for the low roof caused by the Arena roof is from 200 psf to 90 psf over the roof width. The current snow accumulation from the higher Arena roof is less than the original design snow accumulation (see Appendix 'D'). The original minimum snow accumulation from the Arena is 90 psf along Line 6. The current snow accumulation along Line 6 is a maximum of 92.3 psf. This is 2.6% greater than the 90 psf snow load. The original design loads shown for the roof between Lines 6 and 8 meets or exceed current snow loads.

The current snow accumulation from the penthouse roof to the low roof between Lines 6 and 8 has a maximum value of 105.5 psf. The design snow accumulation matches this load at 4'-3 from Line 6. The snow accumulation decreases away from the penthouse. At 4' from the wall the load matches the minimum design load of 90 psf. An area less than 4' x 4' in the corner of the penthouse and Line 6 has a current snow load greater than the design snow load. This is not significant.

According to the Fenco drawings the low roof joists between Lines 6 and 8 were reinforced. The reason for the joist reinforcing is unknown.

The original design snow accumulation over the west and east entrances and the lower roof to the west of the Arena is greater than the current snow accumulation.

The arena and the pool roofs are subject to snow accumulation in the area of the penthouse. The original design drawings do not indicate a snow accumulation in these areas. In addition, the Arena roof has been altered adding dead load to the long span joists.

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The long span steel joists over the Arena are made from cold formed sections. The top and bottom chords are referred to as V-sections. Joist web members are rectangular or circular tubes. Joists using these various cold-formed sections were manufactured in the 1960's and 1970's. Anthes Steel Products Limited and Great West Steel Industries Inc. were two manufacturers of this style of joist. Section properties from Great West Steel literature which are similar in size to the top and bottom chords of the joist were used in our analysis.

The steel material strength of joist elements is not known and the thickness of some of the joist web members could not be field measured.

The results of our analysis of the Arena long span steel joists are as follows:

**Top Chord** - The top chord is overstressed by over 20%with 380 Mpa (55 ksi) material and using the current design standard for cold formed products. Using the design standard in place when the joists were designed and constructed the top chord was acceptable for the original design load.

The current overstress appears related to the additional roof dead load (additional membrane), the snow accumulation and the more stringent current design standard. Whether the joists were analysed when the additional roof membrane was added is not known.

The top chords, based on our limited review do not appear to be under any distress. Reinforcing of the top chord of the joists is not recommended at this time.

**Bottom Chord** - This member is acceptable with Grade 350 Mpa (50 ksi) material. With Grade 300 Mpa (44 ksi) material the bottom chord is overstressed by 3.3%. Bottom chord is acceptable.

**Web Members** - Web members in tension with minimum thicknesses and material grades of 300 Mpa (44 ksi) or 350 Mpa (50 ksi) are acceptable.

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Three web members in compression are overstressed using the minimum current available thicknesses for the tubes. If the next available size is used the web members are acceptable. Our field measurements where tube thicknesses can be partially measured indicate the thicker wall thickness was used.

The arena roof purlins do not appear to be 4" cold rolled channels. Purlins appear to be 4" rolled channels. Channels based on our calculations are adequate for imposed dead and snow loads.

Concrete beams along Lines 6 and 8 at the roof level are adequate for imposed dead and live loads.

The main framing members, WWF 30 x 112, of the Natatorium roof are acceptable under current snow loads including the snow accumulation.

The 10" cold rolled channels, using similar sections from suppliers of cold rolled channels who were in business when the facility was built, are adequate. The channels are marginally overstressed in the area of the snow accumulation from the higher walls at the upper mechanical room.

*.2 Floors*

Design live loads for the structural concrete floors and ramps is not detailed on any of the available drawings.

The ramps between Levels 1, 2 and 3 were analysed with a live load of 4.8 kPa (100 psf). The ramps are adequate for the 4.8 kPa live load.

Level Two slab is not acceptable for either 4.8 kPa, 3.6 kPa or 2.4 kPa live loading based on our analysis. The span adjacent Line 8 is deficient in the mid-span (bottom steel) if assumed pinned at Line 8 and is deficient at Line 8 (top steel) if assumed fixed at Line 8. In areas where there is no balcony the Level Two slab is acceptable. The slab in the lobby area is acceptable.

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Based on our analysis the concrete support beams for Level Two along Line 7 are overstressed. The three span beam, between Lines G and K is overstressed in one location. The bleachers were reinforced according to the Fenco drawings. This reinforcing removes some of the overstress in the slab but also increases the overstress in some areas. The support beams along Line 7 between Lines A and C are overstressed regardless of the applied live load. If the slab is assumed to be fixed along Lines 6 and 8 the beams on Line 7 are acceptable with either 2.4 kPa (50 psf) and 3.6 kPa (75 psf) live loads.

The reinforced concrete beam and columns added by the Fenco drawings reduces, eliminates or increases the overstresses in the floor slabs and support beams according to our calculations.

The level three slab is overstressed in the span adjacent Line 6. The bottom steel is overstressed in the span adjacent Line 6 if the support at Line 6 is considered pinned. The top steel at Line 6 is overstressed if the support at Line 6 is considered fixed.

The Fenco reinforcing lowers the overstressed value but does not eliminate the overstress.

Beams on Line 7 at Level Three are acceptable.

Beams on Line 6 at Level Three are acceptable except in one location. The struts added below Level 3 on Line 6 appear to be designed only for lateral load. These struts can take vertical load. When analysed under full vertical loads these struts are not adequate.

The additional steel reinforcing under the bleachers in the Arena added by the Fenco drawings reduces the overstresses in the floor slabs and support beams.

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### *7.4 Structural Evaluation of Existing Buildings*

In the User's Guide - NBC 2005 Structural Commentaries (Part 4 of Division B) is the following document:

*Commentary L:*
*Application of NBC Part 4 of Division B for the Structural Evaluation and Upgrading of Existing Buildings.*

This commentary concerns the structural evaluation and upgrading of existing buildings to achieve a level of performance that is appropriate, based on the intent of the current National Building Code requirements.

Relevant portions of the commentary are, as follows:

*1) Recommended Code*

*16) Buildings designed and built in accordance with previous Codes may be considered acceptable provided:*
*- the previous Code or Standard essentially satisfies the life-safety requirements of the current Code or Standard and*
*- the building or its use is not altered in such a way as to affect its structural behaviour or to increase loadings on the structure.*

*2) Evaluation Based on Satisfactory Past Performance.*

*18) Buildings or components designed and built to earlier codes than the benchmark codes or standards, or designed and built in accordance with good construction practice when no codes applied, may be considered to have demonstrated satisfactory capacity to resist loads other than earthquake, provided:*

- *careful examination by a professional engineer does not expose any evidence of significant damage, distress or deterioration;*
- *the structural system is reviewed, including examination of critical details and checking them for load transfer;*
- *the building has demonstrated satisfactory performance for 30 years or more;*

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- *there have been no changes within the past 30 years that could significantly increase the loads on the building or affect its durability, and no such changes are contemplated.*

19) *If these conditions are not satisfied, the evaluation should be based on the recommendations in Paragraphs 20 to 36.*

The reason for the building reinforcing completed Fenco has to be determined. With this information it can be determined if Paragraph 16, 18 and 19 apply.

Paragraph 16 would seem to apply assuming the 1970 National Building Code was used. The exception is the answer to the question "Why was the building reinforced?".

Paragraph 18 also applies with the exception of "the building has demonstrated satisfactory performance for 30 years or more". There has been over 20 years of satisfactory performance since the building reinforcing was installed. There has been over 35 years of use of the facility. Was the reinforcing installed because of unsatisfactory building performance?

If we assume these conditions have not been satisfied, we can calculate revised load factors to be used in our calculation.

The indices for the calculation of the Reliability Level are as follows:

| | Index |
|---|---|
| System Behaviour: | |
| • Failure leads to collapse, likely to impact people | 2 |
| Risk Category | |
| • High | 2 |
| Past Performance<br>(at least 20 years with no significant deterioration) | 0 |

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The Reliability Level is the sum of the above indices. For the Reliability Level of 4 the load factors to be used for the structural evaluation are as follows:

| | **Evaluation** | **Current Code (used in initial structural analysis)** |
|---|---|---|
| Dead Load | 1.2 | 1.25 |
| Snow Load/Live Load | 1.4 | 1.5 |
| Wind Load | 1.3 | 1.4 |
| Earthquake | 0.6 | 1.0 |

The revised load factors reduces the overstress in the floor slabs and support beams in the locations previously noted. With the reduced load factors and the Fenco structural reinforcing there are still areas of concrete slabs and beams overstressed according to our calculations.

The reduced load factors decrease the factored loads used in the analysis for the Arena truss. The top chord of the truss is still overstressed.

### *7.5 Masonry Walls*

All lateral loads, wind and seismic, on the building are resisted by the masonry and concrete walls in the east-west direction and the masonry and concrete walls and the two steel buttresses in the north-south direction.

The masonry walls on Line L, Lines 2 to 16 and Line A, Lines 8 to 16 and Lines 2 to 6 are constructed in stack pattern. Stack pattern is the arrangement of masonry units in which the head joints are vertically aligned. Stack pattern is not recommended for walls resisting seismic loads because, unlike a running bond pattern, the wall integrity provided by overlapping units is not available. The term stack pattern is now used, rather than stack bond, to highlight the lack of bond provided by this configuration of units. These walls act as a series of individual vertical columns, and the provision of horizontal reinforcement is essential to tie them together.

The available original design drawings do not detail horizontal reinforcement in these walls.

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The maximum factored vertical in-plane shear resistance in stack pattern shall not exceed that corresponding to the shear friction resistance of the continuous horizontal reinforcing used to tie the wall together at the continuous head joints. This design requirement was added in the 1984 edition of the masonry design standard (Masonry Design for Buildings CAN3-S304-M84).

Assuming typical horizontal masonry reinforcing in every second masonry course, under current wind loads these walls are not adequate to carry the imposed load. This may be one reason the buttresses were added at gridlines 2D and 2F.

There is minimal distress in the masonry walls. Reinforcing the masonry walls is not recommended.

### *7.6 Building Condition*

Victoria Road Recreation Centre has been in place since 1975, thirty-seven years. Major structural reinforcing was completed in 1988, 24 years ago.

There are few visible deficiencies in the structural members.

The visible deficiencies include:

- Exposed and corroding reinforcing in exterior concrete walls
- Cracking in interior masonry walls
- Corrosion on steel members (beams, purlins, deck, etc.)
- Deterioration in exterior masonry face from water flowing down the face

These noted areas do not require immediate repair. These areas should be monitored for further deterioration and repaired when appropriate.

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## *8.0 SUMMARY*

A structural audit was completed on Victoria Road Recreation Centre, 151 Victoria Road North, Guelph, Ontario.

The visual review of structural members was completed. No testing of any material, member or structural system was completed.

Not all roof and floor structural members were visually reviewed. Ceiling finishes restricted access in some areas. Major structural elements were analysed. Cast-in-place concrete slabs were analysed using the original design drawings' reinforcing layout.

The reports prepared prior to the Fenco reinforcing drawings would confirm why the reinforcing was completed. In addition these reports may provide the design loads used for the Fenco designed reinforcing. These reports were not available to **exp**.

The building is visibly in good condition. There is no visible distress noted in any existing structural member.

Various structural members are overstressed under current loads and current design standards. These include the following:

- Top chord of Arena roof long span steel joist
- Pool roof purlins in area of snow accumulation
- Concrete slabs and beams in various locations and floor levels

Reinforcing of these structural members is not recommended.

The structural steel struts added on Line 6 below Level 3 have the possibility of carrying vertical live and dead loads. These struts were added by the Fenco design. How much of the imposed vertical load is carried by the original concrete beam and by the diagonal struts cannot be determined. If the struts are considered a support under the continuous concrete beams, similar to the original columns, then the imposed load is greater than their capacity. These struts should be reviewed further.

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Deterioration in the concrete and masonry walls has been noted. These areas should be monitored for further deterioration and repaired when appropriate.

The facility, pool and arena, is prone to moisture related deterioration (corrosion). In addition, the facility was structurally reinforced in 1988. For these reasons a regular visual structural review, every two to three years, is recommended.

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## 9.0 APPENDICES

### 9.1 Appendix 'A' - Drawing Lists

### 9.2 Appendix 'B' - Drawings

.1 A2 Level One

.2 A3 Level Two

.3 A4 Level Three & Entrance Plans

.4 A5 Roof Plan, Roof Elevations

.5 A8 Cross Section

### 9.3 Appendix 'C' - Photographs

### 9.4 Appendix 'D' - Snow Accumulation

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# *Appendix 'A' -*

# *Drawings Lists*

**Appendix 'A' - Drawing Lists**

**PROJECT: Victoria Road Recreation Centre**

**Briestensky Architect**

| Drawing No. | Title | Revisions |
|---|---|---|
| A1 | Site Plan | - |
| A2 | Level One | As-Built Oct, 1975 |
| A3 | Level Two | As-Built Oct, 1975 |
| A4 | Level Three & Entrance Plans | As-Built Oct, 1975 |
| A5 | Roof Plan Roof Elevations | As-Built Oct, 1975 |
| A6 | Elevations | As-Built Oct, 1975 |
| A7 | Elevations | As-Built Oct, 1975 |
| A8 | Cross Section | As-Built Oct, 1975 |
| A9 | Building Section Wall Sections | As-Built Oct, 1975 |
| A10 | Wall Sections Details | As-Built Oct, 1975 |
| A11 | Entrance Details, Sections | As-Built Oct, 1975 |
| A12 | Pier Details Wall sections | As-Built Oct, 1975 |
| A13 | Stair Details | As-Built Oct, 1975 |
| A14 | Millwork Details & Miscellaneous Metals | As-Built Oct, 1975 |
| A15 | Batter Boards & Related Arena Details | As-Built Oct, 1975 |
| A16 | Window Details | As-Built Oct, 1975 |
| A17 | Room Finish Schedule Door Schedule | As-Built Oct, 1975 |
| A18 | Arena Elevations | As-Built Oct, 1975 |
| A19 | Reflected Ceiling Plan & Elevations of Natatorium | As-Built Oct, 1975 |
| A20 | Reflected Ceiling Plans | As-Built Oct, 1975 |
| A21 | Filtration & Chlorine Rm Details | As-Built Oct, 1975 |
| A22 | Filtration Room Foundation Details | As-Built Oct, 1975 |
| A23 | Main Pool Plan & Profiles | As-Built Oct, 1975 |
| A24 | Main Pool Excavation Details | As-Built Oct, 1975 |
| A25 | Teaching Pool Plan & Profiles | As-Built Oct, 1975 |
| NC.6.A1 | Addition for the Handicapped | As-Built Oct, 1975 |

**Walter Fedy McCargar Hachborn**

| Drawing No. | Title | Revision |
|---|---|---|
| S.1 | Foundation Plan | As-Built Oct, 1975 |
| S.2 | Foundation Plan | As-Built Oct, 1975 |
| S.3 | Level Three & Entrance Framing | As-Built Oct, 1975 |
| S.4 | Roof Framing Plan | As-Built Oct, 1975 |
| S.5 | Roof Framing Plan | As-Built Oct, 1975 |
| S.6 | Structural Details | As-Built Oct, 1975 |
| S.7 | Concrete Details | As-Built Oct, 1975 |
| NC.6.5.1 | Addition for the Handicapped | As-Built Oct, 1975 |

**Fenco (1987)**

| Drawing No. | Title | Revisions |
|---|---|---|

DRAFT

| | | |
|---|---|---|
| A1-52437-SE-01 | Masonry Wall Reinforcement on L<br>Structural Plans and Sections | 1 |
| A1-52437-SE-02 | Masonry Wall Reinforcement on ℄ Ax<br>Structural Plans and Sections | 0 |
| A1-52437-SE-03 | Masonry Wall Reinforcement on ℄6<br>Structural Plans and Details Sheet 1 of 2 | 1 |
| A1-52437-SE-04 | Masonry Wall Reinforcement on ℄6<br>Structural Plans and Details Sheet 2 of 2 | 1 |
| A1-52437-SE-05 | Masonry Pier Reinforcement on ℄8<br>Structural Plans, Sections & Details | 4 |
| A1-52437-SE-06 | Masonry Pier Reinforcement on ℄8<br>Sections & Details | 2 |
| A1-52437-SE-07 | Masonry Wall Reinforcement on ℄6 and ℄8<br>Structural Elevations and Details | 2 |
| A1-52437-SE-08 | Roof Reinforcement<br>Structural Plans and Details | 1 |
| A1-52437-SE-09 | Roof Reinforcement Between ℄6 and ℄8<br>Structural Plans and Sections | 2 |
| A1-52437-SE-10 | Natatorium Roof Reinforcement<br>Structural Plans Sections and Details | 1 |
| A1-52437-SE-11 | Ice Arena Gallery Reinforcement<br>Structural Plans, Sections and Details | 2 |
| A1-52437-SE-12 | Natatorium Gallery Reinforcement<br>Structural Plans, Sections and Details | 1 |
| 50213-80J-1 | Masonry Pier Reinforcement on ℄8<br>Structural Plans Sections & Details | 2 |
| 50213-80J-2 | Masonry Pier Reinforcement on ℄8<br>Sections & Details | 0 |

**Fenco (1991)**

| Drawing No. | Title | Revision |
|---|---|---|
| 15855-A-001 | Plan Level Two | 2 |
| 15855-A-002 | Elevations | 1 |

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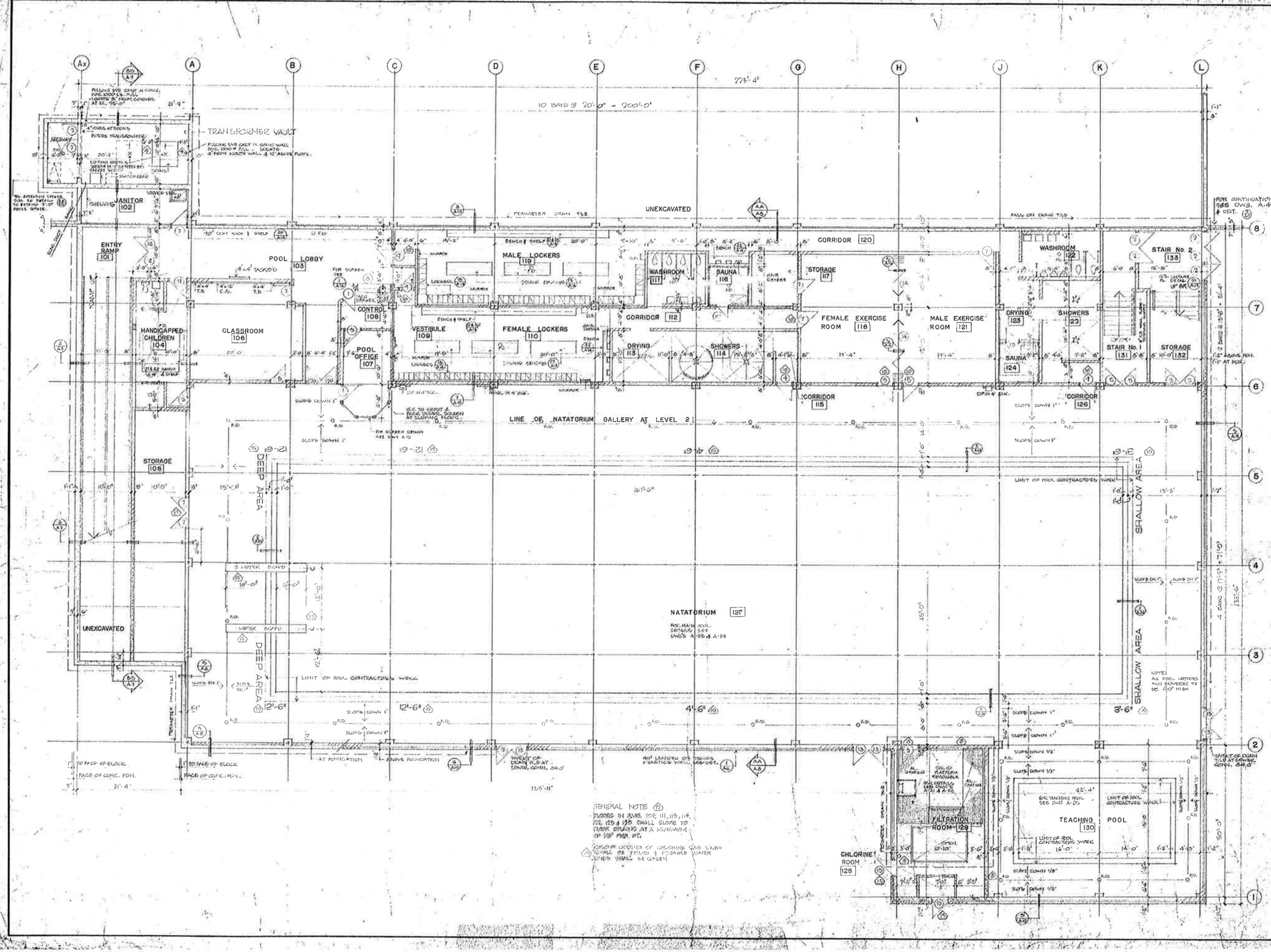
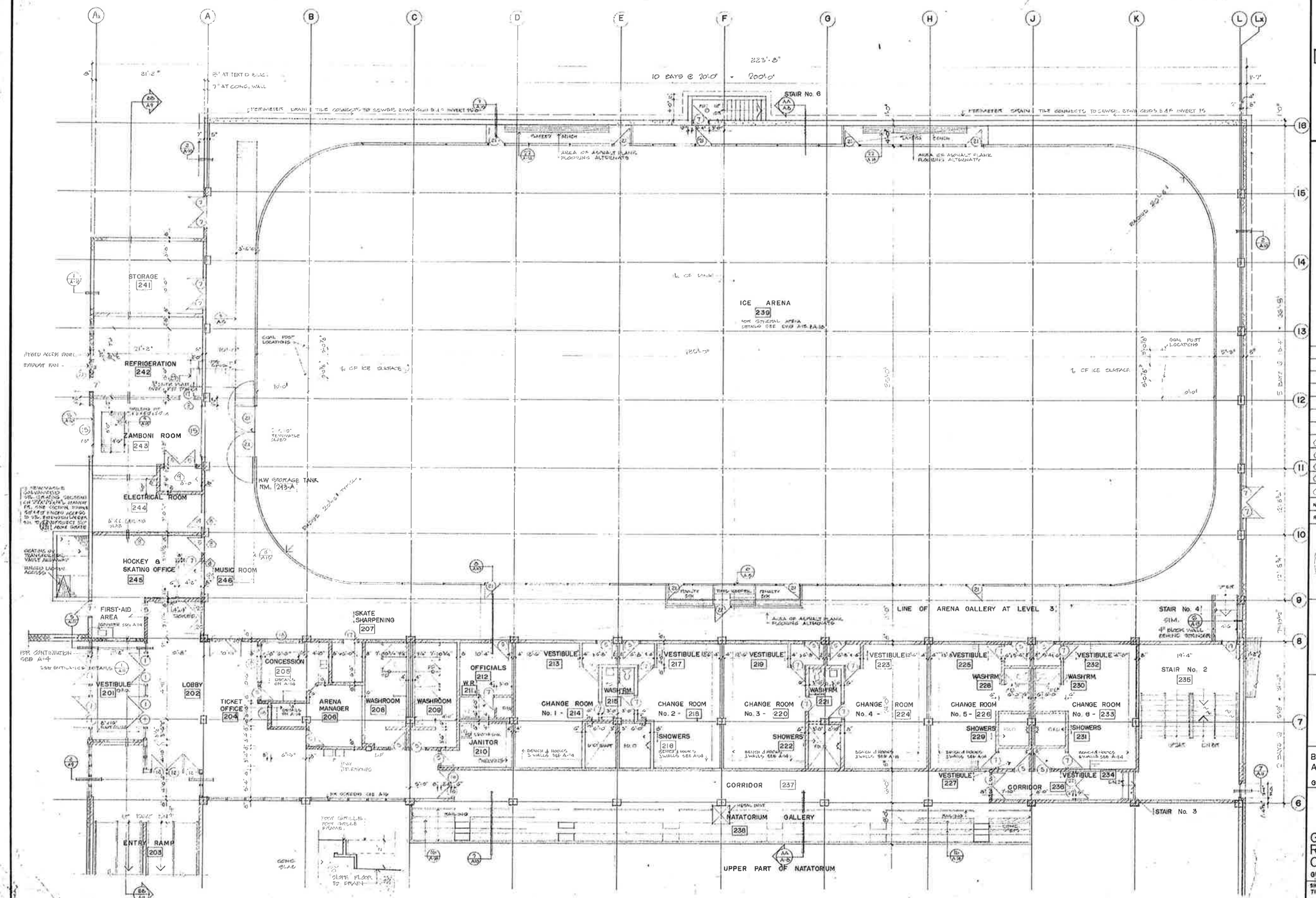
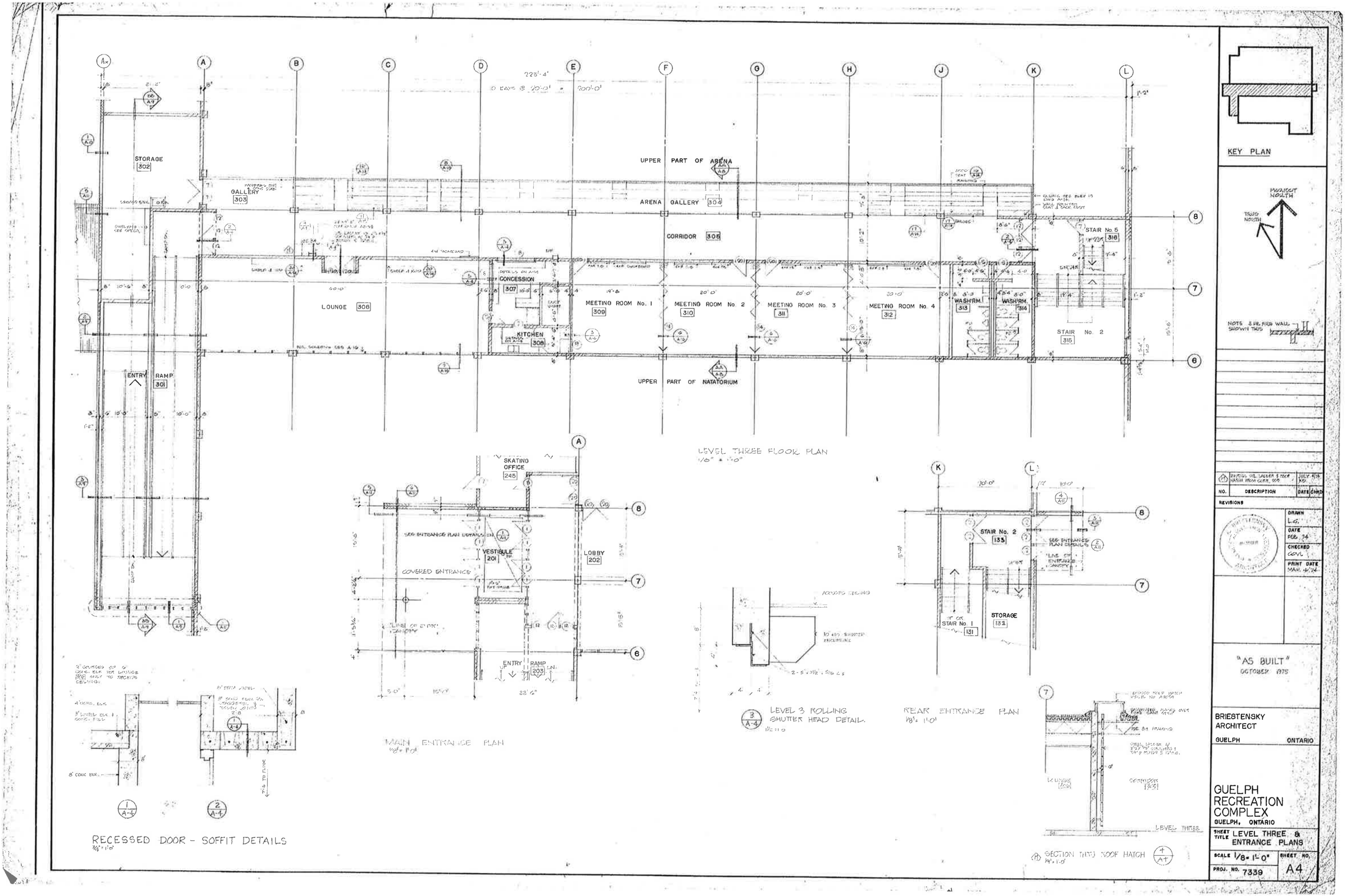
# *Appendix 'B' -*

## *Drawings*


TRANSFORMER VAULT
JANITOR 102
ENTRY RAMP 101
POOL LOBBY 103
CLASSROOM 106
HANDICAPPED CHILDREN 104
CONTROL 108
POOL OFFICE 107
STORAGE 105
UNEXCAVATED
MALE LOCKERS 119
FEMALE LOCKERS 110
VESTIBULE 109
WASHROOM 111
SAUNA 118
STORAGE 117
CORRIDOR 120
CORRIDOR 112
DRYING 113
SHOWERS 114
FEMALE EXERCISE ROOM 118
MALE EXERCISE ROOM 121
CORRIDOR 116
WASHROOM 122
DRYING 123
SHOWERS 125
SAUNA 124
CORRIDOR 126
STAIR No. 1 131
STAIR No. 2 133
STORAGE 132
LINE OF NATATORIUM GALLERY AT LEVEL 2
DEEP AREA
SHALLOW AREA
NATATORIUM 127
LIMIT OF POOL CONTRACTOR'S WORK
FILTRATION ROOM 129
CHLORINE ROOM 128
TEACHING POOL 130
GENERAL NOTE 12
FLOORS IN RMS. 101, 111, 113, 114, 122, 125 & 126 SHALL SLOPE TO FLOOR DRAINS AT A MINIMUM OF 1/8" PER FT.
KEY PLAN
PROJECT NORTH
TRUE NORTH
"AS BUILT" OCTOBER 1975
BRIESTENSKY ARCHITECT
GUELPH ONTARIO
GUELPH RECREATION COMPLEX
GUELPH, ONTARIO
SHEET TITLE LEVEL ONE
SCALE 1/8" = 1'-0"
SHEET NO. A2
PROJ. NO. 7339
NO. DESCRIPTION DATE CHKD
REVISIONS
DRAWN
DATE
CHECKED
PRINT DATE




FLOOR GRILL EDGING
DETAIL - VESTIBULE 201




| NO. | DESCRIPTION | DATE | CHKD |
|---|---|---|---|
| 1 | REVISED GEL. LASSER & ROOF HATCH FROM CLIENT, CCO | JULY 4/74 | KO |

REVISIONS

DRAWN L.G.
DATE FEB. 74
CHECKED COVL
PRINT DATE MAR. 4/74

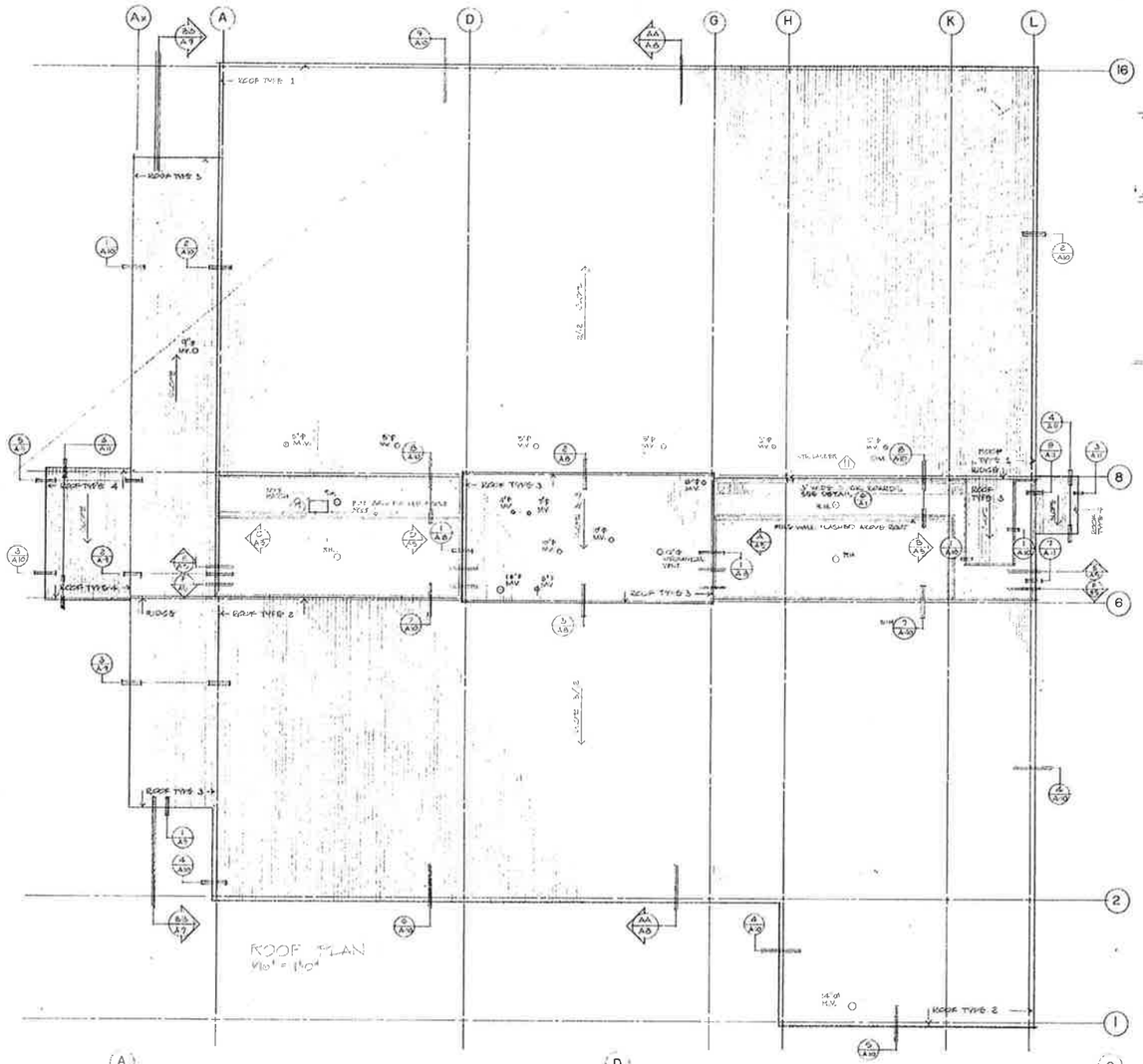
"AS BUILT"
OCTOBER 1975

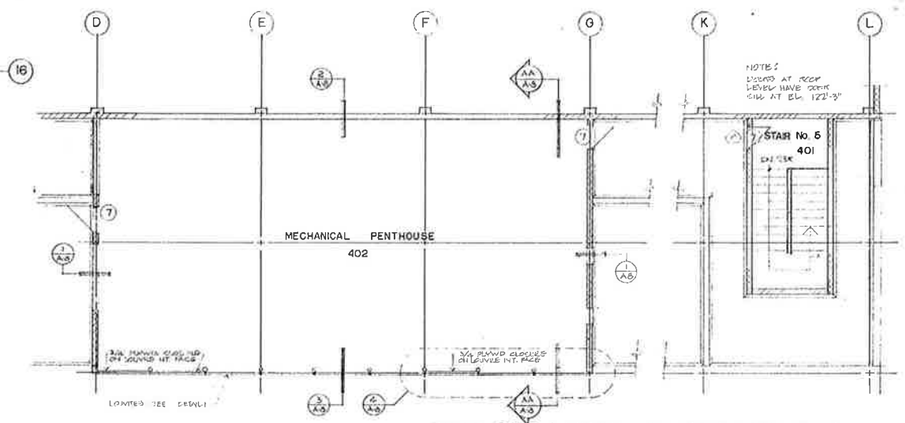
BRIESTENSKY ARCHITECT
GUELPH ONTARIO

GUELPH RECREATION COMPLEX
GUELPH, ONTARIO

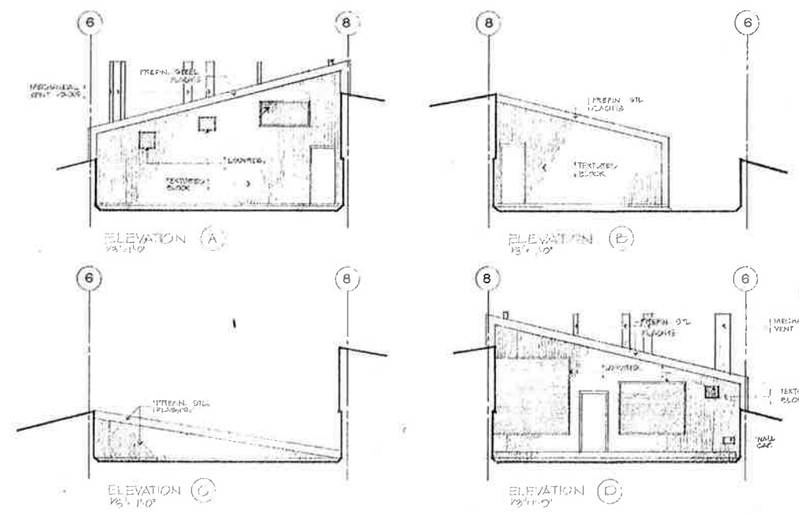
SHEET TITLE LEVEL THREE & ENTRANCE PLANS

SCALE 1/8" = 1'-0"
SHEET NO. A4
PROJ. NO. 7339




ROOF STAIR & MECHANICAL PENTHOUSE PLAN
1/8" = 1'-0"

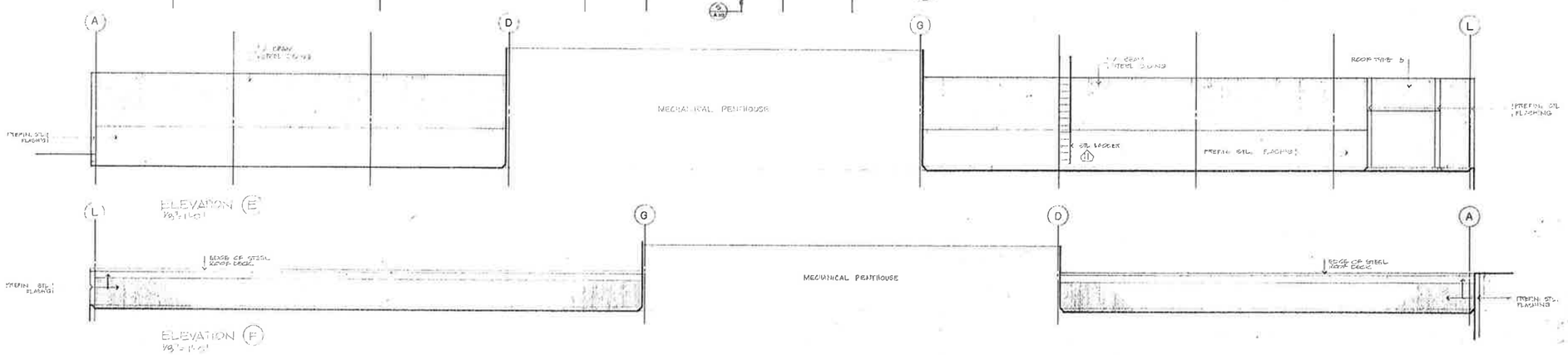



ELEVATION (A)
1/8" = 1'-0"

ELEVATION (B)
1/8" = 1'-0"

ELEVATION (C)
1/8" = 1'-0"

ELEVATION (D)
1/8" = 1'-0"




ELEVATION (E)
1/8" = 1'-0"

ELEVATION (F)
1/8" = 1'-0"

| NO. | DESCRIPTION | DATE | CHKD |
|---|---|---|---|
| 13 | CHANGE DOOR SWING T STAIR No. 5 - 401 | JULY 4/74 | KB. |
| 12 | INSTALL REV. HATCH & LADDER FROM LEVEL 5 - 401 | JULY 4/74 | KB |
| 11 | INSTALL STL. LADDER FROM FLAT ROOF AS SHOWN | JUNE 21/74 | KB |

REVISIONS

DRAWN L.G.
DATE FEB/74
CHECKED G.O.V.L.
PRINT DATE MAR 4/74

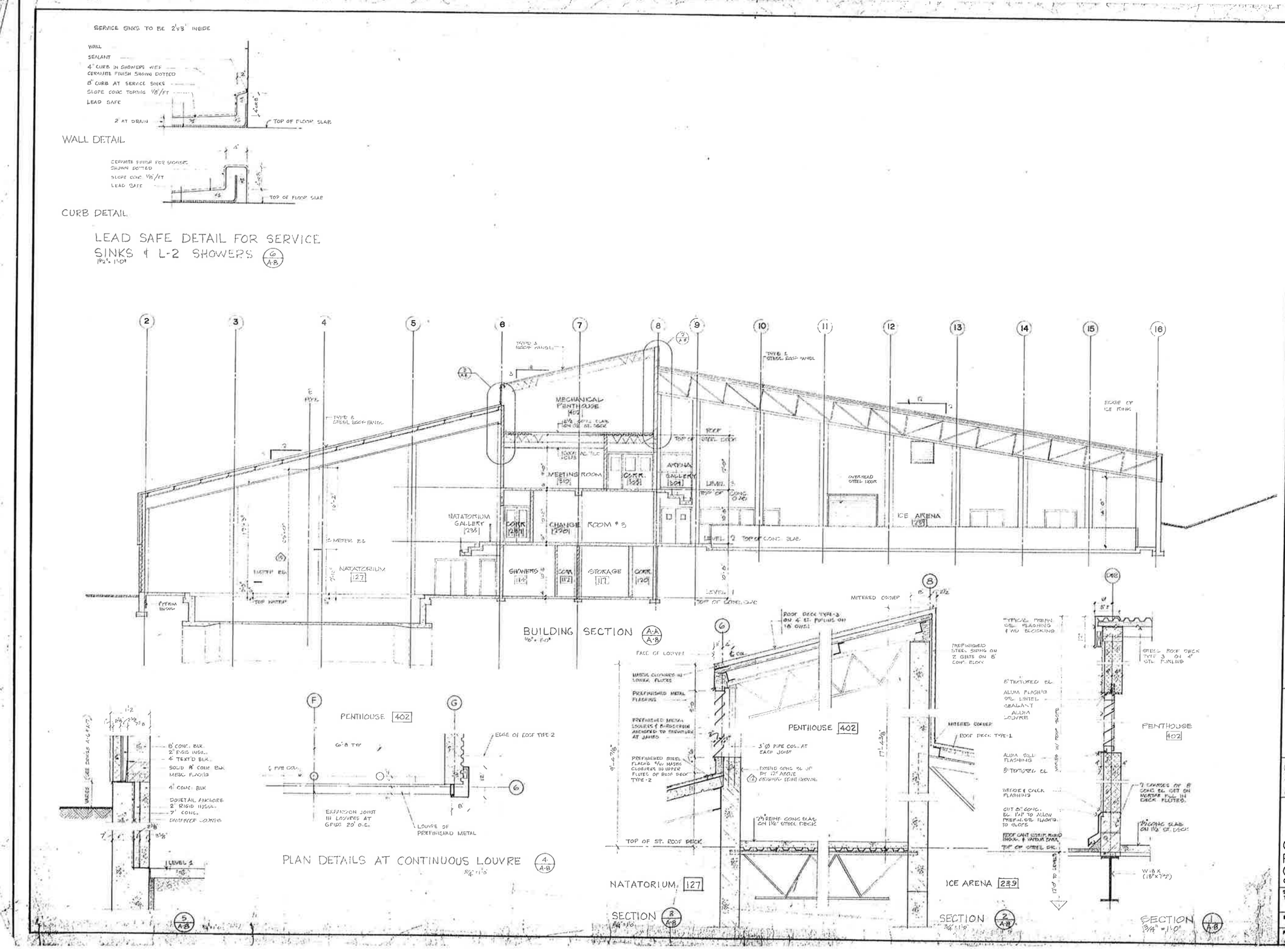
"AS BUILT"
OCTOBER 1975

BRIESTENSKY ARCHITECT
GUELPH ONTARIO

GUELPH RECREATION COMPLEX
GUELPH, ONTARIO

SHEET TITLE ROOF PLAN
ROOF ELEVATIONS

SCALE AS SHOWN
SHEET NO. A5
PROJ. NO. 7339




| NO. | DESCRIPTION | DATE | CHKD |
|---|---|---|---|
| 12 | MATING CONC BL. OF 12" ON SECTION 3. | JUNE 21/74 | AB |
| 13 | LOCATE DRAINS BOARDED AS SHOWN SEE A-2 | JUNE 20/74 | |

REVISIONS

DRAWN L.G
DATE FEB/74
CHECKED G.O.V.L.
PRINT DATE 1 MAR 4/74

"AS BUILT"
OCTOBER 1975

BRIESTENSKY ARCHITECT
GUELPH ONTARIO

GUELPH RECREATION COMPLEX
GUELPH, ONTARIO

SHEET TITLE CROSS SECTION

SCALE 1/8" = 1'-0"
SHEET NO. A8
PROJ. NO. 7339

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# *Appendix 'C' -*

# *Photographs*

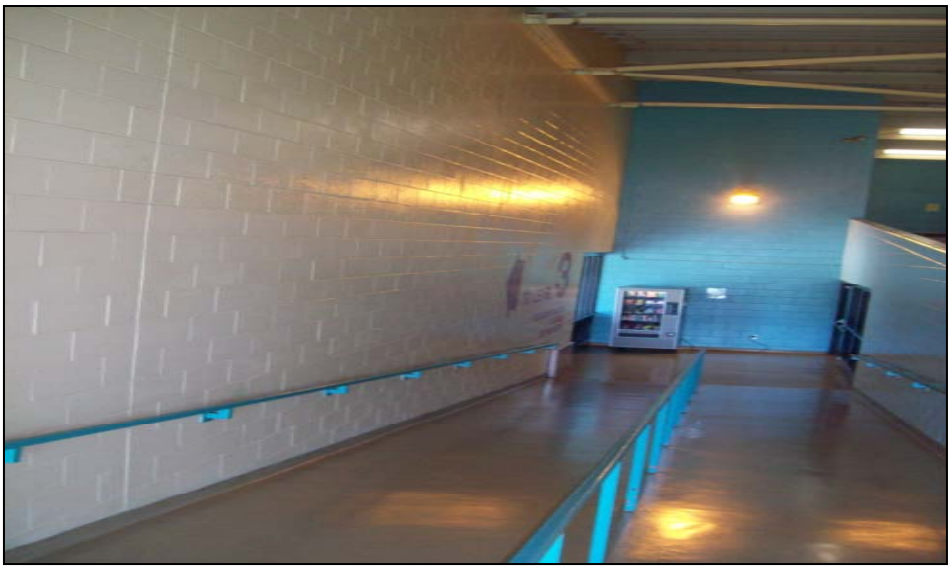
exp.

Photograph No. 1

Photograph No. 2

Photograph No. 3

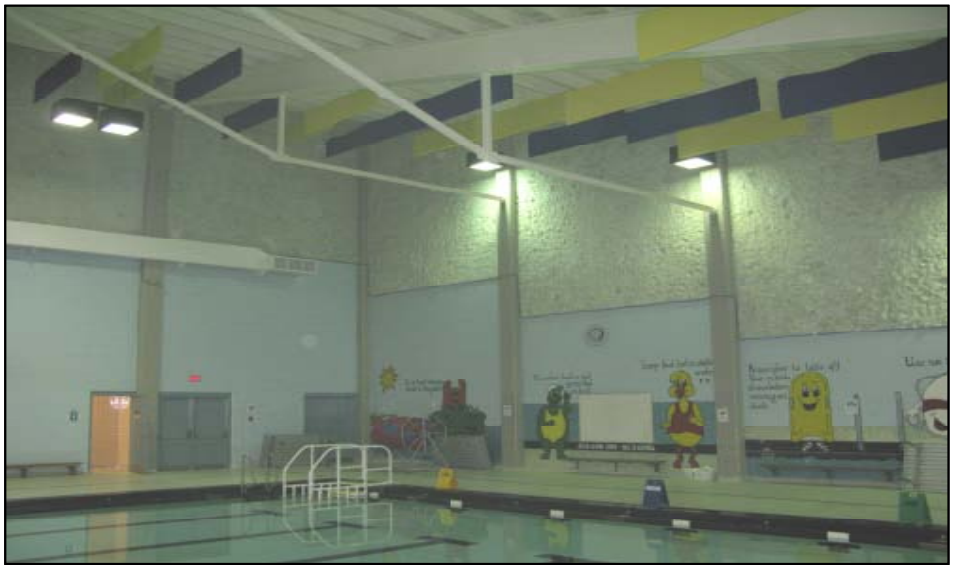
Photograph No. 4



Photograph No. 5

Photograph No. 6

Photograph No. 7



Photograph No. 8

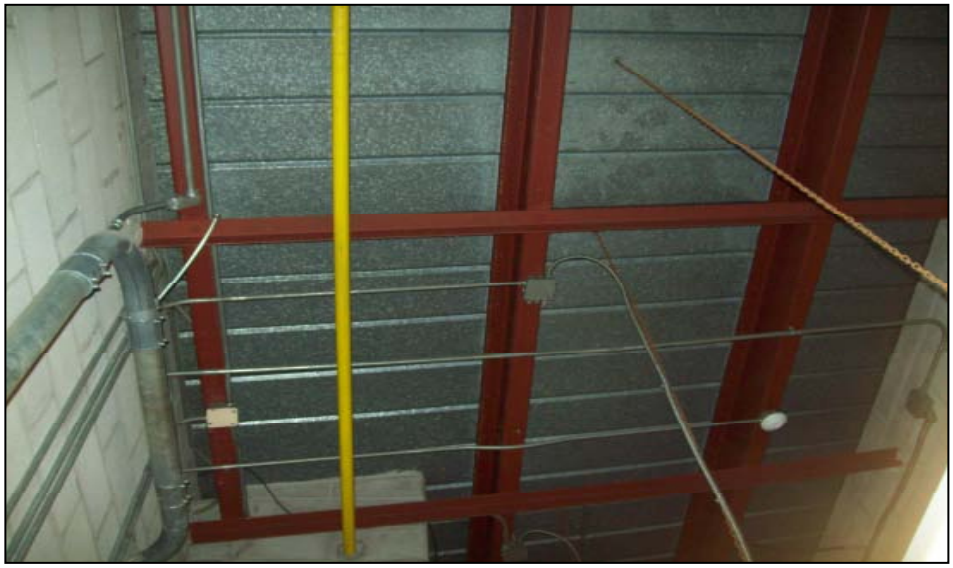
Photograph No. 9

Photograph No. 10

Photograph No. 11

Photograph No. 12

Photograph No. 13



Photograph No. 14

Photograph No. 15

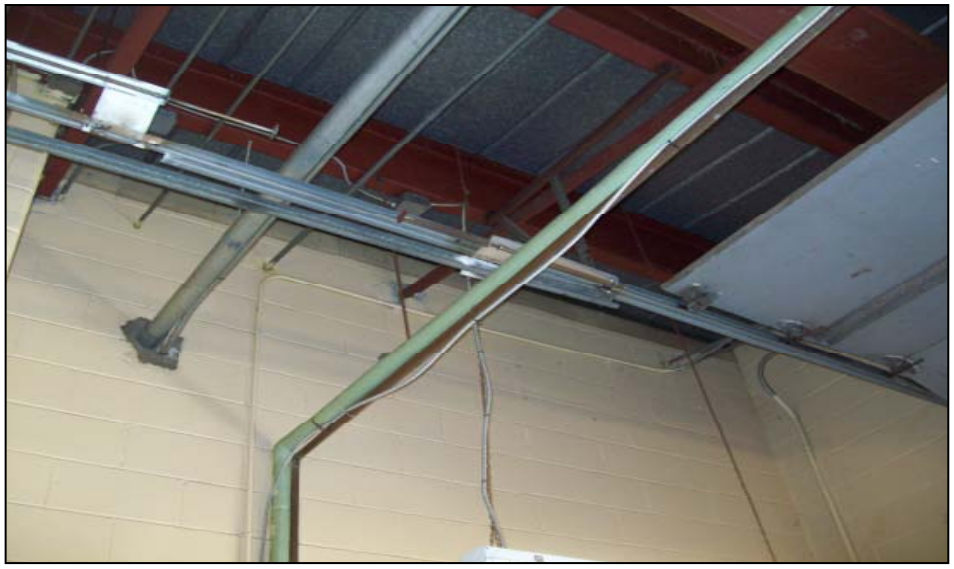
Photograph No. 16

Photograph No. 17

Photograph No. 18

Photograph No. 19

Photograph No. 20



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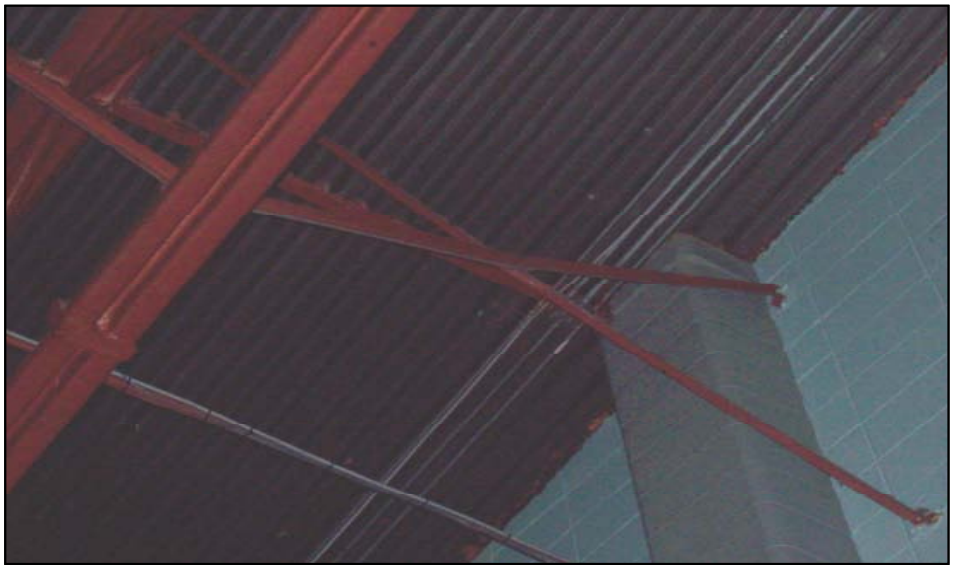
Photograph No. 22

Photograph No. 23



Photograph No. 24

Photograph No. 25

Photograph No. 26

Photograph No. 27

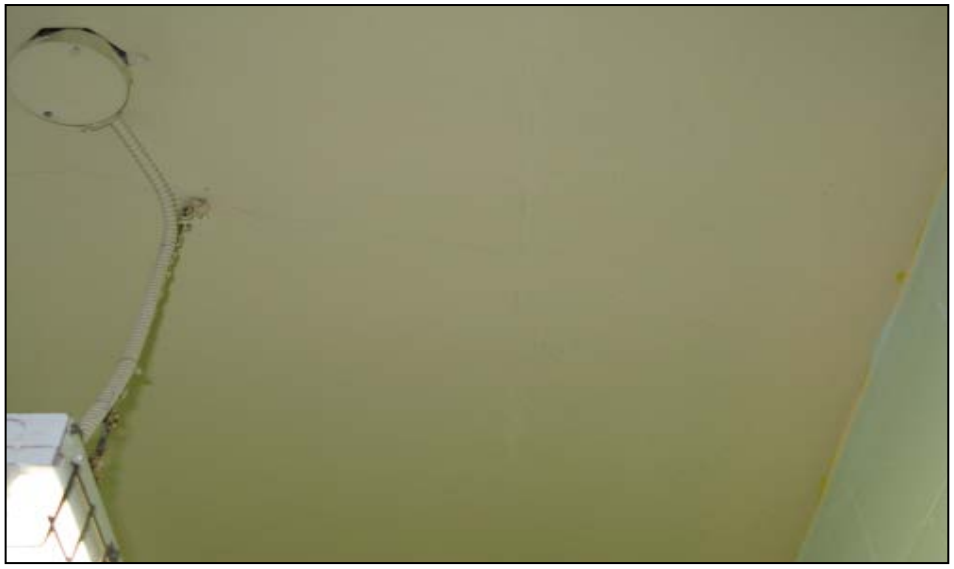
Photograph No. 28

Photograph No. 29

Photograph No. 30

Photograph No. 31

Photograph No. 32



Photograph No. 33

Photograph No. 34

Photograph No. 35

Photograph No. 36

Photograph No. 37

Photograph No. 38

Photograph No. 39

Photograph No. 40

Photograph No. 41

Photograph No. 42

Photograph No. 43

Photograph No. 44

Photograph No. 45

Photograph No. 46

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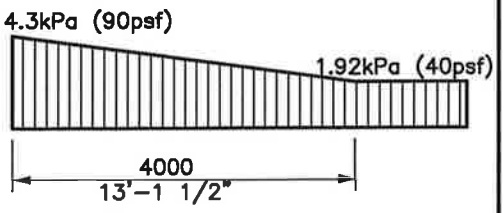
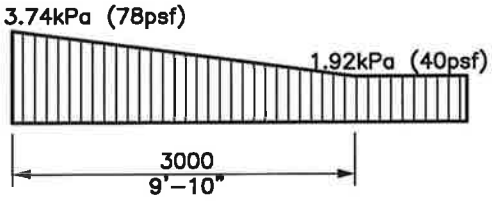
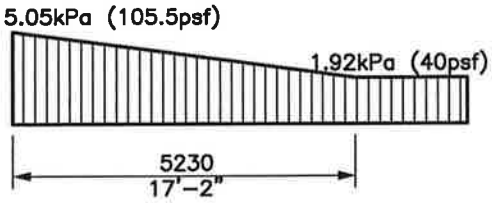
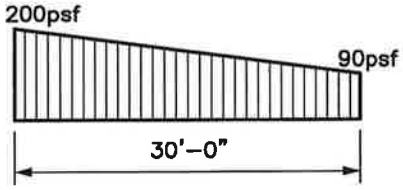
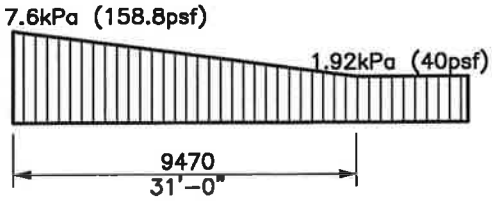
# *Appendix 'D' -*

# *Snow Accumulation*

| LOCATION | ORIGINAL DESIGN DRAWING SNOW ACCUMULATION | CURRENT SNOW ACCUMULATION |
|---|---|---|
| PENTHOUSE/ARENA | 48psf |   |
| PENTHOUSE/POOL | 48psf |   |
| PENTHOUSE/LOW ROOF | 48psf |   |
| ARENA/LOW ROOF |   |   |

Seal


**exp** Services Inc.
t: 905.525.6069 | f: 905.528.7310
499 King Street East, Suite 200
Hamilton, ON L8N 1E1
Canada
www.exp.com


Project Number : 11099

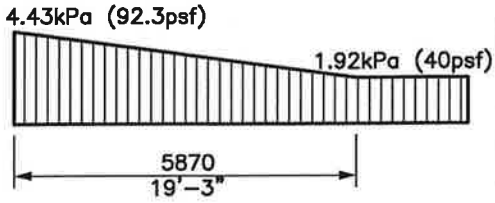
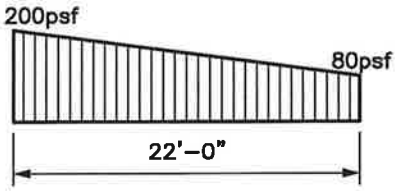
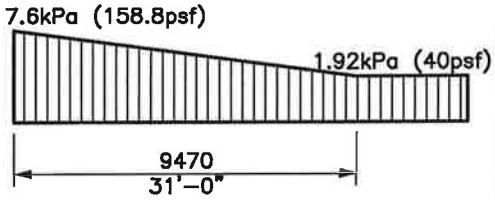
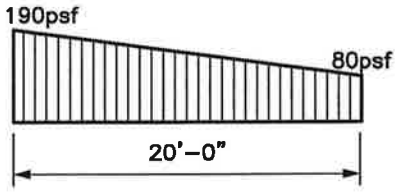
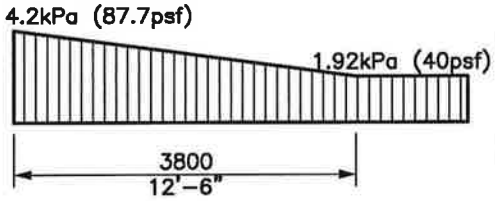
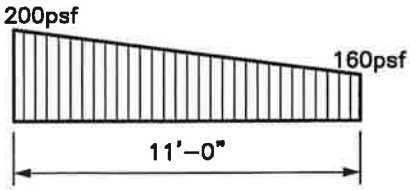
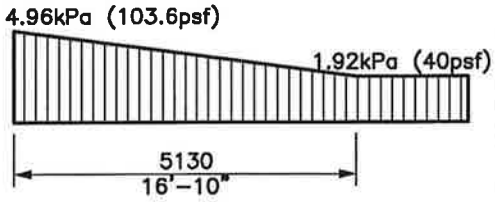
Date : MARCH.2012

Project Title : VICTORIA ROAD RECREATION CENTRE

Drawn by : MS

Drawing Title : SNOW ACCUMULATION LOADS

Drawing Number : SKS–1 Rev. 1

| LOCATION | ORIGINAL DESIGN DRAWING SNOW ACCUMULATION | CURRENT SNOW ACCUMULATION |
|---|---|---|
| POOL/LOW ROOF | 48psf |   |
| ARENA/LOW ROOF (WEST) |   |   |
| WEST ENTRANCE |   |   |
| EAST ENTRANCE |   |   |

Seal

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Project Number : **11099**

Date : **MARCH.2012**

Project Title : VICTORIA ROAD RECREATION CENTRE

Drawn by : **MS**

Drawing Title : SNOW ACCUMULATION LOADS

Drawing Number : SKS-2 Rev. 1