City of Brookings

Larson Ice Center – Ice System Replacement

Feasibility Report

übl design group P.C.

November 19, 2018

Final V2.0

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Executive Summary

The City of Brookings and The Parks, Recreation and Forestry Department authorized the preparation of this report in October of 2018 to determine the feasibility of options for replacement of the ice system at the Larson Ice Center.

In August of 2018 the City of Brookings contracted with CIMCO Refrigeration (CIMCO) to complete an audit of the Larson Ice Center ice system, *Evaluation Study and Site Audit Report*. The audit was contracted initially to review issues with a failing heat exchanger for the subfloor heating system serving the Red Rink. During the review it was determined that the subfloor heating piping was found to be leaking in both the Red Rink and Blue Rink at multiple locations under the concrete slab. The failure in the subfloor heating piping likely lead to damage and the ultimate failure of the heat exchanger. During CIMCO's discovery on-site, it was determined that the Red Rink floor had heaved up to 3 inches, likely due to the failed heat exchanger; the recently discovered high-water table and the naturally occurring freeze/thaw cycle under the concrete slabs. As a result, of the freeze/thaw stress the Red Rink floor has fractured beyond repair. The report goes on to suggest that although the the Blue Rink floor may be in better condition it to must be replaced to correct the leaks under the slab.

In addition to the on-site analysis and specific issues relating to the subfloor heating system, CIMCO provided alternatives for a complete ice system replacement. The replacement options are intended to replace the aging R-22 indirect ice system with a new direct or indirect ice system that contains naturally occurring refrigerants (Ammonia/CO2). Considering that man-made refrigerants (R-22) are under a high amount of scrutiny from the EPA and that R-22 will be no longer be manufactured after January 2020, converting the ice system to a naturally occurring refrigerant is a long-term solution for the facility.

On October 10, 2018 Übl Design Group (Übl) conducted an on-site investigation of the Larson Ice Center which included meeting with the staff and conducting a site walk-through of the facility to gather the required information and data to complete this report. Prior to the walk-through Übl was provided with the CIMCO report and the original drawings and specifications for the building and its subsequent building improvements by Banners Associates. Following the meeting CIMCO provided original engineering drawings to Übl for the ice system.

The primary focus of this report is to dig deeper into the solutions presented by CIMCO and study the potential ice system replacement options along with the other factors that may influence the choice in system. Those include factors such as building usage, facility infrastructure, constructability, life-safety, building operations, phasing strategies, scheduling, budget and long-term sustainability. Upon completion of the report, the City of Brookings will have a comprehensive study that includes recommendations for consideration.

Definitions

ASHRAE

The American Society of Heating, Refrigerating and Air-Conditioning Engineers is a global professional association seeking to advance heating, ventilation, air conditioning and refrigeration (HVAC&R) systems design and construction.

ASHRAE 15

Safety Standard for Refrigeration Systems and Designation and Classification of Refrigerants.

ICE PLANT

The equipment skid and its component parts (pumps, compressors, chillers condensers, etc.) that facilitate the heat exchange required to make ice.

ICE SYSTEM

A term used in totality describing the ice plant skid, ice floor system, header piping, header trench(s), heat recovery and HVAC&R energy saving components and dasher board systems. The ice system typically includes the concrete slab, sand, insulation and other materials encompassing the under-floor system.

DIRECT SYSTEM

A direct system circulates the primary refrigerant directly through the ice rink floor piping within the sand/concrete floor structure. There is no secondary solution of either glycol or calcium chloride in this type of system.

INDIRECT SYSTEM

An indirect system uses two refrigerants. The primary refrigerant is contained in the equipment machine room. The secondary refrigerant is circulated in the rink floor piping. The heat exchange occurs in the equipment machine room.

GWP: GLOBAL WARMING POTENTIAL

The effect of a refrigerant gas when released, aids in increasing the Greenhouse effect by trapping heat within the atmosphere.

ODP: OZONE DEPLETING POTENTIAL

The effect of refrigerant gases, as they breakdown into constituent components that are deleterious to the ozone levels in the atmosphere.

SYNTHETIC (MAN-MADE) REFRIGERANTS

Artificial man-made refrigerant gases such as R-22, R134a, R404a, R507, R407c, R410, etc.

NATURAL REFRIGERANTS

Natural occurring refrigerants such as Ammonia (R717), carbon dioxide (Co2-R-744), air, hydrocarbons.

EPA

Environmental Protection Agency. The agency responsible for mandating the safe and continued use, elimination and or replacement of all refrigerant gases in all industries, including those affecting rink ice systems.

GROUNDWATER

Water found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly geological formations of soils, sand and rock called aquifers.

1.0 Project Information

1.1 BUILDING BACKGROUND

Basic Building Information	Comments
Year Constructed	~2002
Year Put into Service	~2002
Type of Facility	Dual Pad Ice Arena
Building Square Footage	~75,600 SF
Ice Rink Square Footage	Red Rink – 85'x200' ~ 17,000 SF (NHL) Blue Rink – 85x200' ~ 17,000 SF (NHL)
Seating Capacity	Red Rink – 1,350 Blue Rink - 450
Season(s)	Red Rink ~ 11 months Blue Rink ~ 6 months
In Season Hours of Operations	Winter Weekdays ~ 5am to 10pm Winter Weekends ~ 8am to 10pm Summer ~ 15 hours per week Rinks used 50/50
Number of Ice Re-surfacers/Type	Zamboni 546, Propane Olympia, Propane
Number of Staff (Total)	In Season – 6 Full-time/4 Part-time
Number of Certified/Trained Staff	1
User Group(s)	Brookings Ice Skating Association Brookings Figure Skating Club Brookings Blizzard (NAHL, Tier) South Dakota State University (ACHA) Recreational/Public
Number of Locker Rooms	Red Rink - 6 Blue Rink - 4

Ice System Type	R22-Indirect/Glycol – See Below for additional comments
Dehumidification	Yes – see below for additional comments
Water Treatment (Flood Water)	Verify – see comment below
HVAC Building Automation System	No
Other	

1.2 ICE BACKGROUND

Ice Maintenance/Ice Conditions	Comments
Ice Thickness	1-1.25 inches check weekly
Ice Surface Temperature	19-21 degrees, taken from IRC Red rink is pre-chilled on games days
Estimated Number of Floods per day	6-7
Flood Water Temperature	120 degrees estimated
Quantity of flood water	97 gallons per flood, estimated
Quantity of Ice Removed each Resurface	Youth Practice - 50cu.ft or ½ bin, estimated Jr. Team Practice – 100cu.ft. or full bin, estimated
Edging	Weekly
Paint – Ice	Painted
Paint – Lines	Painted
Paint Logos/advertising	Vinyl
Installation Method	Boom and Spray

1.3 EXISTING CONDITIONS

SITE

The Larson Ice Center is located east of US I29 in Brookings, SD adjacent to 32nd Avenue. *See attached map.* Based on a visual observation of the site and the 2001 drawings, the building appears to be built in a low-lying area with the adjacent grade increasing in all directions to above the building finish floor elevation of 1644.50'.

The site drainage system consists of 5 inlets on the north, west and south parking lots and roadways. The east parking lot appears to surface drain to the east and eventually into a ditch adjacent to 34^{th} Avenue. As indicated in the CIMCO report there appears to be site drainage issues that may be adding to the wet subsoil conditions around the building. Upon review of the original Geotechnical Exploration Program from May of 2000, only 1 of the 13 borings indicated any presence of water. Because groundwater is seasonal it is difficult to assume that it did not exist at the time of construction, but given that there was no water observed to 16’-0” below grade in the original borings it is safe to assume that the wet subsoil conditions appearing today are a result of increased groundwater, poor surface drainage and additional development that has occurred in the area.

In addition to the site drainage issues it was also observed that there are roof downspouts draining directly to grade and adjacent to the foundation. According to the original drawings the roof drainage system should be internally piped and connected to the stormwater system on the North and South sides of the building. The downspouts observed should be overflow drains only. There are obvious signs of erosion at the downspout locations, which indicates a potential failure of internal system or roof issue. Further investigation is warranted.

Based on the conditions observed and the information provided in the CIMCO report, additional measures to mitigate site drainage contributing to the regional groundwater issues should be a priority to ensure a new installed ice system is protected.

Regarding construction activities on the site, there is adequate space on the east side of the building that can be isolated from the public for storage of materials and other construction related activities. The site will not hinder the ice system replacement or the options available for the ice systems.

BUILDING

The building, originally constructed in early 2002, is well maintained and appears to be well constructed for its time and intended purpose. The three components investigated for this report are access to the building and ice plant for improvements. Design of the ice plant machine room as it relates to code and life safety. An analysis of the installed groundwater mitigation system. The machine room and groundwater mitigation systems will be specially addressed in future paragraphs.

Both rinks have overhead door access to the east, which will allow for truck access during construction activities. The Red Rink has an overhead mezzanine/catwalk in front of the overhead door which will have to be removed for access to the rink floor. From the site investigation it appears as if the mezzanine can be easily disassembled and re-assembled to improve building access. This access will help minimize material handling costs during demolition and re-construction.

The dasher boards have been properly placed on the playing surface of both rinks. The dasher boards will be required to be removed prior to the concrete slab removal. In addition to being removed, proper storage will be required on-site. During installation of the new slab, new floor anchors will be required to be installed. The anchors should be coordinated with the original installer, Becker Arena Products, Inc.

The supply and return mains from the ice plant to the supply and return headers of the Red Rink are running east and west underground directly adjacent to the ice floor, from the south east corner of the machine room to a valve box located under the bleachers. To access the mains for removal and replacement, concrete will need to be cut and removed, and soils excavated. The removal will largely occur in the crawl space of the bleachers making it difficult to use large equipment. The removal will also require crossing the existing walls and support walls for the bleachers, which will require special considerations for the construction.

Access to the mains for the Blue Rink is somewhat vague on the original drawings. Based on a phone conversation with the Arena Manager, Bill Deblonk, it appears as if the mains for the Blue Rink run in the same location as the Red rink and "T" off to the south through the locker rooms and across the main corridor to a similar location as the Red Rink, in the Blue Rink crawl space of the bleachers. If this is accurate a similar removal procedure as the Red Rink will be required. This will cause disruption for access to the locker rooms and east side of the rink. However, the corridor will have limited or controlled traffic during construction activities.

Based on the site observations there does not appear to be any significant conflicts that will limit replacement of the ice plant or create extensive cost. To minimize disruption and cost an alternative route for the mains could be considered in the final design.

ICE PLANT MACHINE ROOM

The machine room is generally the component of the building that offers the most limits when selecting a new ice plant. In some cases, the machine room may not be up to current building code or it is situated interior to the building which limits access and consequently its availability for certain refrigerant types. In other cases, the room just simply isn't large enough to allow for installation of the new equipment.

The machine room at the Larson Ice Center is located on the east side of the building. The long wall of the machine room is adjacent to an exterior wall. There is no direct access to the exterior of the building from the machine room. However, it appears as if a "block-out" was installed in the east wall to allow for access or installation of the original equipment. The "block-out" is an 8-inch concrete masonry wall and appears to be approximately 12 feet wide and 10 feet high. The machine room is accessed by a pair of doors from the south through the resurfacer room. The machine room has no vestibule. The access doors to the machine room are not fire rated.

The machine room is approximately 20'-0" wide by 35'-0" long x 10'-0" high.

From the site observation, the machine room has some penetrations through the walls that appear to be fire rated, although they are not labeled. There are others that are clearly not rated and will need to be fire rated depending upon ice plant selection. It will be important during final design to verify that all the penetrations meet current building code and fire rating.

The machine room has a separate ventilation (supply and exhaust) system. Its not clear how the system is controlled or if the system is interconnected with leak detectors. The system will need to be upgraded to comply with building code and ASHRAE 15 standards based on the ice system selection.

Overall, the machine room is located and sized such that it will provide few obstacles for replacement of the ice plant. The issues that will require further exploration during design will be access to the room for installation of the new equipment. In other word, exploring how much demolition will be required to install the new ice plant. In addition to access, the room will need to be modernized to meet current building codes and standards, which may require new doors with exit hardware, fire rated joint sealants, exterior access door and a fire rated vestibule to adjacent spaces, including the resurfacer room.

GROUNDWATER MITIGATION

The CIMCO Report specifically identifies wet and saturated soils exist just below rink floor. As discussed earlier in this report it is believed that the heave in the Red Rink floor reflects the wet soils under the rink floor freezing during the ice season. At the time of the CIMCO Report a piezometer was installed on the east side of the building, east of the Red Rink. A complete log of the readings is below.

Date	Water Level Depth	Weather Conditions
9-06-18	96” below GL	Sunny/dry – rained 9-04-18
9-12-18	42” below GL	Sunny/dry
9-18-18	42” below GL	Rained 9-17 and 9-18
9-20-18	15” below GL	Rained 3” from 9-18 to 9-20
9-27-18	29” below GL	Rained on 9-24/sunny 9-27
10-22-18	38” below GL	Dry
10-26-18	39” below GL	Rained 10-25/Dry today

Based on the readings it appears as if groundwater is present near the building at times. Without further destructive investigation it difficult to ascertain if the groundwater witnessed at the exterior of the building is affecting the interior slab condition. The geotechnical report provided in the CIMCO report along with eye witness reports strongly suggest wet soils and high-water table do exist below the Red Rink slab. This was most evident when an excavation was conducted adjacent to the Red Rink while searching for the underfloor heating system leak. Standing water was observed in the excavation. During the October visit Übl witnessed wet soils were still present in the excavation.

The building has a typical installation of a foundation perimeter drainage system. Perforated perimeter drain pipe connected to two sump pits. The drawings are unclear as to where and how the pipes are connected to the sump pits and if the sump pits are connected to the stormwater system. From observations in the CIMCO report, sump pumps may not have been installed in 2002. There are currently sump pumps installed and water is being evacuated from below the building.

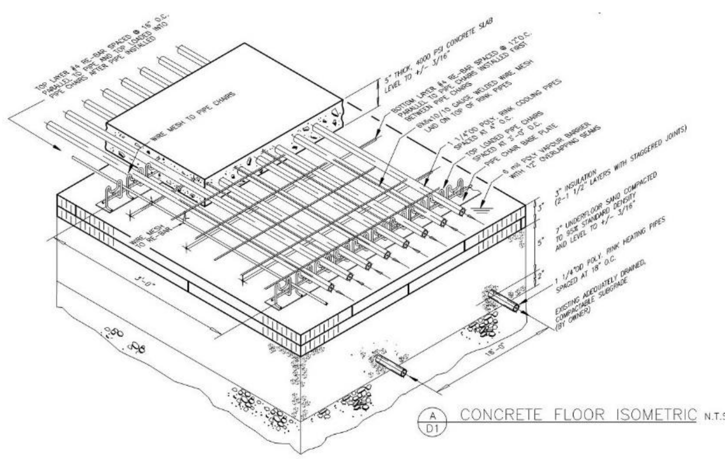
Based on the information observed and contained in the CIMCO Report, its clear to protect the slabs from future groundwater related issues a fully connected groundwater mitigation system will need to be installed. The system should include over excavation of the rink floor to a minimum of 18 inches below the 7-inch sand base to remove wet or saturated soils. Installation of an inter-connected, perforated pipe system surrounded by washed rock and sloped to a new sump and pump location. The new sump pit should include redundant pumps and remote monitoring. The new sump will then be connected the storm water system near the building. It will be important that both rink floors be corrected.

In addition to the groundwater mitigation measures, it will be important to resolve site related issues that are contributing to the wet soil conditions in the area.

RINK FLOORS

The existing ice rink floors are the same for both rinks. They consist of a 5-inch think reinforced concrete slabs with No. 4 bars at the bottom and 10-gauge welded wire mesh at the top. The cooling piping is 1-1/4” OD poly at 4” on center spacing, connected to 6” steel supply and return headers, located on the east side of the rink at about the face off dots. The headers are used to evenly distribute glycol in the nearly 16 miles of floor piping.

The floor section below the ice rink slabs includes 2 layers of foam insulation, the subfloor heating piping system surrounded by 7 inches of sand fill. The subfloor heating system consists of 1-1/4” OD poly piping at 18 inches on center spacing, fed by 3-inch headers. The drawings do not indicate if the subfloor heating headers are steel or poly, but from site observation it is clear they are steel.



A D1 CONCRETE FLOOR ISOMETRIC N.T.S.

As documented in the CIMCO Report, the Red Rink floor has deteriorated beyond repair from the frost heave associated with the failed heat exchanger. Without a destructive investigation I would suspect that the failure in the heat exchanger is due to the documented high-water table causing corrosion and failure of the steel subfloor heating headers. CIMCO did verify that the subfloor piping is leaking. During development of this report, it was reported by Bill DeBlonk that the Red Rink floor has shown signs of heaving this fall.

The Blue Rink floor, as documented in the CIMCO report, has minor cracking that can be repaired. However, the report indicated that the subfloor heating system is leaking under the Blue Rink as well, which would require complete removal to repair. If the Blue Rink is not repaired, within the next two seasons, it will likely fail like the Red Rink rendering it unusable.

Based on the investigation, both floors and their associated piping systems will need to be replaced. The Red Rink floor should be the priority as it has failed. The Blue Rink floor replacement should be priority number two. I would estimate given the information provided by the piezometer readings that if groundwater conditions stay consistent contributing to the freeze/thaw potential under the floor that the Blue Rink floor could begin to fail within the next two seasons.

ICE SYSTEM

The ice system is described in detail in the CIMCO Report. ***See Appendix A***

In basic terms, the ice system is an indirect R-22/Glycol ice plant by CIMCO Refrigeration with air cooled condensers located on the roof. The capacity is approximately 170 tons. The ice plant is original, installed sometime in 2002 making it about sixteen years old. The life expectancy of this plant is approximately 20 to 25 years with proper and regular schedule maintenance. Records provided by the staff indicate the system has received regular maintenance since at least 2009. Prior to 2009, the records are incomplete. With two of the compressors recently being overhauled and a third scheduled to be overhauled this fall/winter. Since 2009, $313,000+/- has been spent to keep the system maintained and refrigerants topped off.

Based on this assessment there are three significant issues that need to be considered as part of evaluating a replacement.

1. As has been well documented the heat exchanger has failed and needs immediate replacement to protect the Blue Rink Floor. The projected replacement of the heat exchanger will cost between $44,000 to $50,000. However, replacing the heat exchanger alone does not solve the frozen soils conditions as the piping is leaking.

2. The roof top condensers have multiple fans that have failed or reached end of life and need replacement. This essentially means new condensers for the ice plant. The projected replacement of the condensers will cost between $165,000 and $175,000.

3. The final and most significant issue is the discontinued production of R-22. After January 1, 2020 R-22 in its virgin form will no longer be produced. This will cause significant unknow consequences for users relying on R-22 as refrigerant source. As with other refrigerants that have been phased out it is expected that the cost of remaining supplies will rise dramatically. There are supplies of recycled R-22 available as an interim solution. However, there is no accurate documentation on the quantity of supplies available or how it will be priced.

As a side note to the ice system, the heat exchanger also provides heat for the resurfacer room ice melt pit. Currently the ice melt pit is non-functional, which means in order to dispose of the “snow” from the resurfacer the operator must dump the snow outside the building. As winter progresses this will place a burden on the building HVAC system resulting in higher energy costs to heat the building. This is also not an acceptable procedure for maintaining a safe and clean ice surface. The resurfacer can and will pick up rocks and debris that will get imbedded in the ice surface creating potential damage to the resurfacer and dangerous conditions for the users. It's important to building operations to get the ice melt pit up and working properly.

CONCLUSIONS

1. Ground water under and around the building has contributed to the concrete slab heaving. Excess water in the soils under the ice rink slab was permitted to freeze which caused the heaving of the slab. If the soils had not frozen it is doubtful that the heaving would have ever occurred. It is also likely that the excess ground water corroded the steel headers under the concrete which distributes the warm fluid needed for the subfloor heating system. Failure of the heating system is what caused the soils to freeze and heave. It is impossible to identify the root cause of the excess water. The best solution is it install a system to remove the water and make the site improvements required to minimize excess water being added to the surrounding soils.

2. The underfloor heating system for both rinks, which is critical for protecting the concrete rink floors, has failed from a combination of leaks under the concrete floor and a damaged heat exchanger. The heat exchanger is a piece of equipment that can be replaced, however without repairing the leaks it would eventually become damaged again. The piping under the concrete floor needs to be replaced for the system to work correctly. The only way to ensure all the leaks are fixed is to replace all the piping under the concrete floor. This will require a complete removal and replacement of the floor.

3. The Red Rink concrete slab has failed. It is damaged beyond repair with multiple cracks that cannot be fixed. If the slab continues to heave and recover it will become weaker, which will result in a widening of the cracks and eventually it will begin to break into small pieces at that point the slab will be unusable for its intended purpose. It must be replaced.

4. The Blues Rink concrete slab has minor cracking, which can be fixed. However, it must be removed to access and replace the leaking underfloor heating system. If the underfloor heating system is not replaced not only will it continue to cost the city money to replace the leaking glycol, but the floor will eventually suffer the same fate as the Red Rink floor. It will heave, become weak and crack to point it cannot be repaired.

5. The ice plant, the equipment used to cool the rink floor, is sixteen years old. It operates using R-22 as its primary refrigerant. R-22 in its virgin form will no longer be available after January 1, 2020. There are no known replacements for R-22 that can operate the ice plant. The other synthetic "blends" being considered as R-22 replacements are not proven to be safe for this type of use. After January 2020, the replacement cost for the remaining supplies and recycled R-22 will become unpredictable. As with other synthetic refrigerants that have been

phased out it will become expensive. In addition to the R-22 issue, the ice plant needs over $250,000 worth of upgrades and improvements to operate correctly and efficiently. The improvements in conjunction with the Rink floor repairs could allow the ice plant to operate for an additional 9-10 years. However, the replacement equipment will be limited for use on this system only and if the ice plant is replaced from either age or the discontinued use of R-22 this new equipment will be obsolete and abandoned at that time.

2.0 Ice System Replacement Options

2.1 OVERVIEW

The CIMCO Report provided four “Options” for a complete system replacement. The assumption in that report was that the rink floors could be saved. We now know that the underfloor heating loops and/or headers are leaking and both rink floor must be replaced. This report examines the potential replacement ice systems for determining a solution that best meets the needs of the Larson Ice Center and City of Brookings.

2.2 RINK FLOOR REPLACEMENT

The rink floor replacement is largely based on the selected ice plant replacement option. However, the following is a new typical installation that is recommended for both rink floors.

1. Over excavation of existing soils, 12-18” below that sand cushion to remove wet soils. Replacement with engineered fill and compacted to 95%. Sloped to drain.
2. Installation of the groundwater mitigation system. Consisting of 4-inch perforated pipe at the perimeter of the playing surface and 4-inch perforated pipe through the middle of the surface at 8’-0” on-center connected to a sump system.
3. Geotextile fabric separating the engineered fill from sand cushion.
4. 7 inches of under floor sand cushion compacted to 95% standard density.
5. Subfloor heating system consisting of 1-1/4-inch OD high density polythene piping (HDPE) at 18 inch on-center spacing, fed by HDPE header piping, located in a similar location as the current headers. All piping connections to be fusion welded to eliminate leaking potential. The HDPE will not breakdown if exposed to regular moisture.
6. Two 1-1/2-inch layers of rigid foam insulation with staggered joints.
7. 6 mil poly vapor barrier.
8. Cold floor piping per system selection, sitting on top loaded pipe chairs at 3’-0” on center.
9. 5-inch-thick concrete, reinforced with No. 4 bars and wire mesh, with smooth troweled finish.
10. Concrete densifier/sealer

2.3 ICE PLANT REPLACEMENT OPTIONS

The following are basic descriptions of the available Ice plants that could be considered for this application. More detailed descriptions are included in the CIMCO Report.

Indirect R507/134A

R507/134A primary skid with glycol floor in existing engine room connected to new mains for new floor systems. R507/R134A are man-made refrigerants, because of the volatility associated with man-made refrigerants we are not recommending one of these system for this project.

Indirect AMMONIA/GLYCHOL

Ammonia skid with Glycol floor in existing, updated machine room connected to new mains for new floor system. Ammonia is a natural occurring refrigerant.

Indirect CO2/GLYCHOL

Twin Co2 primary skids and glycol floor in or adjacent to existing engine room connected to new mains for new floor systems. Co2 is a natural occurring refrigerant.

Direct CO2

Twin Co2 primary skids in or adjacent to existing machine room connected to new mains and new floor systems. Co2 is a natural occurring refrigerant.

Ice Plant Selection

On page seventeen, a comparison chart is included which is to be used as a tool to evaluate the four available ice plant systems for this application. The chart identifies the major factors that must be considered when evaluating new systems. The chart includes factors such as the following:

- Phasing/Construction
- Machine room
- Cost(s)
- Regulations
- Energy efficiency
- Ice quality
- Life Cycle costs

There are instances when the chart is customized to address specific “localized” factors that may be unique to a specific rink. In those instances, the unique factors will be identified in the chart.

The chart compares and scores each system one thru four. The system which receives the highest point total is considered the preferred ice plant and will be the recommended system for this application. In the instance of a tie or a pair of scores that are very close, the Recommendation Section 3.0 will expand on the preferred ice plant.

COMPARISON CHART

	507/134a	Ammonia/Glycol[1]	Co2/Glycol	Co2 / Direct
Easily staged over two seasons with 2 floor phases	4	4	4	1
Delivery Lead Time	3	1	4	4
Demolition and rebuild of room required	2	1	2	2
Future Gas Phase-out	Y (1)	N (4)	N (4)	N (4)
Gas charge (lbs.)	1600 (2)	1000 (2)	500 (3)	3000+ (1)[2]
Gas cost ($/lbs.)	$20-30 (1)	$ 1.50 (4)	$2.00 (2)	$2.00 (1)
Energy Efficiency[3]	1	3	2	4
GWP (eq-Co2) [4]	1	4	3	3
Ice Quality	2	3	2	4+
Government Regulations	2	1	4	3
Diffusion Tank Required	4	1	4	4
Highly Codified Room [5]	2	1	4	4
Operator Experience[6]	2	1	3	4
Cost of Maintenance	2	2	3	4
Initial First Cost	4	3	2	1
Total Cost (LCC) 30+yrs	1	2	3	4
Total	34 Points	37 Points	49 Points	48 Points

[1] Calcium chloride or Glycol (Calcium much more efficient)
[2] Each direct floor would contain ~ 3000 pounds of Co2
[3] Assumed year round or 10-month operations (Co2 improves on shorter colder ambient seasons)
[4] Each pound of gas (inclusive of manufacture penalty) shown as equivalent pounds of Co2 (international GWP nomenclature)
[5] Room refers to Machine or Engine room only
[6] Refrigeration knowledge base required

3.0 Recommendations

3.1 RECOMMENDATION 1: SITE AND GROUNDWATER MITIGIATION

The groundwater and surface run off problems are a large contributing factor to the failing of the subfloor heating system and consequently the damaged Red Rink floor. This is an ongoing problem that needs immediate attention. Even with a new subfloor heating system this has the potential to contribute to future issues for the building, such a differential settlement, that could cause serious damage. It is recommended to focus on solutions to this issue first, such as the following:

- Verify that roof drainage system is working properly.
- Add downspout extensions and valley gutters to all over flow downspouts to divert water to roadway or parking areas.
- Ensure stormwater inlets in roadways and parking lots are clear of debris and working correctly.
- Install stormwater measures at north parking lot to retain gravel and silt from entering roadway and inlets.
- Re-grade and re-pave the east lot to ensure proper drainage to the ditch on east side of lot. Install additional storm water system to ensure proper drainage.
- Verify sump pumps for perimeter drain tile are working and are monitored. Connect sump pits to the stormwater system and make provisions for future sump pits for under floor drainage system to be connected to storm water system

This work should be completed in 2019.

Cost of Work: Unknown, further investigation is required.

3.2 RECOMMENTDATION 2: ICE PLANT

The Larson Center is in a precarious position. The R-22/glycol ice plant is an industrial quality plant that can operate effectively for 20-25 years, which means it still has 8-10 years of life left. However, it operates utilizing a synthetic refrigerant (R-22) that will no longer be produced after 2020. As of this report there are no synthetic replacements for R-22 that have been proven to replace it in the current system configuration and are safe for building occupants. This means that within the next 14 months from the date of this report the ice plant will likely become very expensive to operate.

In addition to the R-22 issue, the plant currently needs over $250,000 worth of service and recommissioning to continue to run as expected. That would include a new heat exchanger, new condensers, overhaul of compressor one, and updated controls. Replacement of the heat exchanger and compressors would be a short-term fix that would allow the ice plant to operate until such time that it was replaced with new plant utilizing a naturally occurring refrigerant. However, the newer equipment could not be reused on an ammonia or Co2 plant and would be abandoned at the time of decommissioning of the plant. What we are not able to predict at this time is how much additional cost will be required for unforeseen repairs to the current ice plant if it was kept operational for the next 8 to 10 years. What we do know is that over that past 9 years, at a minimum $313,000 has been spent keeping the ice plant running. Most of which was spent on refrigerant.

As a result of the impending R-22 concerns along with the necessary repairs to the current system It is recommended that the current ice plant be replaced with a new industrial quality Co2/glycol plant. This new plant would eliminate the R-22 issue before 2020 and would eliminate the necessity to spend funds to repair an aging plant.

The benefits of the Co2/Glycol package include the following:

1. It can be staged to accommodate phased replacement of the floors.
2. The delivery lead time accommodates the proposed design and construction schedule.
3. The plant utilizes a naturally occurring refrigerant that is not scheduled to be phased out. This will make the plant viable for its life span.
4. The plant does not require a codified machine room.
5. It has a slightly better life cycle cost than ammonia/glycol
6. It has a slightly better cost of maintenance than ammonia/glycol

The drawbacks of the Co2/Glycol package include the following:

1. The plant has a slightly higher first cost than ammonia/glycol
2. It has slightly less energy efficiency that ammonia/glycol or Co2 direct. Especially during the warmer months.

If the entire ice system is replaced as one phase and not multiple phases as proposed, it is recommended to consider replacement with a direct Co2 ice plant. The direct Co2 plant is superior to the other systems in all categories on the comparison chart with the exception that it cannot be phased and has a marginally higher first cost.

This work should be completed by 2019.

Indirect Co2/Glycol Ice System, Cost of the Work: $3,248,362[1] (See Appendix D)

Direct Co2 Ice System, Cost of the Work: $3,573,218[2] (See Appendix D)

[1] Includes the cost of the Red Rink floor and Blue Rink floor listed under recommendations 3.3 and 3.4.
[2] Includes the cost of the Red Rink floor and Blue Rink floor

3.3 RECOMMENDATION 3: RED RINK FLOOR

The Red Rink subfloor heating system and concrete floor has failed beyond repair. Continued use of the current ice plant with no subfloor heat and the groundwater issues will result in additional heaving of the floor, as has been recently witnessed. This will continue to further damage the floor and will cause damage to the cold floor piping and dasher boards.

The Red Rink floor needs to be fully replaced, including installing of a groundwater mitigation system. It is advisable to replace the Red Rink floor at the same time as the ice plant. The concern is that if the ice plant is staged to be installed following the Red or Blue Rink floors even one season later, there is the potential that the new floors could be damaged with no subfloor heat being installed.

It's important to note that because the subfloor heating system is not working there is a real possibility that the ground under the slab will be frozen. The frozen ground will be required to be fully removed and replaced with compactable material that is less susceptible to moisture. Removing frozen soils is costly and unpredictable. It is recommended that prior to removing the concrete floor, test holes be drilled to confirm underfloor conditions. The estimates included in this report assume that frozen soils will need to be removed.

This work should be completed by 2019.

Cost of the Work: Included with estimate for ice plant (See Appendix D)

3.4 RECOMMENDATION 4: BLUE RINK FLOOR

The Blue Rink subfloor heating system has failed beyond repair. However, the concrete floor does not appear to show signs of movement or heaving currently. It's difficult to predict if or when that will occur, but without a subfloor heating system and with the groundwater present it will likely happen within the next two seasons.

The Blue Rink floor needs to be fully replaced including the installation of a subfloor groundwater mitigation system to ensure it does not damage the cooling piping or dasher boards and that it remains useable for its intended purpose. Given its current condition, replacement does not need to occur immediately but should be budgeted for replacement within the next two seasons.

As with the Red Rink, the subfloor heating system is not working there is a real possibility that the ground under the slab will be frozen. The frozen ground will be required to be fully removed and replaced with compactable material that is less susceptible to moisture. Removing frozen soils is costly and unpredictable. It is recommended that prior to removing the concrete floor, test holes be drilled to confirm underfloor conditions. The estimates included in this report assume that frozen soils will need to be removed.

This work should be completed by 2020-2021, or as required to accommodate the building usage schedule

Cost of the Work: $711,520 (See Appendix D)

3.5 STAFFING AND TRAINING

At the time that the new ice plant is installed and commissioned it is recommended that a review of facility staffing occur. This should include:

- Review of the staff training and credentials. Regular staff training and professional development can affect building performance, operational costs and user experience. Also, with the introduction of a new refrigerant to the building it will be important that the staff is fully trained on procedures for handling the material.

3.6 FACILITY SPECIFIC CAPITAL IMPROVEMENT PLAN

Given the current age of the building 16 years old, the building is at a point that multiple systems will begin to approach their end of life or at a minimum will require major overhaul. It is recommended that a multi-year capital improvement plan be prepared to address future capital expenditures to ensure efficient operations of the facility. A plan would include:

- Review of exterior building components, to include roof, walls, joint sealants, doors, windows, etc.
- Review of the HVAC systems, to include dehumidification system in both rinks, controls and equipment.
- Review of plumbing systems, to include fire suppression.
- Review electrical systems, communications, fire alarm, electrical equipment and lighting.
- Review of energy efficiency measures

Appendix A

CIMCO Refrigeration, Evaluation Study and Site Audit Report.
Dated: August 2018

Appendix B

Banner Associates, Construction Plans for Brookings Ice Arena and Multi-purpose Room
Dated: February 2002

Appendix C

CIMCO Refrigeration, Shop Drawings Brookings Ice Arena
Dated: May 2001

Appendix D

Construction Budget(s) for Recommendations

The project budget(s) provided are the opinion of the design professional and are intended to be used for budgetary purposes only. They shall not be construed a “hard” bid. The accuracy of the budgets will vary depending upon the available information, local market conditions as well as other variables outside the control of the design professional.

The budgets are valid for 90 days from date of this report. Beyond that point it is recommended that a 2.5% to 3.5% multiplier be added for every 12-month period beyond the date of the report.

Larsen Center - Ice System Replacement

Cost Analysis | Co2/Glycol and Red Rink Floor

11/5/2018

	Unit	Quantity	Cost	Total	Notes
DEMOLITION				$ 302,520.00	
Demolition - Site	Lump	0	0	$ -	
Demolition - Rink Floor (concrete cutting and removal)	SF	17000	6	$ 102,000.00	Concrete floor only
Demolition - Soil excavation, removal, stockpile	SF	17000	5	$ 85,000.00	Assumes frozen soils removed to 24" below sand
Demolition - Mains to headers	SF	752	35	$ 26,320.00	For both Rinks, hand removal
Demolition - Existing Ice Package	Lump	1	35000	$ 35,000.00	
Demolition - Machine Room	Lump	1	25000	$ 25,000.00	For install of new skid
Demolition - Concrete at Engine Room	SF	600	12	$ 7,200.00	House keeping pads
Demolition - HVAC	Lump	1	12000	$ 12,000.00	To allow for upgrade to meet code
Demolition - Electrical	Lump	1	10000	$ 10,000.00	Disconnect systems
NEW CONSTRUCTION				$ 1,671,676.00	
New Sitework	Lump	1	0	$ -	
Ground water mitigation system and subgrade prep	SF	17000	2	$ 34,000.00	Up to sand bed
Geotextile fabric	SF	17000	1	$ 17,000.00	Between new soil and sand
Sand and pipe chairs	ea.	1	11880	$ 11,880.00	
Underfloor heating loop pipe and headers	ea.	1	22500	$ 22,500.00	
Sand install, re-level and compact	ea.	1	14500	$ 14,500.00	
4" insulation and VB	ea.	1	53000	$ 53,000.00	
Concrete floor c/w pipe, mains, re-bar, headers	SF	17000	10	$ 170,000.00	
Transmission mains, trenching and backfill	SF	752	76	$ 57,152.00	
Glycol, test, top up and filtration	ea.	1	12500	$ 12,500.00	
Supply and install new HDPE mains and valves	SF	752	72	$ 54,144.00	
Glycol, oil refrigerant and supplies	Lump	1	15000	$ 15,000.00	
Supply and install Co2 skid, gas cooler and piping	ea.	1	635000	$ 635,000.00	
Code ventilation systems, leak detectors	ea.	1	45000	$ 45,000.00	
Labor and supervision	ea.	1	235000	$ 235,000.00	
Refrigerant, insulation and supplies	ea.	1	45000	$ 45,000.00	
Electrical and controls	ea.	1	45000	$ 45,000.00	
Engine Room Renovation	Lump	1	125,000	$ 125,000.00	
System Commissioning	Lump	1	10,000	$ 10,000.00	
Other - Hole cutting (Piping)	Lump	1	8,000	$ 8,000.00	
Other - Roof modifications (gas cooler)	Lump	1	6,000	$ 6,000.00	
Other - Fire rated sealants	Lump	0	3,000	$ -	
Other - Remove , store and Re-install Dasher Boards	Lump	1	25000	$ 25,000.00	
Other - Goal posts, pegs and install	Lump	1	8500	$ 8,500.00	
Other - Refrigeration isolation and service (Blue Rink)	Lump	1	12500	$ 12,500.00	
Other - Pump out, store glycol and recharge	Lump	1	10000	$ 10,000.00	
NET SUBTOTAL				$ 1,974,196.00	
SOFT COSTS				$ 562,645.86	
General Conditions	Lump			$ 177,677.64	9% of Net Subtotal
Contingency - Construction	Lump			$ 98,709.80	5% of Net Subtotal
Contingency - Design	Lump			$ 59,225.88	3% of Net Subtotal
A/E Fees	Lump			$ 167,806.66	8.5% of Net Subtotal
Permitting/Insurance	Lump			$ 19,741.96	1% of Net Subtotal
Testing	Lump			$ 39,483.92	2% of Net Subtotal (Geotech, concrete, soils)
PROJECT BUDGET				**$ 2,536,841.86**	
	Actual	**Low Range**	**High Range**		
PROJECT BUDGET RANGE	$ 2,536,841.86	$ 2,409,999.77	$ 2,663,683.95		
COST PER SF	$ 39.17	$ 37.21	$ 41.13		

Larsen Center - Ice System Replacement

Cost Analysis | Blue Rink Floor

11/5/2018

	Unit	Quantity	Cost	Total	Notes
DEMOLITION				$ 187,000.00	
Demolition - Site	Lump	0	0	$ -	
Demolition - Rink Floor (concrete cutting and removal)	SF	17000	6	$ 102,000.00	Concrete floor only
Demolition - Soil excavation, removal, stockpile	SF	17000	5	$ 85,000.00	Assumes Frozen Soils
Demolition - Mains to headers	SF	0	35	$ -	
Demolition - Existing Ice Package	Lump	0	35000	$ -	
Demolition - Machine Room	Lump	0	25000	$ -	For install of new skid
Demolition - Concrete at Engine Room	SF	0	12	$ -	House keeping pads
Demolition - HVAC	Lump	0	12000	$ -	To allow for upgrade to meet code
Demolition - Electrical	Lump	0	10000	$ -	Disconnect systems
NEW CONSTRUCTION				$ 426,380.00	
New Sitework	Lump	1	0	$ -	
Ground water mitigation system and subgrade prep	SF	17000	2	$ 34,000.00	Up to sand bed
Geotextile fabric	SF	17000	1	$ 17,000.00	Between new soil and sand
Sand and pipe chairs	ea.	1	11880	$ 11,880.00	
Underfloor heating loop pipe and headers	ea.	1	22500	$ 22,500.00	
Sand install, re-level and compact	ea.	1	14500	$ 14,500.00	
4" insulation and VB	ea.	1	53000	$ 53,000.00	
Concrete floor c/w pipe, mains, re-bar, headers	SF	17000	10	$ 170,000.00	
Transmission mains, trenching and backfill	SF	0	76	$ -	
Glycol, test, top up and filtration	ea.	1	12500	$ 12,500.00	
Supply and install new HDPE mains and valves	SF	0	72	$ -	
Glycol, oil refrigerant and supplies	Lump	0	15000	$ -	
Supply and install Co2 skid, gas cooler and piping	ea.	0	515000	$ -	
Code ventilation systems, leak detectors	ea.	0	45000	$ -	
Labor and supervision	ea.	0	0	$ -	
Refrigerant, insulation and supplies	ea.	1	45000	$ 45,000.00	
Electrical and controls	ea.	0	45000	$ -	
Engine Room Renovation	Lump	0	105,000	$ -	
System Commissioning	Lump	0	10,000	$ -	
Other - Hole cutting (Piping)	Lump	0	8,000	$ -	
Other - Roof modifications (Condensers)	Lump	0	6,000	$ -	
Other - Fire rated sealants	Lump	0	3,000	$ -	
Other - Remove , store and Re-install Dasher Boards	Lump	1	25000	$ 25,000.00	
Other - Goal posts, pegs and install	Lump	1	8500	$ 8,500.00	
Other - Refrigeration isolation and service (Blue Rink)	Lump	1	12500	$ 12,500.00	
Other - Pump out, store glycol and recharge	Lump	0	10000	$ -	
NET SUBTOTAL				$ 613,380.00	
SOFT COSTS				$ 98,140.80	
General Conditions	Lump			$ 27,602.10	9% of Net Subtotal
Contingency - Construction	Lump			$ 12,267.60	2% of Net Subtotal
Contingency - Design	Lump			$ 12,267.60	2% of Net Subtotal
A/E Fees	Lump			$ 27,602.10	4.5% of Net Subtotal
Permitting/Insurance	Lump			$ 6,133.80	1% of Net Subtotal
Testing	Lump			$ 12,267.60	2% of Net Subtotal (Geotech, concrete, soils)
PROJECT BUDGET				**$ 711,520.80**	

	Actual	Low Range	High Range
PROJECT BUDGET RANGE	$ 711,520.80	$ 675,944.76	$ 747,096.84
COST PER SF	$ 10.99	$ 10.44	$ 11.53

Larsen Center - Ice System Replacement

Cost Analysis | Co2 Direct and both rink floors
11/5/2018

	Unit	Quantity	Cost	Total	Notes
DEMOLITION				$ 489,520.00	
Demolition - Site	Lump	0	0	$ -	
Demolition - Rink Floor (concrete cutting and removal)	SF	34000	6	$ 204,000.00	Concrete floor only
Demolition - Soil excavation, removal, stockpile	SF	34000	5	$ 170,000.00	Assumes frozen soils removed to 24" below sand
Demolition - Mains to headers	SF	752	35	$ 26,320.00	For both Rinks, hand removal
Demolition - Existing Ice Package	Lump	1	35000	$ 35,000.00	
Demolition - Machine Room	Lump	1	25000	$ 25,000.00	For install of new skid
Demolition - Concrete at Engine Room	SF	600	12	$ 7,200.00	House keeping pads
Demolition - HVAC	Lump	1	12000	$ 12,000.00	To allow for upgrade to meet code
Demolition - Electrical	Lump	1	10000	$ 10,000.00	Disconnect systems
NEW CONSTRUCTION				$ 2,302,056.00	
New Sitework	Lump	1	0	$ -	
Ground water mitigation system and subgrade prep	SF	34000	2	$ 68,000.00	Up to sand bed
Geotextile fabric	SF	34000	1	$ 34,000.00	Between new soil and sand
Sand and pipe chairs	ea.	2	11880	$ 23,760.00	
Underfloor heating loop pipe and headers	ea.	2	0	$ -	Included with cold floor piping cost
Sand install, re-level and compact	ea.	2	14500	$ 29,000.00	
4" insulation and VB	ea.	2	53000	$ 106,000.00	
Concrete floor c/w pipe, mains, re-bar, headers	ea.	2	235000	$ 470,000.00	
Transmission mains, trenching and backfill	SF	752	76	$ 57,152.00	
Glycol, test, top up and filtration	ea.	0	12500	$ -	
Supply and install new HDPE mains and valves	SF	752	72	$ 54,144.00	
oil refrigerant and supplies	Lump	0	15000	$ -	
Supply and install Co2 skid, evap condensers and piping	ea.	2	375000	$ 750,000.00	
Code ventilation systems, leak detectors	ea.	1	45000	$ 45,000.00	
Labor and supervision	ea.	1	275000	$ 275,000.00	
Refrigerant, insulation and supplies	ea.	2	73000	$ 146,000.00	
Electrical and controls	ea.	1	78000	$ 78,000.00	
Engine Room Renovation	Lump	1	75,000	$ 75,000.00	
System Commissioning	Lump	1	10,000	$ 10,000.00	
Other - Hole cutting (Piping)	Lump	1	8,000	$ 8,000.00	
Other - Roof modifications (Gas Coolers)	Lump	1	6,000	$ 6,000.00	
Other - Fire rated sealants	Lump	0	3,000	$ -	
Other - Remove , store and Re-install Dasher Boards	Lump	2	25000	$ 50,000.00	
Other - Goal posts, pegs and install	Lump	2	8500	$ 17,000.00	
Other - Refrigeration isolation and service (Blue Rink)	Lump	0	12500	$ -	
Other - Pump out, store glycol and recharge	Lump	0	10000	$ -	
NET SUBTOTAL				$ 2,791,576.00	
SOFT COSTS				$ 781,641.28	
General Conditions	Lump			$ 251,241.84	9% of Net Subtotal
Contingency - Construction	Lump			$ 139,578.80	5% of Net Subtotal
Contingency - Design	Lump			$ 83,747.28	3% of Net Subtotal
A/E Fees	Lump			$ 223,326.08	8.0% of Net Subtotal
Permitting/Insurance	Lump			$ 27,915.76	1% of Net Subtotal
Testing	Lump			$ 55,831.52	2% of Net Subtotal (Geotech, concrete, soils)
PROJECT BUDGET				**$ 3,573,217.28**	

	Actual	Low Range	High Range
PROJECT BUDGET RANGE	$ 3,573,217.28	$ 3,394,556.42	$ 3,751,878.14
COST PER SF	$ 55.17	$ 52.41	$ 57.93

Larsen Center - Ice System Replacement

Cost Analysis | Indirect Ammonia/Glycol and Red Rink Floor
11/5/2018

	Unit	Quantity	Cost	Total	Notes
DEMOLITION				$ 302,520.00	
Demolition - Site	Lump	0	0	$ -	
Demolition - Rink Floor (concrete cutting and removal)	SF	17000	6	$ 102,000.00	Concrete floor only
Demolition - Soil excavation, removal, stockpile	SF	17000	5	$ 85,000.00	Assumes frozen soils removed to 24" below sand
Demolition - Mains to headers	SF	752	35	$ 26,320.00	For both Rinks, hand removal
Demolition - Existing Ice Package	Lump	1	35000	$ 35,000.00	
Demolition - Machine Room	Lump	1	25000	$ 25,000.00	For install of new skid
Demolition - Concrete at Engine Room	SF	600	12	$ 7,200.00	House keeping pads
Demolition - HVAC	Lump	1	12000	$ 12,000.00	To allow for upgrade to meet code
Demolition - Electrical	Lump	1	10000	$ 10,000.00	Disconnect systems
NEW CONSTRUCTION				$ 1,554,676.00	
New Sitework	Lump	1	0	$ -	
Ground water mitigation system and subgrade prep	SF	17000	2	$ 34,000.00	Up to sand bed
Geotextile fabric	SF	17000	1	$ 17,000.00	Between new soil and sand
Sand and pipe chairs	ea.	1	11880	$ 11,880.00	
Underfloor heating loop pipe and headers	ea.	1	22500	$ 22,500.00	
Sand install, re-level and compact	ea.	1	14500	$ 14,500.00	
4" insulation and VB	ea.	1	53000	$ 53,000.00	
Concrete floor c/w pipe, mains, re-bar, headers	SF	17000	10	$ 170,000.00	
Transmission mains, trenching and backfill	SF	752	76	$ 57,152.00	
Glycol, test, top up and filtration	ea.	1	12500	$ 12,500.00	
Supply and install new HDPE mains and valves	SF	752	72	$ 54,144.00	
Glycol, oil refrigerant and supplies	Lump	1	15000	$ 15,000.00	
Supply and install Co2 skid, gas cooler and piping	ea.	1	515000	$ 515,000.00	
Code ventilation systems, leak detectors	ea.	1	45000	$ 45,000.00	
Labor and supervision	ea.	1	235000	$ 235,000.00	
Refrigerant, insulation and supplies	ea.	1	45000	$ 45,000.00	
Electrical and controls	ea.	1	45000	$ 45,000.00	
Engine Room Renovation	Lump	1	125,000	$ 125,000.00	
System Commissioning	Lump	1	10,000	$ 10,000.00	
Other - Hole cutting (Piping)	Lump	1	8,000	$ 8,000.00	
Other - Roof modifications (gas cooler)	Lump	1	6,000	$ 6,000.00	
Other - Fire rated sealants	Lump	1	3,000	$ 3,000.00	
Other - Remove , store and Re-install Dasher Boards	Lump	1	25000	$ 25,000.00	
Other - Goal posts, pegs and install	Lump	1	8500	$ 8,500.00	
Other - Refrigeration isolation and service (Blue Rink)	Lump	1	12500	$ 12,500.00	
Other - Pump out, store glycol and recharge	Lump	1	10000	$ 10,000.00	
NET SUBTOTAL				$ 1,857,196.00	
SOFT COSTS				$ 529,300.86	
General Conditions	Lump			$ 167,147.64	9% of Net Subtotal
Contingency - Construction	Lump			$ 92,859.80	5% of Net Subtotal
Contingency - Design	Lump			$ 55,715.88	3% of Net Subtotal
A/E Fees	Lump			$ 157,861.66	8.5% of Net Subtotal
Permitting/Insurance	Lump			$ 18,571.96	1% of Net Subtotal
Testing	Lump			$ 37,143.92	2% of Net Subtotal (Geotech, concrete, soils)
PROJECT BUDGET				**$ 2,386,496.86**	

	Actual	Low Range	High Range
PROJECT BUDGET RANGE	$ 2,386,496.86	$ 2,267,172.02	$ 2,505,821.70
COST PER SF	$ 36.85	$ 35.00	$ 38.69

Appendix E

Proposed Design and Construction Schedule

The Construction Schedules provided are the opinion of the design professional and are intended for planning purposes only. Actual time for design and construction will need to be confirmed and agreed upon at the time of Contract award.

Proposed Design & Construction Schedule – Co2/Glycol Ice System Replacement and Red Rink Floor	
Übl submits Final Report to Council	November 27, 2018
Contract prepared and awarded for design	December 11, 2018
Design and Engineering	March 15, 2019
Bidding	April 5, 2019
Contract Award	April 9, 2019
Contracts Completed	April 16, 2019
Construction Begin	May 1, 2019
Substantial Completion	August 23, 2019
Commissioning and System Orientation	August 23, 2019
Cool floor down	August 26-30
First Ice Making	August 30, 2019
Final Completion	September 13, 2019
Refresh Training	January 2020
Pre-warranty walk-through	August 2020

Proposed Design and Construction Schedule – Blue Rink Floor	
Design and Engineering	March 15, 2019
Bidding	April 5, 2019
Construction Begin	May 2020
Substantial Completion	July 2020
Commissioning	July 2020
Cool floor down and First ice making	August 2020
Final Completion	October 2020

Proposed Design & Construction Schedule – Co2 Direct Ice System Replacement and Both Rink Floors	
Übl submits Final Report to Council	November 27, 2018
Contract prepared and awarded for design	December 11, 2018
Design and Engineering	March 15, 2019
Bidding	April 5, 2019
Contract Award	April 9, 2019
Contracts Completed	April 16, 2019
Construction Begin	May 1, 2019
Substantial Completion	August 23, 2019
Commissioning and System Orientation	August 23, 2019
Cool floor down Red Rink	August 26-30
First Ice Making	August 30, 2019
Final Completion	September 13, 2019
Refresh Training	January 2020
Pre-warranty walk-through	August 2020