

APPENDIX 4N

**DETAILED VENUE
ANALYSIS: OLYMPIC
OVAL**

CALGARY BID EXPLORATION COMMITTEE

VENUE BRIEF:

University of Calgary Olympic Oval:

**PROPOSED Long Track Speed Skating
CALGARY, ALBERTA, CANADA**

PREPARED FOR

CALGARY BID EXPLORATION COMMITTEE, Master Facilities Plan

PREPARED BY

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DATE

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INTRODUCTION

As part of an exploratory exercise to determine the feasibility of Calgary presenting a bid to host another Olympic and Paralympic Winter Games, a high level survey and study was conducted to review potential major competition and non-competition sites. One of the primary components of the exercise was to look at where there were synergies between venues and maximize existing infrastructure and transportation links/corridors.

The Oval at the University of Calgary has been identified as the potential site for Speed Skating competition. The Calgary Bid Exploration Committee (CBEC) focused their attention on the Oval at the University of Calgary, which was built for Speed Skating competition at the 1988 Winter Olympic Games. Using the concept to maximizing existing infrastructure, the venue provides substantial efficiencies in operational readiness, time, and costs.

The information contained in this document is to provide the (CBEC), Facility Owners, and Planning Teams further information on venue use, spatial requirements, and any challenges that need to be explored regarding this venue.

PROPOSED SCOPE & WORKING ASSUMPTIONS

The University of Calgary Oval has been proposed as a competition venue, hosting the following events:

Sport:	Skating	
Discipline:	Speed Skating	
Events:	Men's	500 m
	Ladies'	500 m
	Men's	1,000 m
	Ladies'	1,000 m
	Men's	5,000 m
	Ladies'	3,000 m
	Men's	10,000 m
	Ladies'	5,000 m
	Men's	Team Pursuit
	Ladies'	Team Pursuit
	Men's	Mass Start
	Ladies'	Mass Start

Throughout the exploratory discussions the following working assumptions have been applied:

- Ice surface meets International Skating Union (ISU) Winter Olympic track standards for an ISU 400m Speed Skating track, and is laid out in accordance with ISU Regulations for warm-up and competition lanes;
- Ice plant is fully operational and sized for Olympic Games operations and use;
- Heating, Ventilating, Air Conditioning (HVAC) is fully operational and able to meet games requirements for temperature and humidity levels or is feasible for modification;
- Venue seating capacity meets a minimum of 6,000 seats;
- Seating bowl is code compliant and meets best practice for accessible and amenity seating. Any additional seating required to meet venue capacity to be provided for through temporary infrastructure;
- Full use of venue is available for Olympic use including external compounds, parking, and all ancillary spaces. Shared or exclusive use periods to be determined during venue use agreement planning phase;

- Venue is located within an operating University, secure perimeters, vehicle and pedestrian screening, transport operations, and other amenities and services are required and will alter current access, use, and movements of the venue and surrounding areas;
- Lighting levels will require upgrades to meet the Olympic Games Broadcast requirements, see Appendix A;
- Roof structure has the capacity to hold additional loads for lighting, cameras, flags, look banners and/or dimensional rings, audio, video boards, and score boards;
- Toilets are code compliant and meet accessible guidelines and best practice;
- Concessions are in good working condition with all services operational, code compliant, and accessible;
- Adjacent sports fields to be used for venue operations, site works will be required to modify site for access and operations;
- Back of House (BOH) athlete access and operational vehicle access is required,

The material below is a non-exhaustive listing of the major areas and will act as a preliminary benchmarking tool when assessing the overall venues ability to operate as the Speed Skating competition venue. Using this material will provide the information needed to complete the next series of space studies to confirm flows, functional area space allocation, and develop further confirmation of required permanent works necessary.

As part of the University, there needs to be further dialogue around the overall site access, egress, vehicular flows and security footprint, but as an initial phase of work the brief below will advise as to the baseline requirements. There is minimal reference to the interior spatial requirements for the sport venues as most of the facilities have the primary requisites within their standard operating design, any gaps observed are noted at the end of the document for consideration. Further information on the Sport Federation and Media requirements will come later in the process.

OVAL BASELINE REQUIREMENTS

1 | General Venue Use

The Organizing Committee Olympic Games (OCOG) will need to take possession of the venue and its surrounding site areas to allow sufficient time for build out and overlay works. Build out requirements are based on the number of compounds, cabling requirements, and overall build scale and complexity.

A typical build out duration for a Speed Skating venue is approximately 6-12 weeks prior to athlete training start, this includes venue lock down, technical rehearsals, and hand over to the games time operations team.

Coordination between the venue owner and the OCOG is required to confirm non-exclusive use and exclusive use periods to allow for games build out, games operations, and remediation of the venue and site post games. As Speed Skating is not a Paralympic sport, remediation works can begin immediately post the end of Olympic Games competition, [REDACTED]

[REDACTED]

[REDACTED]

Full use of the venue is required, including all exterior compounds, parking, ice maintenance areas, suites, food service areas, retail outlets, storage areas, home team locker rooms, offices, and facilities, and all operational spaces necessary to operate during the games.

2 | Front of House (FOH) Program Requirements

Front of House (FOH) areas are where spectator access, circulation, accommodations, and event viewing spaces are provided. FOH operations include spectator entry points, ticket scan, circulation concourses, concessions, ticket resolution, spectator services and information, retail outlets, toilets, water stations, spectator medical, and access to spectator seating and competition viewing areas.

The main entry and exit at the venue happens in the FOH through a secure venue perimeter fence line, spectator security screening, and ticket rip operations. Venue entry and exit points will be determined through crowd modeling exercises with the University and the potential

Athlete's Village operations to established through put rates to ensure optimal spectator flows around the venue and load-in of spectators to the Oval for competition.

General considerations for the front of house include providing spectator toilets and seating to meet best practices in accessibility, amenity seating, and concessions to ensure all spectators are able to enjoy the games without limitations. A thorough review of the venue's accommodations needs to be completed to determine where improvement works may be necessary to meet best practice and code compliance for an international sporting event. In addition to ensuring all seating is accessible and code compliant, all existing suites will need to be made available for use in operations, sport production, international federation spaces, and additional spectator seating.

FOH areas optimally occur in existing spaces internally, however, there may be a requirement for additional spectator spaces to be provided to meet operations and games planning requirements. These spaces would be provided through temporary infrastructure in the spectator plaza, entry spaces, and concourses. Internal space allocation and the requirements for external temporary spaces will be confirmed in the next phase of the venue confirmation and detailed planning.

a. FOH External Program Requirements

i. Venue Perimeter

A secure venue perimeter fence line is required around the full perimeter of the venue, including compounds and entry plazas. Depending on the security threat level at the time of the Games, this perimeter fence line may be a double fence system with a footprint of approximately 3m in depth. The fencing would be ballasted to ensure stability in the event of heavy winds, and may be engineered as part of a vehicle mitigation system. The fence will be covered in fence fabric with the look of the games applied, and entry and egress points.

ii. Ticket Box Office

A ticket box office is required outside the venue secure perimeter, next to the spectator entry point for ticket sales, will-call, or ticket related services. This is a cabin structure with ticket portals, approximately 30m² plus queuing space.

iii. Pedestrian Security Screening

Entry into a venue, whether by spectators or accredited persons, happens through a pedestrian security screening (PSA) process occurs in tent portals where each individual is scanned and checked prior to entry into the venue. The area and number of PSA's will be determined in the crowd modeling exercise, which will determine the spectator throughput rates into the venue, establishing the number of PSA's required. One dedicated lane for accredited persons will need to be provided at the Spectator/FOH PSA's.

iv. Ticket Scan

Ticket scan will occur just after security screening operations at the venue perimeter, prior to access into the spectator plaza, as an extension to the entry process. The area and number of ticket scan portals will be determined once the PSA throughput rates have been established.

v. Spectator Plaza

The spectator plaza occurs between the PSA's and the venue, with direct access to the spectator concourses, where spectator amenities and services are provided, as well as access to spectator seating and competition areas. The size of the spectator plaza will be determined through the crowd modeling exercise and spectator load-in/egress rates. Based on the existing conditions of the venue, the spectator plaza, concourses, and amenities may be provided with temporary infrastructure including toilets, concessions, retail outlets, spectator medical, ticket resolution, and information, prior to entry into the seating bowl and competition areas.

vi. Spectator Services – Plaza

Spectator services storage and staging areas are required for golf carts, wheel chairs, and stroller storage – this area should be no larger than 25m². In addition, an animal relief area, with direct access to potable water and drainage, is required. This area should be no larger than 10m².

vii. Exit or Blow Out Gates

Exit gates or blow out gates are located adjacent to the entry PSA portals. The number of

gates is determined based on the venue capacity and crowd modeling, to accept the exiting spectators from the Oval into the University's general population and circulation.

b. FOH Internal Program Requirements**i. Spectator Services – Information and Storage**

An area, existing or temporary, to be provided for spectator information, lost and found, and additional wheel chair and stroller storage. This space should be located centrally in the main spectator concourse area and should be approximately 25m² in area with provisions for a counter to provide separation between event services staff and spectators. Use of the existing venues information office is preferred.

ii. Ticket Resolution

A ticket resolution office or area, existing or temporary, to be provided centrally in the main spectator concourse area. This area should be approximately 10m² in area, with provisions for a counter to provide separation between ticketing staff and spectators. Use of the existing venues ticket box office is preferred, if located within the venue secure perimeter.

iii. Concessions

Use of the existing concession areas to be provided, depending on the number of existing concession areas, additional temporary areas for concession sales may be required. Approximately 108 linear meters of concession counter space is required. A thorough review of the existing concessions conditions, operations, and services to be completed to determine if upgrades are required to ensure code compliance along with spectator accessibility best practice and compliance.

iv. Retail Outlets

Use of the existing retail store outlet to be provided, depending on the size, additional temporary retail outlets may be required. Approximately 108 lm of retail outlet counter space is required.

v. Spectator Toilets

Use of all existing spectator toilets to be provided, and additional temporary toilets may be required to accommodate the venue use. A thorough review of the existing toilets to be completed to determine if upgrades are required to ensure all toilets provide the required accessibility provisions to meet best practice and code compliance per the venue capacity.

vi. Spectator Medical

Use of the existing spectator medical area to be provided. If the existing spectator medical does not exist, a space of approximately 50m² is required. The space needs to have water and drainage, along with direct access to an accessible toilet.

vii. Water Stations

Water areas to be provided within the venue through existing drinking fountains or water fill stations. Water to be tested for drinking water compliance. Number of stations to be compliant with venue capacity and located throughout the spectator concourse areas.

c. Other Major FOH Program Requirements

i. Seating

The existing spectator seating gross capacity will be reduced by 15 – 20% due to accredited seating requirements, camera platforms, broadcast and press tribunes, and photo positions.

3 | Back of House (BOH) Program Requirements

Back of House (BOH) areas are where sport, competition management, and all venue operational spaces are located. Several spaces are required to be internal to the venue, with others in compounds outside the venue, with access to the venue for servicing and operations.

BOH operational areas include athlete areas, competition management, athlete medical, anti-doping, International Federation and Olympic Family areas, sport presentation, technology, food and beverage compound, cleaning and waste compound, workforce check-in and break areas, logistics compound, site compound, security, venue operations and management,

broadcast compound, press operations (venue media center and press conference room), and venue accreditation. In addition, there are services compounds, parking, venue access points, and emergency services vehicle staging points required in the BOH.

General considerations for the external BOH compound spaces include paved surfaces for high traffic use – vehicle and pedestrian, along with structures – tents, cabins, containers, and equipment. Connections to water and waste, along with fibre communications is a plus to minimize additional works that would be required for necessary service connections. Overall drainage of the BOH compounds is critical for proper surface water drainage. Considerations for internal BOH spaces include direct connections to the external BOH spaces for cabling and venue servicing.

a. BOH Internal Program Requirements

i. Athlete Areas

Space for all athlete areas should be provided inside the venue with direct access to the Field of Play (FOP) infield for on and off ice athlete areas. Speed Skating specific athlete areas include (11) athlete dressing rooms, bike storage, athlete lounge, and warm-up area with an area requirement of approximately 3,300m².

ii. Competition Management

The competition management space is where sport operations offices and work areas are located. Specific spaces include competition management offices, draw room, conference room, as well as International Technical Official and Technical Delegates work areas. The space should be located with direct access to the FOP level and easy access to the timing and scoring platform, with an area requirement of approximately 400m².

iii. Athlete Medical

Athlete medical to be located with direct access to the FOP level, the ice, and athlete areas, requiring a space allocation of approximately 250m², and connections to water and waste.

iv. Anti-Doping

If space is not available within the venue adjacent to the athlete locker and warm-up areas,

anti-doping operations can be located outside the venue, with direct covered access to the athlete spaces within the venue. Anti-Doping space to be compliant with World Anti Doping Agency (WADA) space and processing guidelines, whether located within the venue or in a temporary cabin structure. The anti-doping space required is approximately 250m² and requires connections to water and waste.

v. International Federation

The International Federation (IF) for Speed Skating is the International Skating Union (ISU). There is a requirement for IF spaces within the venue for offices, meeting space, and an ISU lounge. This space is approximately 300m² and should provide direct access to toilets.

vi. Olympic Family

The Olympic Family (OF) lounge and protocol offices to be located in existing lounge or club spaces or areas directly adjacent to the Olympic Family seating areas, with dedicated toilets. This space needs to be a minimum of 400m².

vii. Sport Presentation

Sport presentation includes spaces for medals ceremonies offices, presenter staging and dressing rooms, and mascot changing. These areas need to be located on the FOP level with easy access to the FOP, with an area of approximately 150m².

viii. Technology Operations

Dependent on readily available connections to fibre, there may be a requirement for compound spaces for technology and cellular structures, staging, and containers for equipment and storage. This storage can be in the form of a tent or several containers. The compound space required is approximately 500m². Operational spaces for timing and scoring, work areas, and offices to be located on arena level with direct access to the FOP, this area is approximately 500m².

b. BOH External Program Requirements**i. Food and Beverage Compound**

The food and beverage compound is the space for storage of both food and beverages, along with kitchen and food prep areas. Dependent on the venue, a temporary kitchen and additional storage is necessary to service all the additional lounges and food services outside concessions and standard venue operations. Food and beverage sponsors, i.e. Coke, will also provide their own containers for storage on site and require a minimum of 1.5 days storage of products. This compound also requires offices, workforce areas, toilets, connections to water, waste, power, and easy truck access for daily off-hours deliveries. The compound space required is approximately 1000 – 1500m², depending on existing venue kitchen facilities.

ii. Cleaning and Waste Compound

The cleaning and waste compound is an area for the staging of the large mobile collection bins, bin wash down area, compactors for the required waste streams, storage of cleaning and waste cleaning and paper products, along with offices. The compound space required is approximately 800m² with an additional area of 1000-2000m² for snow removal equipment and snow storage.

iii. Workforce Check-In and Break

An area to be provided for workforce check-in and break areas adjacent to the venue and workforce accredited entry to the venue. These spaces can be in a tent structure, with workforce check-in space allocation at approximately 225m² and workforce break at approximately 650m².

iv. Logistics Compound

The logistics compound requires space for an office cabin, toilets, staging, and storage space. Additionally, this compound will provide containers for storage for other functional teams, dependent on in-venue storage, as well as parking for large equipment and vehicles. This compound is approximately 1000m², and must be secured due to the equipment and goods stored.

v. Site Management Compound

The site compound requires space for offices, toilets, staging, and storage areas for Site Management along with Energy, Look of the Games, and Signage and Wayfinding. Additionally, this compound requires parking for large equipment, vehicles, and spares, with an overall compound space requirement of approximately 1000m², and must be secured due to the equipment and goods stored.

vi. Security (SEC) Operations

As a venue within the University, a full secure perimeter is required with control points and accredited pedestrian security screening, entry/exit access points. Accreditation access points are located BOH, with exception to one FOH accredited entry. Accredited entry points are provided for Staff, Olympic Family, Athletes, IF, and Media.

In addition, security operations requires offices, control centre, briefing, and storage spaces – these can be in the venue or in an external compound tent or cabin structure, with a compound size of approximately 300m². Dedicated power and direct fibre communications connections are required to support their secure independent servers and operations.

vii. Venue Management Operations

If space is not available in the venue, a venue operations centre is required. This space will house the offices for venue management and miscellaneous functional areas, event services offices and storage, venue briefing area, venue communications centre, and storage as required. If located externally, these spaces can be in a tent or cabin structure, and is approximately 400m².

viii. Broadcast Compound

The Speed Skating broadcast compound for the Olympic Broadcast Service at the Winter Games, requires approximately 5000m² of clear open space immediately adjacent to the venue. The compound provides Rights Holder Broadcast (RHB) spaces and Olympic Broadcast Service technical operations, offices, and connections to the International Broadcast Centre and in venue operations.

The compound will also require its own dedicated generator compound, dedicated to Olympic

Broadcast Service operations in the compound and at the venue. This space is roughly an additional 500m² of required space, directly adjacent to the BRD compound.

In venue operations include camera positions and platforms, commentator positions, mixed zone, broadcast studio(s) at approximately 30 m², commentator control room at approximately 50m², and Broadcast Information Office at approximately 25m².

ix. Press Operations

Dependent on space available in the venue, a Media Centre may need to be located externally to the venue, with direct access for the media to travel between the tribunes, photo positions, mixed zone, and the media centre. The media centre can be housed in a tent, with requirements for offices, lounge, lockers, and workroom. A media centre for Speed Skating is approximately 1000m².

In addition, there is a requirement for a Press Conference Room – if space is not available in the venue with connections to the media center and the tribunes, it can be located next to an external media center, adjacent to the venue with direct access for the press and athletes, to and from the tribunes and mixed zone, and is approximately 300m².

x. Transport

A transport office, storage, and drivers lounge is required outside the venue secure perimeter to manage vehicle access, traffic, and venue load zones. This area is next to the VSA and parking areas. These structures can be tents or cabins and require space approximately 50m² for the Driver's lounge and 100m² for offices and storage.

xi. Venue Accreditation

A venue accreditation office is required outside the venue secure perimeter, next to the Olympic Family and Media entry points. This is a cabin structure approximately 30m².

c. Other Major BOH Program Requirements

i. Services and Access

Access to water and waste, along with access to fibre connections is required for BOH

compound spaces. In addition, there will be a Field of Play (FOP) and BOH energy requirement for prime generated power, along with redundancy generated power requirements. Energy compounds are broken into specific areas adjacent to the compounds and the venue with the most direct routes to reduce cable lengths. Roughly 4 compounds should be considered, outside the broadcast (BRD) compound, of approximately 500m² each.

ii. Parking and Vehicular Access

Each BOH compound will require parking within its compound for various operations. Additionally, Athlete's, officials, Olympic Broadcast Service and operational staff require parking – this can be as high as 150 parking stalls, with an area of approximately 4000m².

Further transportation planning with new and existing public and games transportation systems can reduce this number, but should not be less than 50 stalls for this venue.

BOH venue vehicle access is through a security vehicle screening area. A loop in and out of a venue is preferred, allowing for easy access of large trucks without backing up at any point of its entry into a venue. There is only one point of entry and exit for vehicles at a venue.

iii. Ambulance Staging

Emergency services vehicles will also require space within the venue BOH, dependent on the safety plans – fire trucks would be centrally located within the venue, however, two ambulances would be required for the venue – one dedicated to Athlete's and the other for Spectators. These ambulances are located adjacent to the building, with direct access to both the FOP and spectator areas, and require connections to power.

4 | Field of Play Space Requirements

The field of play (FOP) is the area where competition takes place, for Speed Skating this area is the ice surface. In addition, to the FOP area, there are several areas that are directly adjacent which are also considered part of the FOP. These areas include athlete access to the infield, infield area, starter's platforms, lap counters, athlete prep area, broadcast camera platforms and track camera, photographer risers, ice resurfacing operations and equipment storage, pad storage area, off-ice staging, medical staging, and the mixed zone for both broadcast and press.

General considerations for the FOP include the requirement for the ice surface to meet International Skating Union (ISU) Winter Olympic track standards for an ISU 400m Speed Skating track, and is laid out in accordance with ISU Regulations for warm-up and competition lanes. In addition, humidification requirements for the ice, along with on ice temperature requirements for the athletes. HVAC systems need to be reviewed to confirm compliance for games, as modifications may be required.

Further, lighting levels are required to meet Broadcast lighting requirements, See Appendix A. Lighting may require modification to meet the lighting levels and to cover the international ice surfaces.

a. Ice Program Requirements

i. Ice Surface

International ice surface is required to meet federation requirements for Winter Olympic Games track and lane requirements based on the ISU track standards.

ii. Ice Surface Platform and Staging Zone

There is a zone at the edge of the ice surface and pad system that expands the FOP approximately 3-4m in depth around the full circumference of the ice surface. This area houses the padding system, sport circulation, broadcast platforms and track camera, photographers' risers, officials, and timing and scoring FOP equipment and positions.

iii. Infield

The infield area is located in the center of the oval ice surface, this is where athletes and officials enter and exit the competition area. The infield operations and space allocation includes athlete on and off ice, athlete prep area, infield medical positions, broadcast platforms and handheld positions, and timing and scoring equipment.

b. FOP Off-Ice Program Requirements**i. Off-Ice Areas**

Ice maintenance operations to be located directly off ice and requires a space of approximately 150m² for staging of equipment. Use of existing venue pits, staging, plant, and other ice maintenance operational spaces to be utilized.

ii. Mixed Zone

The mixed zone is the location where media interview athletes immediately post competition, and is the athletes' pathway back to the athlete areas from the FOP. There are three areas required in a mixed zone, the athlete lane, broadcast and press corrals, and the circulation corridor to feed the broadcast and press areas. The athlete lane needs to be 2m deep minimum, the full length of the mixed zone. Broadcast requires roughly 18 (1.8m x 1.8m) positions with the circulation corridor behind, approximately 2m deep. Press requires roughly 70m length by 3m deep as a minimum, with the circulation corridor, 2m deep. Back drops are required on the Athlete side that may take an additional .5m of space the full length of the mixed zone. Access to the mixed zone is directly adjacent to the athlete off-ice area.

c. Other Major FOP Program Requirements**i. Training**

Training and competition occur at the venue, creating long operational periods and requirements for services.

ii. Roof Loads

The FOP roof structure requires the capacity to hold additional loads for lighting, cameras,

flags, look banners and/or dimensional rings, audio, internet and mobile antennas, video boards, and score boards. An estimated load requirement is 29 tons to meet games requirements. The structure should be surveyed to confirm load capacity.

iii. Field of Play Lighting

Requirements for broadcast level lighting must be provided at each venue to meet the OBS technical specifications for broadcast lighting. See Appendix A for the OBS Broadcast Lighting Technical Specifications.

VENUE TRANSPORT SUMMARY

Refer to Appendix 4AA

DRAFT

VENUE PROFILE SUMMARY

Venue: Speed Skating Oval

Location: University of Calgary

Key Contact: Boris Dragicevic / Yves Hamelin

Owner/operator: U of C

Current use: National and International Events

	Yes/No	Comments:
FOP standards/IF approval:	Yes/no?	IF approved 88 olympics
Operational space	No	Need separation for non-accredited spectators Locker rooms Could be provided in temp. structure.
External space – FOH	yes	Could work with temporary structure or permanent addition
External space – BOH	yes	Requires new access road
Parking	Limited	Most parking is us in A.V. lay down
Utilities services (gas/water):	yes	existing
Mechanical/electrical:	Yes	May require upgrade. Electrical needs distribution upgrade for existing loads and to accommodate emergency power.
Technology/BMS:	yes	
Fiber connectivity:	Yes	Redundant fiber exists.
Access & Egress Transit:	Yes	Existing venue served by LRT
Access & Egress Pedestrian:	yes	
Long term use contracts:	yes	Used for national speedskating community.
Capital improvement plan:	yes	Ice plant is old but well maintained, no plans for slab replacement
Adjacent land (plans in use):	yes	Very tight with athletes village.
Lighting levels for broadcast use:	no	Needs to be supplemented for 2026 Olympic standards.

VENUE GAPS, CHALLENGES, AND CAPITAL WORKS PROJECTS

The Oval at the University of Calgary, is an ideal location for consideration for the Olympic Games. The operations and legacy use of the facility are Speed Skating focused and operated by an expert team. In addition, the venue has been currently used for ISU World Cups and Distance Championships, showing the feasibility of the venue for competition, ensuring as a baseline, that this venue can be developed, using existing and temporary infrastructure to build out the venue to meet current Olympic Games requirements for competition, space and operations.

The Olympic games brings a different number of users and accredited groups, protocols, security, and overall operations that are not seen in daily operations at smaller competitions like the ISU World Cups and Distance Championships or past Olympic Games. With this in mind, along with the age of the facility, there are several areas to be reviewed and considered for upgrades.

The following gaps, challenges, and capital works projects are discussed to give a complete view to the feasibility and potential requirements for additional works at this venue.

1 | Venue Gaps

a. Seating Capacity

The current gross seating capacity is lower than the ideal number for this venue. CEBC has commissioned a seating study using existing and temporary seating to confirm the maximum capacity to ensure understanding of existing venue maximum capacity.

Fixed Seating to Existing Concrete Terrace/Steppings

- Capacity of 1786 seats
- Minimum 460mm seat centres
- Stanchions fixed in to existing concrete (riser fixed to face of terrace)
- Existing concrete 'going' at 700mm
- Front row to be handrail as 'going' only 400mm (see sections)
- Handrails required to all gangways as risers deeper than 200mm (i.e. 450mm – 494mm). Existing central gangway handrails to be removed
- Assumes requirement for handrail to rear of terrace (none shown on existing drawings)
- Please refer to all other 'notes' and 'recommendations' on drawing title blocks

Arena 'Clearview' Temporary Stand

- Capacity of 1692 seats
- 500mm seat centres
- Stand built on level ground
- 6 x vomitory staircases to gangways for access and egress
- Tunnel access to centre
- 800mm 'going'
- 533mm risers



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DRAWN BY: [Name]
CHECKED BY: [Name]
APPROVED BY: [Name]

1. SEATING CAPACITY

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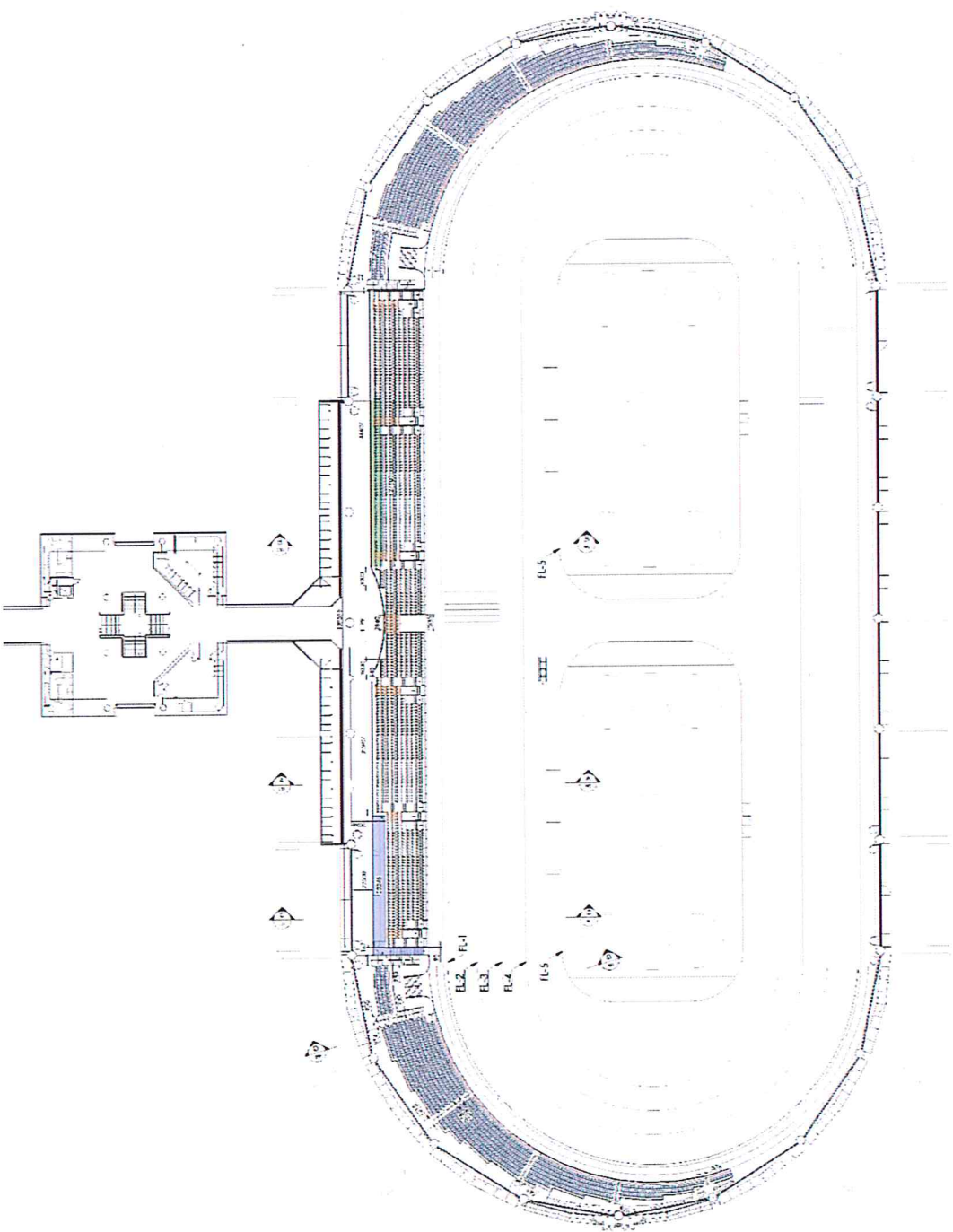
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- 1. SEATING CAPACITY FOR ARENA N. 1000
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PROJECT: ARENA GROUP LTD.
LOCATION: 1000 10th Avenue, Suite 1000
Calgary, Alberta T2P 1A1
DATE: 13/03/17
DRAWN BY: [Name]
CHECKED BY: [Name]
APPROVED BY: [Name]

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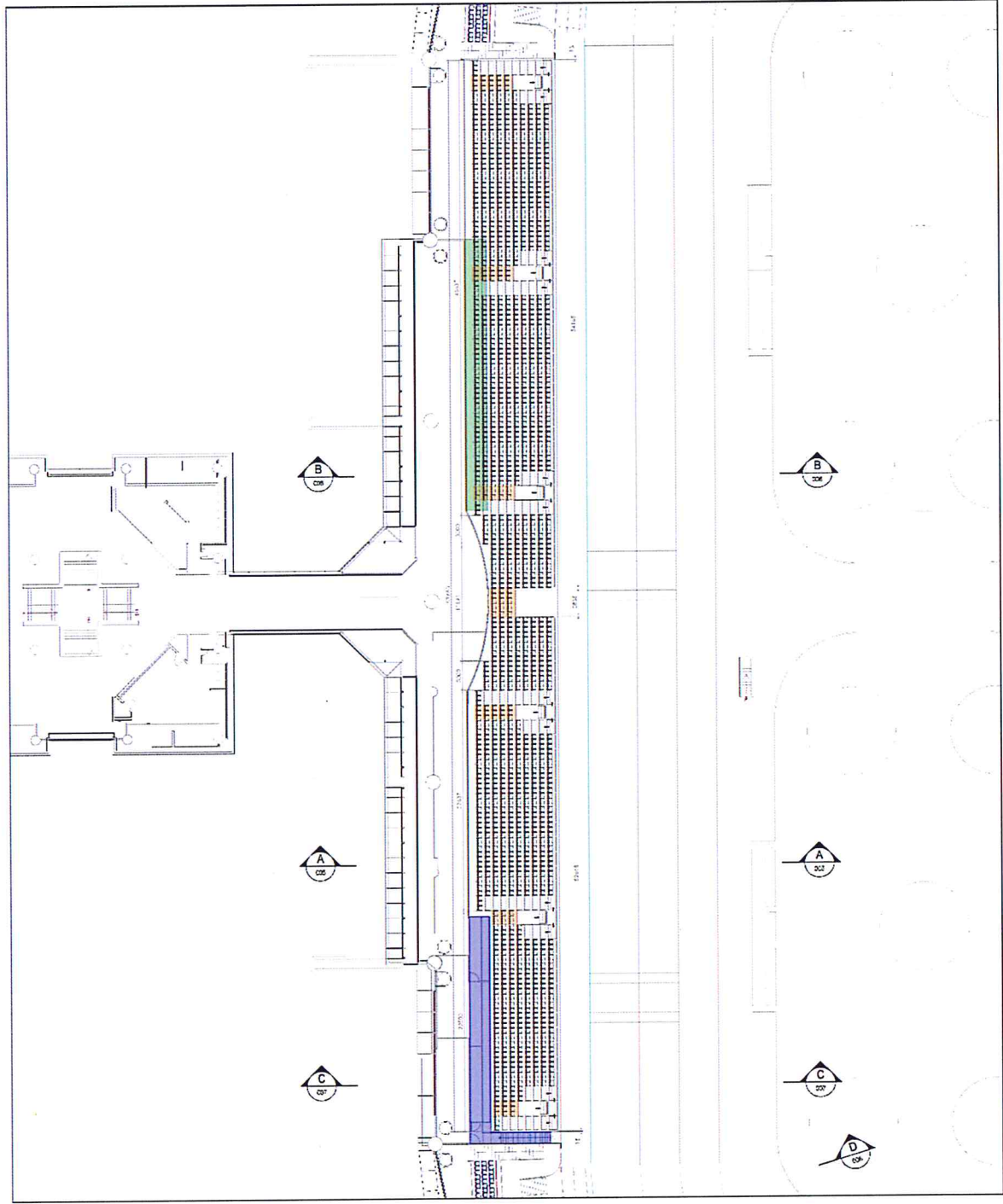
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PROJECT: CALGARY OLYMPIC OVAL
DRAWING: SEATING CAPACITY
DATE: 13/03/17
BY: [Signature]
CHECKED: [Signature]
APPROVED: [Signature]

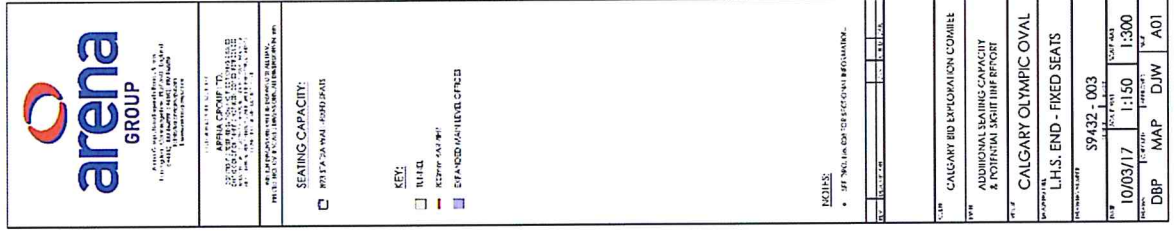
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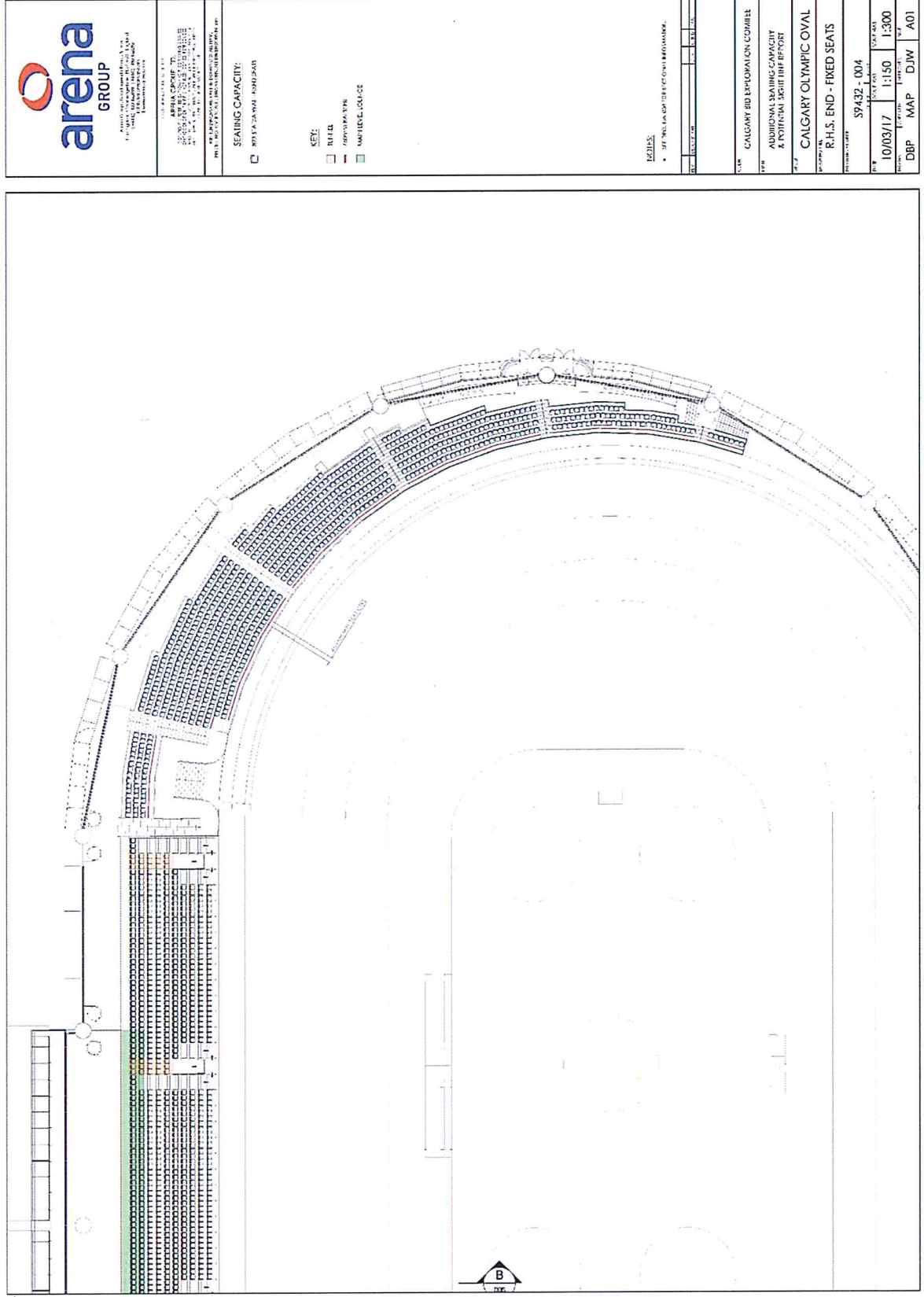
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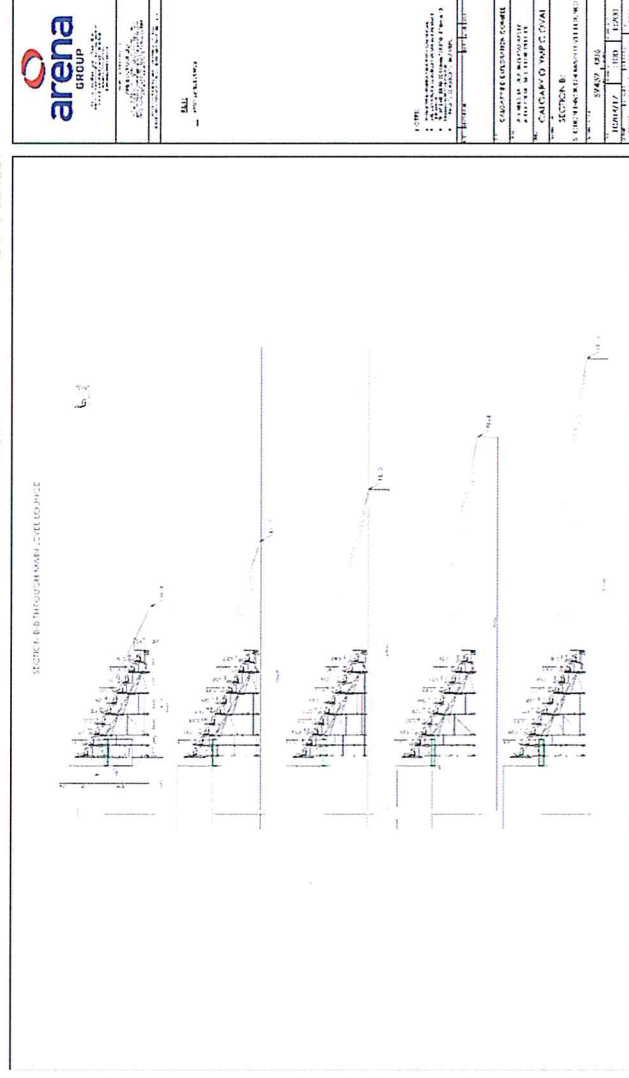
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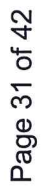
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ADDITIONAL SEATING CAPACITY
A TECHNICAL SEATING REPORT
CALGARY OLYMPIC OVAL
MIDDLE STAND PLAN VIEW
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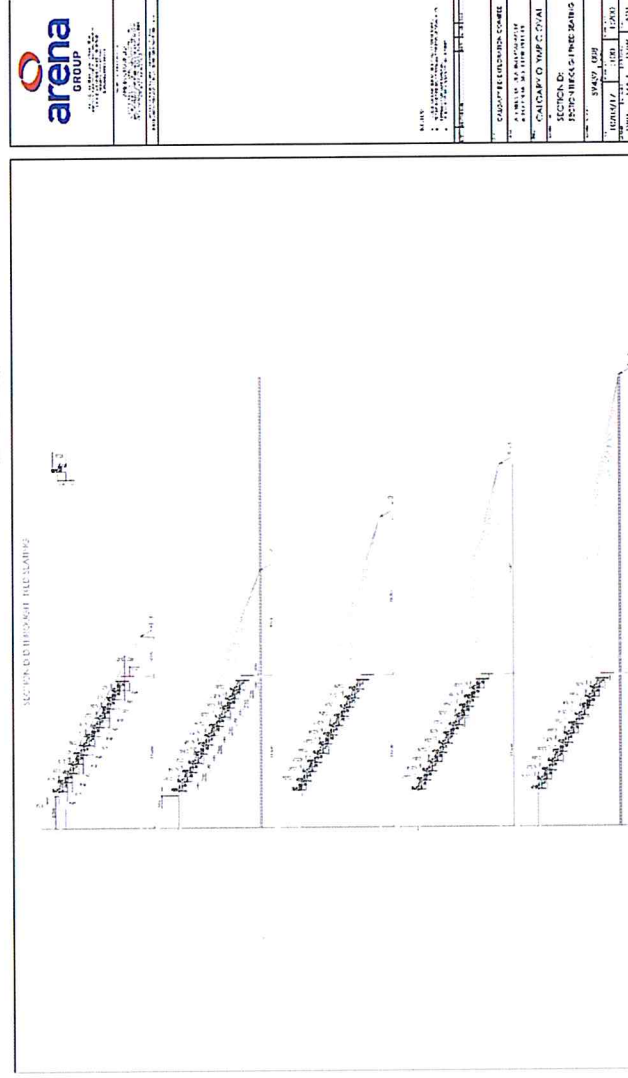












b. Venue Challenges

i. Spectator Entry, Plaza, and Services

The existing venue does not have sufficient area in the FOH for spectator entry and services to meet Games requirements, this includes concessions, toilets, retail outlets, ticketing resolution, information, and storage. A spectator plaza, using temporary infrastructure will be required to provide this additional space.

ii. BOH Compounds

The current Oval structure does not have enough internal space to meet Games operational requirements. Additional compounds will need to be provided on the exterior in adjacent fields and areas, which will require additional scope for ground works and services to create these compound spaces and make the necessary connections to the existing venue.

iii. University Location

The Oval is located within an active University with direct connections to a high traffic Kinesiology Building. Access and flows around the Oval during build out and Games will alter the way the venue and surrounding operate.

c. Capital Works Projects

As an existing venue, specific areas need to be reviewed to determine if upgrades will be necessary to meet Games requirements. The following items have been reviewed by GEC Architecture, to confirm current conditions and provide recommendations for upgrades to meet Olympic requirements.

i. FOP

- 1) FOP Requirements and Conditions
- 2) Refrigerated Slab and Ice Plant Conditions
- 3) FOP Access Tunnel Expansion

ii. Spectator Areas and Amenities

- 1) New Spectator Entry

- 2) Toilet Facilities Capacity
- 3) Toilet Facilities Conditions including Code Compliance, Family, and Accessible Requirements
- 4) Concessions Capacity and Conditions
- 5) Accessible and Amenity Seating Conditions

iii. Athlete and Support Amenities

- 1) Locker Toilet Capacities and Conditions

iv. Roof Loads and Capacities

- 1) Current Roof Loads and Overall Capacities

v. FOP Lighting

- 1) Current Lighting Conditions and Capacities

vi. Mechanical Systems

- 1) Current Conditions and Capacities of the HVAC System
- 2) Current Humidity Control Conditions
- 3) Water and Sanitary Load Capacities

vii. Site

- 1) BOH Compound Ground Works
- 2) Vehicle Access to BOH Plant Area

APPENDIX A: BROADCAST LIGHTING TECHNICAL SPECIFICATIONS



Esteem Projects & Consultancy

Date: 8th February 2017

Re: Olympic Broadcasting Service (OBS) summary of current Broadcast Lighting Technical Specifications.

Following is a summary of the OBS technical specification for broadcast lighting. The IOC and OBS would provide a comprehensive specification on confirmation of the Olympics Host City.

Below sets out the key areas for consideration when planning and design for games time lighting.

In addition to the completion area that require quality lighting are the non field of play areas such as

- Mix zones
- Press conference rooms
- Announcer positions
- Athlete holding areas
- Athlete pathways to FOP
- Spectator areas
- Warm up areas and Fields of play
- Medal and Flower Ceremony's
- Flags of Nations and Ceremony Flags

The technical specifications provide the detailed requirement for all venues. Sport specific requirements can vary between sports and venues. Consideration should be given to these specific requirements when formulating designs and equipment.

OBS Technical Specifications Summary **Version February 2017**

Light source (lamp)

The specified requirements apply to all light source (lamp) technologies e.g. HID (MHN, HQI, HSI, HIT, MSR, MSD etc.), LED, fluorescent etc.

Flicker

To support HFR production requirements and irrespective of the lamp technology e.g. HID, LED etc., the lighting shall be flicker free; the lamp driver/control gear shall be of the electronic type with an output frequency $\geq 1,000\text{Hz}$.

Low wattage lamps are preferred. The lamps shall be from the same manufacturer and from the same production batch.

Colour temperature:

The colour temperature, Tk, shall be 5600K (standard TV camera preset).

All lamps shall have the same colour temperature. That is, the colour temperature shall be nominally one value e.g. 5600K. Differences in colour temperature between different wattage lamps (at the FOP in question) are not acceptable.

It follows that if the competition of a sport is held at two (or more) venues, the FOP broadcast lighting of each shall have the same colour temperature.

Colour rendering¹⁰:

The CIE CRI Ra shall be ≥ 85 ;

and if no proven international standard installations of the lamp/luminaire system exist, a live field test with the intended light source/luminaire and a broadcast quality camera in cooperation with a national sports broadcaster shall be conducted and the results made available for review;

or

- Alternatively, TLCI11 Qa ≥ 85 ; or
- Alternatively, CRI Ra ≥ 85 and a R9 ≥ 45 ; or
- Alternatively, CRI Re(R1-R15) ≥ 85 .

If, for practical reasons (legacy, economics etc.), the lighting over the spectators has different lamp technology luminaires to the FOP, the colour temperature of these (spectators) luminaires shall not be higher than the FOP lamps.

Lighting equipment and operating conditions

The lighting equipment shall be suitable for the operating environmental conditions of the venue in question; and ensure that the lamps operate at the correct colour temperature and light output characteristics. The lighting equipment shall comply with the relevant host country's electrical safety standards. Luminaires shall comply with IEC 60598. The lamps shall comply with the relevant IEC lamp standards.

Winter Games outdoor venues, cold weather and lamp performance.

Extreme cold weather affects the proper functioning of all lamps (HID, HMI, fluorescent, LED). Apart from a lower light output, in particular the colour temperature may change significantly even between individual lamps and become unacceptable.

Lamps shall be operated on control equipment designed for very low temperatures so that the lamp operates to the stated nominal performance characteristics and meets the above requirements; and be utilised in luminaires designed for cold temperatures.

Anticipated light output losses due to low temperatures shall be factored into the lighting design.

The projected Games time temperatures shall be established well in advance.

Secondary warming (heating) the localised ambient temperature and air space control to ensure compliance should be considered. If necessary tests should be carried out to ensure the equipment would operate at the Games time predicted operating temperatures.

Calculation and measurement grids

Calculation grid intervals shall nominally be 2m (varies per sport – see specific sport requirements).

Illuminance towards a camera - known as camera illuminance, E_c , shall be on a plane nominally at 1.5m above the FOP surface.

Vertical illuminance, E_v , towards a nominated side of the FOP shall be on a plane nominally at 1.5m above the FOP surface.

Horizontal illuminance, E_h , shall be calculated/measured on the FOP surface.

Compliance illuminance measurement grid intervals shall nominally be 4m.

Note: the calculation plane shall match the gradient/slope of the FOP; e.g. cycling track, alpine skiing slalom; and/or the athlete's principal competition 'line' through the space above the FOP which may be a vertical plane e.g. skiing freestyle aerials, diving and ski jumping.

Camera locations

The camera positions modelled in a lighting design shall be as specified by OBS. Nominal camera plans are provided as production teams can survey the venues and formulate related plans.

HD, 4k and HDR

The on-going evolution from standard definition to high definition and beyond raises the question of

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illuminance levels. The reality is that with most professional broadcast camera system cameras, the sensitivity remains the same. In other words, the illuminance criteria herein remain the same for HD and 4K.

Similarly, high dynamic range (HDR) provides no additional restriction. At the time of publication 8K is in the early stages but it likely that the same requirement will prevail. The reader should check with OBS for currency.

Minimum illuminance

The minimum vertical illuminance at any point of the FOP shall be $E_c \geq 1,600$ lux towards the main cameras.

Note: the minimum average illuminance and the average horizontal illuminance are determined by the uniformity ratios. For HDTV/4K it is imperative the uniformities are met or exceeded. The minimum vertical illuminance at any point of the FOP towards the orthogonal directions of the FOP, where camera #1 is central to a side, or 45° to the 4 sides of the FOP where camera #1 is not central to a side shall not be less than 70% of the minimum illuminance towards any main camera.

Uniformities for FOP

Vertical illuminance uniformity for each relevant main camera.

The minimum to maximum camera illuminance ratio, $E_{c \min}/E_{c \max}$, shall be ≥ 0.7 for the FOP; and ≥ 0.4 for the FOP-surround.

The minimum to average ratio, $E_{c \min}/E_{c \text{ ave}}$, shall be ≥ 0.8 for the FOP; and ≥ 0.6 for the FOP-surround.

Horizontal illuminance uniformity

The minimum to maximum ratio $E_{h \min}/E_{h \max}$, shall be ≥ 0.7 for the FOP; and ≥ 0.4 for the FOP-surround and/or run-off

The minimum to average ratio, $E_{h \min}/E_{h \text{ ave}}$, shall be ≥ 0.8 for the FOP; and ≥ 0.6 for the FOP-surround and/or run-off

The ratio of vertical illuminances at any point on the FOP between the orthogonal planes (at either 90° or 45°; i.e. four calculation planes only) facing the four sides of the FOP shall be ≥ 0.75 and ≤ 0.9 .

The average vertical illuminance on the FOP towards camera #1, or the designated principal camera, shall be greater than the average vertical illuminance towards the other 3 orthogonal directions.

The uniformity gradient UG , for both horizontal (UG_h) and vertical illuminance to main cameras (UG_c) shall nominally be $\leq 10\%$ on a 2m calculation grid (varies per sport by interpolating the appropriate calculation grid).

The UG_v of the vertical illuminance towards the backlight side or sides where there are no fixed cameras shall nominally be $\leq 20\%$ at 4m grid intervals (varies per sport and interpolation).

The ratio of the average horizontal illuminance of the FOP surround to the average horizontal illuminance of the FOP shall be ≥ 0.6 and ≤ 0.8 , target 0.7.

Slow motion replay zone (SRZ): some sports will have a defined SRZ. In the absence of a specific SRZ requirement, the $E_{c \max}$ towards the main camera, shall be at the FOP centre.

Coefficient of variation (CV): the CV shall be ≤ 0.13 .

Maximum illuminance

Whilst firstly complying with the six basic specified uniformity criteria i.e. $E_{c \min}/E_{c \max}$, $E_{c \min}/E_{c \text{ ave}}$, $E_{h \min}/E_{h \max}$, $E_{h \min}/E_{h \text{ ave}}$, UG_c and UG_h , the maximum illuminance towards the main cameras, $E_{c \max}$, $\geq 2,000$ lux.

Luminaires and aiming logic

The luminaire-aiming angle shall be $\leq 65^\circ$. Light should reach any point within the total FOP from at least three directions where the third directional component should form a 'backlight' to one or both of the other two directions, with respect to the main cameras.

No luminaire shall be aimed directly at a camera, and not within a 50° cone centred on the camera lens. If the aiming point potentially coincides with a (hard/main) camera, the azimuth aiming angle shall be outside a cone of 50°.

A luminaire within the field-of-view (FOV) of the main cameras and aimed generally in a direction towards the cameras shall be constructed, or fitted with a glare-controlling device. The control shall be such that the light emitting area of the lamp is shielded from the camera's FOV or fitted with barn-doors, louvres or similarly acceptable devices.

Fit-for-purpose louvres, shields, hoods, barn-doors etc. may also be required to minimise the effects of glare, spill light and reflected (skip) light.

Equipment type and position shall be chosen to meet the specified glare limits.

Where the sport includes athlete action above the FOP surface (e.g. gymnastics, ski-jumping, diving etc.), there shall be light projected through the space above the FOP. The athlete's performance space in effect becomes the 'field of play' with respect to broadcast.

The total amount of light (luminous flux) projected from the camera #1 side shall not be less than the total luminous flux from the opposite side. Lighting equipment (luminaires, truss, cable looms, and chain motors etc.) located between the main cameras and the far side of the FOP shall be outside the cameras' field of view (FOV) when shooting the competition.

Noise – lamp control gear or drivers shall be silent (no ballast "hum"). Apart from aerial sports, in principle the luminaires should be designed, installed and aimed such that there is no light projected above the horizontal.

Multiple venues for one sport

Some sports take place at two or more venues accommodating preliminary rounds and the finals. The BRD LX quality of the two (or more) venues shall be the same, or as close as possible – a difference of not more than 5% of both the average horizontal and the average vertical illuminance (to camera 1). The colour temperature shall be the same or not more than a 5% differential.

The baseline lighting quality shall be set by the venue that stages the finals.

End of Technical Specifications

Report Author:

Steven Allen
Esteem Projects & Consultancy LTD. London UK

Broadcast Lighting Consultants to PyeongChang 2018 & Tokyo 2020
Previous Olympics: - Rio 2016, Sochi 2014, London 2012, Vancouver 2010

End of Report



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APPENDIX C: UNIVERSITY OF CALGARY OLYMPIC

OVAL—SCOPE OF WORK

The Oval at the University of Calgary is the proposed venue for speed-skating. The venue is existing and can meet the needs of the Olympics with the addition of temporary facilities only.

Deliverables:

- Text document describing the anticipated capital cost improvements as determined by CBEC. Also include text on the building engineering including roof load capacity, mechanical HVAC description, plumbing and electrical capacities.
- Text document outlining temporary works that will need to be completed on the site (that would be considered capital costs) as well as remediation measures that will need to be undertaken post games.
- Simple sketches as outlined below.

Deliverables as required to complete a Level 5 costing.

Format of Deliverables:

- The CBEC team will ensure that credit is given to all work completed by architectural and engineering professionals; however, information needs to be provided to CBEC in a 'raw' form as it will be included within an overall report that will require a consistent look.
- Text documents should be provided in WORD.
- Drawings - provide pdf drawings, as well as AutoCAD plans. AutoCAD plans are required by CBEC to complete an overlay analysis. Also provide your logo for inclusion in the CBEC title block for the overlay drawings.

BELOW IS A SUMMARY OF THE KEY REQUIREMENTS AND AREAS TO BE ASSESSED:

Field of play:

- Existing field of play meets requirements - await instruction from CBEC if any exploration on modifying the field of play should be explored.
- Provide a brief on the slab and ice plant describing upgrades that will be required to be made. This will include replacement of the slab, new wider tunnel, new refrigeration and piping. Allow for warmer corners. Sketch and brief as required to develop order of magnitude pricing.

Spectator Area & Amenities:

- New spectator entrance to may be explored to the north east. CBEC to provide additional information on the addition prior to any study taking place. Deliverable will be a simple sketch complete with square foot numbers and text document to be used to determine an order of magnitude cost.
- It is assumed that washrooms will not be provided to support all spectators plus Athletes and Personnel - what capacity do the existing washrooms accommodate?
- Washrooms to include family washrooms to serve people with disabilities.
- Concessions to be located within temporary facilities.
- Accessibility - accessible and amenity seating in multiple locations to serve 1% of the seating.

Athlete & Support Amenities:

- Provide a list of existing locker rooms, meeting spaces, lounges, etc. including square footages.

Roof:

- Roof to be able to support and additional 29 tons of hanging loads

Electrical & Lighting:

- Lighting levels to meet Olympic Games Broadcast requirements of 2000 lux with zero flicker tolerances. The oval is currently looking to replace the existing lighting. What would the anticipated permanent build lighting be? How much will we need to supplement?

Mechanical/Civil:

- Description of existing HVAC system including temperature and humidity controls.
- Will the existing services (water and sanitary) be able to handle the increased loads?

Site Operations:

- A back of house lay down area will be provided in the North West corner of the site - CBEC to provide a sketch to outline the area - this will be asphalt. This area will need to be put back to fields post olympics.
- Second back of house operational vehicle access to be provided - likely a temporary build which will be put back to existing conditions. CBEC to provide initial location for conceptual development.

FULL VENUE REPORT:

Olympic Oval

Architectural (Lead): GEC Architecture

Structural: Read Jones Christoffersen Ltd.

Mechanical: Remedy Engineering

Electrical: SMP Engineering

Refrigeration: Thermocarb

Civil: Urban Systems

Drawings: GEC Architecture

Cost Consultants: BTY

April 06, 2017

CBEC - Olympic Oval

Architectural

The Olympic Oval is now over 30 years old. Limited renovation and maintenance work has been undertaken - with the exception of replacement of the waterproofing membrane and insulation in the existing porcelain tile roof. Major life cycle upgrades, enhancements to athlete/public support spaces and life safety upgrades will be required to extend the building's useful life and meet the needs of users including high performance athletes in the future.

A review of the Olympic overlay requirements, planned oval refurbishments and enhancements, and the UofC's plans for Kinesiology facility expansion has resulted in the development of four levels or "tiers" of possible modernization and refurbishment strategies. Each of these strategies will meet the minimum requirements for the proposed 2026 Olympics, however each level sees additional investment to enhance the legacy aspect of athlete training and university future use.

Tier 1: Olympic Specific - Life Cycle Replacement

The basic Olympic overlay requirements for the Oval can be accommodated with minimal permanent *additions* to the existing oval. Life cycle replacement of mechanical & electrical systems, replacement of the refrigerated slabs, acoustic modifications, and support space upgrades will be required. Potentially, the seating count may be reduced from the existing 3700 maximum to accommodate accessibility, code and circulation restrictions.

We have reviewed the existing slab geometry and note that replacement will provide the opportunity to construct a slab that can accommodate the full range of compliant oval geometries from 25 m radius to 26 m radius. This will require a modest increase in the oval slab area with some reduction in the area available for seating and running tracks.

The Event Level slab replacement consists of separate slabs categorized into 4 distinct items; Refrigerated Oval Track Slab, two Refrigerated Rink Slabs @ 1750 m² each, the infill slab on grade, and the running track slab on grade. The infill and running track slabs on grade will need to be replaced as a result of replacing the refrigerated slabs and their associated systems due to their proximity and integration with these systems.

Replacement of the refrigerated slab and the associated refrigeration system can be done at the same time, or separately. Replacement of these items will accommodate enhanced ice control strategies including "soft corners" and other potential adjustments to support competition and training. Sufficient contingency is being carried in our estimate to allow for a variety of strategies to be investigated at the time of detailed design. A new tunnel dedicated to users would be added during replacement of the refrigerated slab.

Additionally, refurbishment of the existing change room facilities and support spaces by area would be required. Other modifications to the Oval in Tier 1 include: replacement of the existing temporary aluminum bleachers, and acoustic treatment for 50% coverage of the roof area. A life cycle roof replacement is anticipated as being required by 2026, and it is recommended that anodized stainless panels be used for roof replacement.

Tier 2: Venue Revitalization (University) – Athletic & Academic Support Improvements.

In addition to the Tier 1 work, Tier 2 work incorporates an addition to the Kinesiology building with some necessary program enhancements for the Athletes that utilize the Oval; these would allow for ice support spaces, public amenity, and code and circulation enhancements. Tier 2 would enhance and expand athlete support and public spaces in order to meet contemporary standard standards for dressing room accessibility, mixed gender teams etc.

Tier 2 includes a retractable seating system to provide ease of set up of future world cup events. Seating numbers would remain close to the present 3700 maximum number.

Tier 3: Venue Revitalization (Sport) - Athletics & Academics Integration

Tier 3 work is an expanded version of Tier 2 that includes a larger addition to the support and public amenity spaces. A number of studies have been undertaken proposing improvements to public and athlete support spaces. The existing support spaces are no longer consistent with comparable contemporary facilities with respect to supporting high performance training and coaching.

Tier 3 provides the opportunity to integrate athletics and academics with the Oval and the addition to the Faculty of Kinesiology.

Tier 3 would perpetuate and re-establish the Oval's status as the training centre for the National Speed Skating Teams; renewing the program for high performance competition and training. This tier brings the Oval and its associated support spaces in line with comparable contemporary facilities.

Tier 4: Venue Enhancement – Increased Public Space and Seating

This tier incorporates tiers 1, 2, & 3; however, its addition would allow for more ice support spaces, public amenity, and code and circulation enhancements than Tier 3. It will provide significantly more public concourse space to allow for spectator amenity and additional seating at concourse level with as many as 4700 seats in total. As this option would create a significant amount of space that in theory would not be required post games, this option would result in additional area that could be reprogrammed for Kinesiology use beyond 2026; further enhancing Kinesiology integration.

We have reviewed the option of relocating the oval slab in the centre of the structure. This would allow for 360 d seating but would not likely result in additional seating. This approach would reduce the available area for dry land training inside the oval. We think there is merit in revisiting this idea in later stages, but at this time reposition the oval slab does not seem to confer significant benefits.

Background

The Olympic Oval roof structure consists of a network of prestressed concrete arches spanning approximately 88 metres over the arena. This network of arches forms diamond shaped roof bays that are infilled with custom steel joists. In order to support the lighting for the venue, structural steel space trusses are suspended from the roof to provide continuous lines of support for fixtures and cabling. We understand that the existing lights are to be replaced with modern fixtures and that the light levels are to be increased by adding fixtures. We were asked to confirm whether the roof structure is capable of supporting an additional 29 tonnes of lighting weight.

We have assessed the Oval's ability to support additional lighting weight on the basis of: record drawings from the original structural design (Simpson Lester Goodrich, 1985), shop drawings for the roof replacement (Skyline Roofing, 2011), and our observations made during a 2008 investigation of the roof structure. Our assessment is conceptual only; further detailed engineering analysis will be required if the project proceeds beyond the feasibility stage.

Condition of the Structure

The Oval's roof structure appears to be in very good condition with no obvious signs of deterioration. With the roof having been replaced in 2011, the potential for degradation to occur between now and the 2026 Olympics is minimal. There are some drainage concerns around the exterior buttresses, but we are not aware of any active areas of structural deterioration. So long as the condition of the structure is reviewed in intervening years, and ongoing maintenance concerns are addressed, we expect the Oval structure to perform as designed for many years to come.

Design Snow Load

The design of the Oval's roof structure was based on snow loads established with a site-specific snow study. This study allowed the Engineer of Record to use a reduced snow load for the design of the roof. Any plans for future development of the land around the Oval should take this into account. Snow shadows or changes to airflow around the Oval should be carefully assessed.

Additional Lighting Loads

We understand that the lighting in the Oval performs well in its current configuration. Although additional lighting is required to boost light levels, the location of the lighting is unlikely to change drastically. If the existing space trusses are retained, and additional lighting is added to them, approximately 1 kN/m (70 lbs/ft) of additional lighting weight could be supported. Based on the length of the trusses, the total additional weight that could be supported in this manner is 50 tonnes. This amount of lighting could be supported in areas away from the lighting trusses if necessary, so long as it is distributed evenly over the roof area.

Although the primary roof structure is capable of supporting the additional lighting weight without modification, the lighting trusses and secondary structural elements are not. We

recommend allowing for approximately 50 additional pairs of hangers over the length of the lighting trusses. These additional hangers would distribute the added weight and reduce the demand on the lighting trusses.

DRAFT



Background

The west side of the Olympic Oval includes a small parking lot, mechanical building, and service access doors. As part of the proposed site modifications, an access road connecting this west parking lot to surrounding compounds is anticipated. Due to the level of existing grades and the proximity of adjacent facilities, retaining walls are required.

We have assessed the extent of retaining walls based on digital aerial survey files for the area. The topographic information provided in these files is accurate to approximately 150mm in elevation. We have based the road alignment on the facility overlay files provided by CBEC.

Design Assumptions

We have assumed that the proposed access roadway is intended for service/delivery vehicles, back of house access, and occasional pedestrian use. On this basis, we have assumed a maximum road grade of 6%, which is manageable by vehicles and comfortable for most pedestrians. This grade would not meet accessibility standards; however, the route is not anticipated to carry regular public traffic. We have assumed that the adjacent tennis courts and existing retaining walls will be retained as-is.

Retaining Wall Parameters

Based on the assumed 6% roadway grade, we have estimated that a total retaining wall area of 125 m² per wall would be required for the proposed alignment. Two symmetrical walls should be allowed for at this stage to avoid adjustments to the grade around the Oval's buttresses. If steeper roadway grades are permitted, the total wall area could be reduced. At 8% grade, the total wall area would become 100 m² per wall. Refer to the two attached sketches for more detailed information.

We recommend budgeting based on a modular block retaining wall, using a reinforced earth system. This approach permits a shallower depth of excavation, and reduced wall area. In our experience, walls of this type and scale cost approximately \$1,000/m² inclusive of retained soil excavation, backfill, wall structure, coping, and railings. Roadway excavation, roadworks, storm tie-ins, and landscaping would be in addition to the cost noted.