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DP-34-11 – West Coast Super Storage

REPORT TO THE JUAN DE FUCA LAND USE COMMITTEE
MEETING OF TUESDAY, MAY 15, 2012

SUBJECT **DEVELOPMENT PERMIT WITH VARIANCE FOR STRATA LOTS 1, 2, 3 and 4, SECTION 16, OTTER DISTRICT, STRATA PLAN VIS7097**

ISSUE

The purpose of this report is to request a development permit with variance in order to permit the placement of up to 1,044 intermodal storage containers on four industrial properties.

BACKGROUND

The subject properties are located along the southern boundary of the Sooke Business Park at Butler and Ramsden Roads in Otter Point (Appendix 1). Strata Lots 1 through 4 are zoned General Industrial M-2 in the Juan de Fuca Land Use Bylaw No. 2040. The Sooke Business Park development was created by subdivision in 2011 and consists of 31 general industrial bare-land strata lots. A development permit with variance (DP-07-08) was issued in 2008 for the subdivision that established a landscape concept plan for boulevard planting, identified a pond and wetland, waived the requirement for potable water at subdivision, and required registration of a covenant to prohibit uses that would discharge harmful substances and have an adverse effect on the quality of drinking water in the Kemp Lake reservoir. The variances approved as part of the DP did not apply to Strata Lot 2.

The applicant has placed 165 intermodal shipping containers in 9 rows on Strata Lot 2, for the purpose of providing private, outdoor storage lockers (Appendix 2). The remainder of the property is currently used for vehicle, RV and boat storage. The applicant now wishes to site an additional 879 containers on the subject properties, for a total of 1,044 units (Appendix 3). Gage-Babcock and Associates (GBA) has prepared an "Alternative Solution Report" (Appendix 4) demonstrating that the shipping containers/storage units meet the standards of the *BC Building Code*.

As noted above, prior to the submission of this application or an application for a building permit, 165 storage containers were placed on the property in Rows A – H. At that time, the lockers in Row A were located within the 4.5 m rear yard setback. The containers have since been filled by clients and cannot now be moved without some degree of hardship. The applicant, therefore, has requested a development variance to relax the rear yard setback of the General Industrial M-2 Zone from 4.5 m to 0.7 m (Appendix 3). The applicant also proposes to continue Row A, within the 4.5 m setback to the western side of Strata Lot 2.

Since the subject properties are within an industrial development permit area in the Otter Point Official Community Plan (OCP), Bylaw No. 3354, a development permit is required prior to construction. Section 4.10.8 of the OCP establishes guidelines for the form and character of industrial development due to their unique location and relationship to surrounding land uses. The applicant has submitted a development permit application and supporting information to address the development permit guidelines.

ALTERNATIVES

1) Approve the development permit with variance to relax the rear yard setback from 4.5 m to 0.7 m on Strata Lot 2, as shown on the Curtis Paxton Miles Site Plan dated April 16, 2012.

2) Deny the development permit with variance and request revised plans.

LAND USE IMPLICATIONS

Industrial Development Permit Guidelines:
The industrial development permit guidelines outlined in the Otter Point OCP establish parameters to encourage a building design theme that is complementary to and respectful of the natural setting. The site of the Sooke Business Park was a former log-sort operation which resulted in considerable alteration of the natural landscape. The approximately 20 ha bare land strata development spans the Kemp Lake and Sooke River watersheds although natural drainage patterns have largely been altered over time. Approximately 16 ha are now covered with asphalt atop several feet of drain rock.

DP-07-08 identified a 15 m streamside protection and enhancement area setback from the north side of the pond situated on the common property lot (Attachment 3). The placement of containers on Strata Lots 1 and 2 is outside the required 15 metre setback area.

As part of the development permit for subdivision (DP-07-08), chain-link fencing and boulevard landscaping have been installed throughout Sooke Business Park (Attachment 5). There appears to remain some boulevard plantings to be completed along the edge of Strata Lots 1, 3 and 4. Strata Lot 1 is currently undeveloped and will require landscaping when Ramsden Road is completed.

The industrial development permit guidelines do not specifically outline form and character recommendations for building construction. The developer registered a building scheme on title which requires all future construction to comply with set design requirements including that pitched roofs shall be finished in steel, front entrances must use some rock, tile, brick, stone or similar and designed to differentiate the business entrance, and exterior colours are to be approved by the developer. DP-26-11 addressed the form and character of an office building and care-taker's residence located at the entrance of the West Coast Super Storage site. The remainder of the site is to be used as a storage facility.

While the applicant has primarily addressed the DP guidelines through previously approved DPs, the Land Use Committee (LUC) may wish to request additional information or details pertaining to the proposed development. Should the LUC determine that the applicant has sufficiently addressed the DP guidelines and no further information is requested, staff recommend approval of the DP subject to public consultation.

Variance:
As part of this DP application, the applicant is requesting a variance to reduce the rear yard setback along the private strata road from 4.5 m to 0.7 m, as shown on Appendix 3. Bylaw No. 2040 defines the front lot line as the shortest line that divides the lot from a highway. In the case of Strata Lot 2, the lot line adjacent to the Wieland Road right-of-way meets this definition. The rear lot line is defined as the lot line opposite the front lot line, which in this case is that line adjacent to the private strata road.

Planning staff note that the request to reduce the setback from 4.5 m to 0.7 m is significant; however, the applicant has stated that moving the existing containers at this time would present a substantial hardship since they are now in use by customers. While the containers where designed for shipping and transport, they cannot be moved without first being emptied due to risk of content damage. Further, in order to move Row A, Rows B through F would also need to be moved (140 containers).

Given that 1) the containers are located adjacent to a strata road, rather than a public road; 2) that the containers are located along a property line where traffic sight-lines will be unaffected; and 3) that fence and landscape screening has been installed in the boulevard between the buildings and the strata road (Appendix 5), staff recommend approval of the variance subject to public notification.

Parking:
Part 3 of Bylaw No. 2040 establishes off-street parking and loading requirements. For general industrial uses on a property, one stall for every two employees or a minimum of five parking stalls is required, whichever is greater. In addition, two loading spaces are required for industrial buildings of this size. No parking areas shall be located within the required front yard of the zone. Sufficient parking spaces for this project were provided in conjunction with DP-26-11. The nature of the development requires that adequate loading space be made available in front of each storage unit.

Signage:
No signage is proposed at this time; however, should signage be erected in the future, a permit will be required in accordance with Sign Area C of Part 4 of Bylaw No. 2040.

LEGISLATIVE IMPLICATIONS

The Juan de Fuca Land Use Bylaw No. 2040 specifies yard requirements for the General Industrial (M-2) Zone. To vary these requirements, a development variance permit is required. The bylaw also establishes parking and signage requirements which are considered in the review of this application.

The Otter Point Official Community Plan, Bylaw No. 3354, outlines development permit guidelines. The property is within Development Permit Area No. 5: Commercial & Industrial Development Area; therefore, a development permit is required.

PUBLIC CONSULTATION IMPLICATIONS

Pursuant to the *Local Government Act,* Section 922(4), if a local government is proposing to pass a resolution to issue a development variance permit, it must give notice to each resident/tenant within a given distance as specified by bylaw. Capital Regional District Bylaw No. 3110, Fees and Procedures Bylaw, states that the Board, at any time, may refer an application to an agency or organization for their comment. In addition, it states that a notice of intent must be mailed to adjacent property owners within a distance of not more than 500 metres. Any responses received from the public will be presented at the May 15, 2012 Land Use Committee meeting.

CONCLUSION

The applicant is requesting a development permit with variance for the purpose of permitting the placement of up to 1,044 intermodal storage containers on four industrial properties. The Otter Point OCP outlines industrial development permit guidelines to encourage a building design theme that is complementary to and respectful of the natural setting. The applicant has submitted a building design to address the development permit, parking and signage requirements. The applicant has requested a variance to relax the rear yard setback of Strata Lot 2 from 4.5 m to 0.7 m in order to allow the siting of storage containers along its northern property line. Staff recommend approval of the development permit with variance subject to public notification.

RECOMMENDATIONS

That the Land Use Committee recommends to the Capital Regional District Board:

1. That the Commercial & Industrial Development Areas Development Permit (DP-34-11) for Strata Lots 1, 2, 3 and 4, Section 16, Otter District, Plan VIS7097, as shown and described in Appendices 2, 3, 4 and 5, be approved subject to the following conditions:
   a. That the proposed construction comply with the Commercial & Industrial Development Areas Development Permit Guidelines outlined in the Otter Point Official Community Plan, Bylaw No. 3354; and
   b. That the conditions of this development permit be verified as part of the building permit process.

2. That Juan de Fuca Land Use Bylaw No. 2040, Part 2, Section 27.08(d)(ii) be varied to reduce the rear yard setback of Strata Lot 2, Section 16, Otter District, Plan VIS7097, from 4.5 m to 0.7 m, as shown on the Curtis Paxton Miles Site Plan, dated April 16, 2012.

Original signed

Iain Lawrence
Planner

Original signed

June Klassen, MCIP
Manager, Local Area Planning
Concurrence

Original signed

Robert Lapham, MCIP
General Manager
Planning & Protective Services

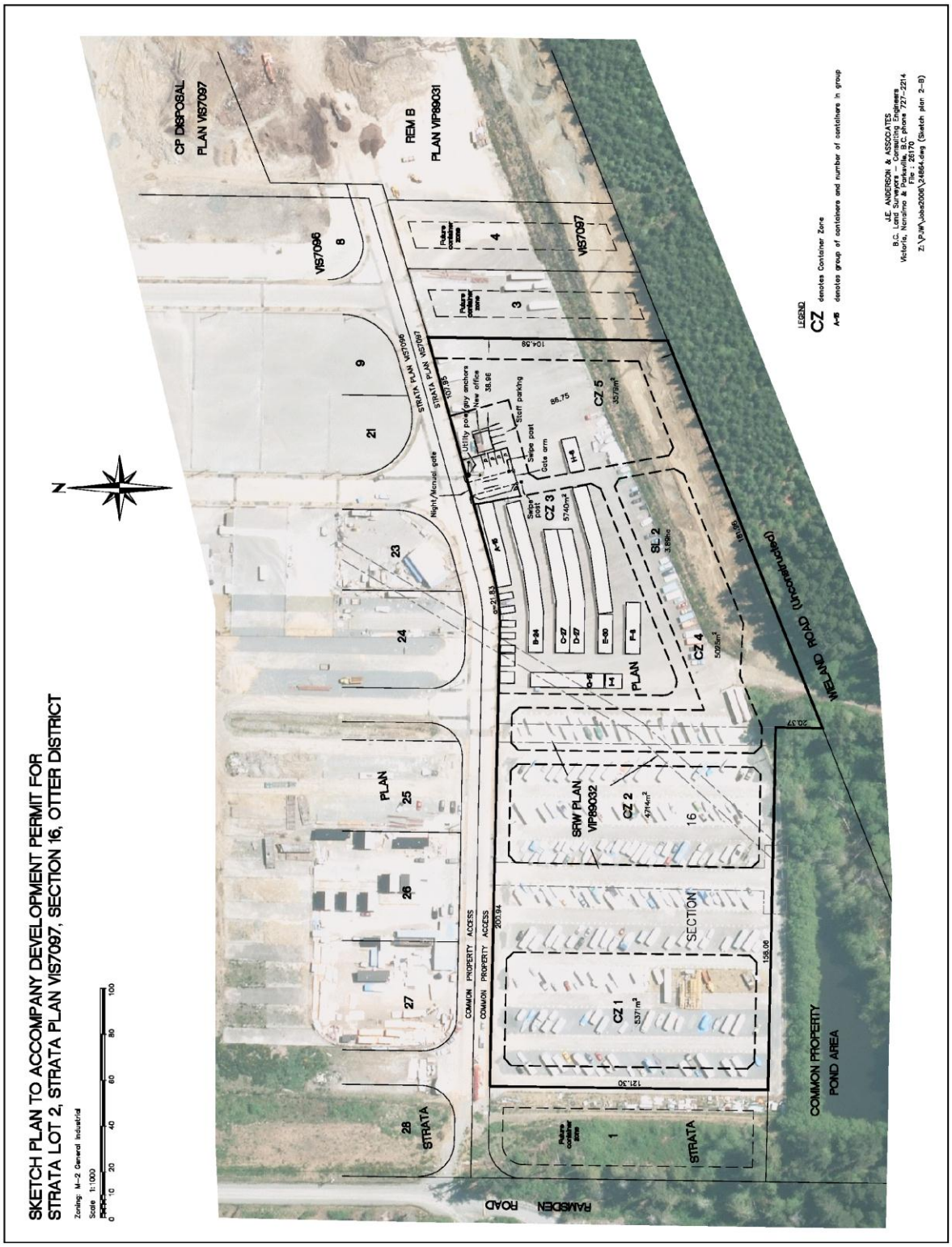
Original signed

Kelly Daniels
Chief Administrative Officer
Concurrence

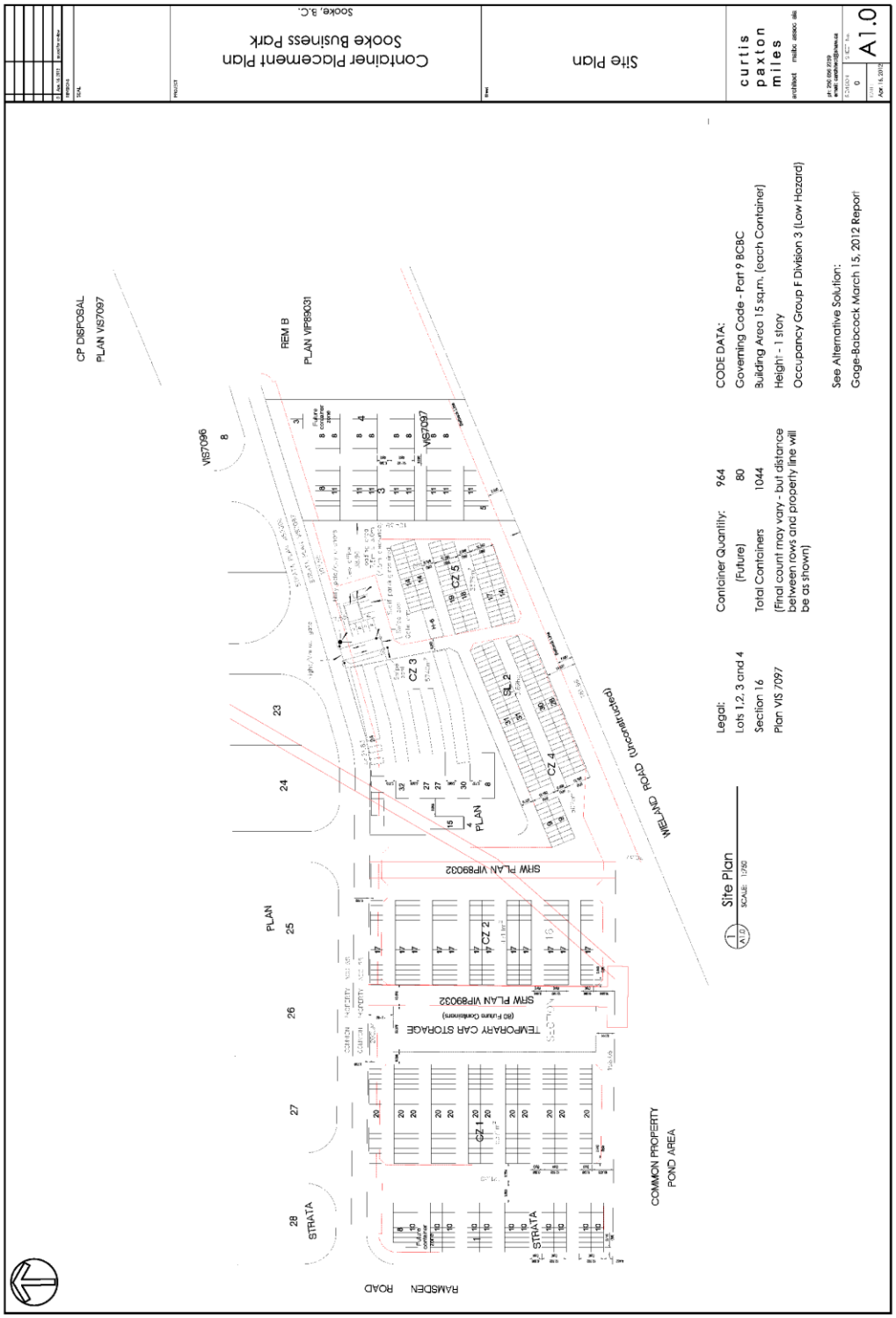
Appendix 1: Subject Property Map
Appendix 2: Current Site Plan
Appendix 3: Proposed Site Plan
Appendix 4: Alternative Solution Report, Gage-Babcock & Associates Ltd., March 15, 2012
Appendix 5: Site Photos, April 17, 2012.

Appendix 1: Subject Property Map

Appendix 2: Current Site Plan
(to be altered as proposed on Appendix 3)



Appendix 3: Proposed Site Plan



Appendix 5: Alternative Solution Report

ENGINEERS & CONSULTANTS INTEGRATING FIRE PROTECTION, LIFE SAFETY & SECURITY

GBA
GAGE-BABCOCK & ASSOCIATES LTD.

Alternative Solution Report

Container Placement at Sooke Business Park

Strata Lot 2, Strata Plan VIS7097,
Section 16 Otter District, B.C.

FINAL REPORT

GBA File #120480
March 15, 2012

Prepared for:
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APPENDIX

1.0 INTRODUCTION

The project involves the placement of 165 intermodal shipping containers located at the site of Sooke Business Park, Strata Lot 2, Strata Plan VIS7097, Section 16, Otter District on Vancouver Island, BC. The shipping containers will be used as storage space by the strata and each one will be considered a separate building governed by Part 9 of the 2006 British Columbia Building Code (BCBC). Each container will be considered as a single building and will be facing one street provided by a common property access road off Ramsden Road.

It is required by the BCBC to provide a 1 h fire-resistance rating between the containers. The purpose of this report is to demonstrate that the shipping containers will provide the level of safety contemplated by the BCBC. Gage-Babcock & Associates Ltd. (GBA) has been retained by Curtis Paxton Miles Architect to develop an alternative solution to address the issue. The alternative solution is provided in **Section 3.0** of this report.

The scope of GBA's services for this project is limited to the alternative solution noted above and is based on the Code Application Report prepared by Curtis Paxton Miles Architect dated August 29, 2011. All aspects of the construction not specifically discussed in this report are assumed to be in compliance with the Code. Information contained in this report is based upon review of the sketch plan prepared by J.E. Anderson & Associates and included in the appendices to this report. Unless otherwise noted, all references in this report are to the 2006 BCBC. Acceptance of the alternative solution is at the discretion of the Authority Having Jurisdiction (AHJ) and does not create a precedent for future submissions.

2.0 BUILDING DATA

Site Area:	19,800 m^2
Number of buildings:	165
Governing Code:	Part 9 of the BCBC
Building Area:	15 m^2 (Each container)
Container Height:	1 storey
Major Occupancy:	Group F, Division 3 (Low Hazard Industrial)

3.0 ALTERNATIVE SOLUTION: INTERMODAL SHIPPING CONTAINERS AS STORAGE

3.1 Introduction

The project involves the placement of 165 intermodal shipping containers at Strata Lot 2 (see sketches in **Appendix A**). The shipping containers are enclosed structures with fully sealed doors constructed of steel, and are noncombustible. Each container will be an individual building governed by Part 9 of the BCBC. The containers will be used as storage and will have minimal occupancy. They will also be arranged in nine rows, 6 m apart.

Spatial separation requirements of the BCBC require buildings to have 1 h fire separations. This alternative solution report will demonstrate that the containers will achieve the same level of protection as code-compliant buildings.

Should this facility be expanded in the future to accommodate additional storage containers identical to those discussed in this report, the mitigating measures and analysis outlined in this report will be equally applicable to this expansion.

3.2 Code Reference

Spatial separation requirements from Article 9.10.14.4. of the BCBC restricts buildings with a limiting distance less than 1.2 metres to not have any unprotected openings.

Subsequently, Article 9.10.14.5. of the BCBC states that

> "...each *exposing building face* and any exterior wall located above an *exposing building face* that encloses an *attic or roof space* shall be constructed in conformance with Table 9.10.14.5."

Table 9.10.14.5. requires the exposing building face of buildings with 0% maximum area of unprotected openings to have a minimum fire-resistance rating of 1 h, and to be constructed of noncombustible materials.

3.3 Objective and Functional Statements

The BCBC summarizes the intent of the Code with a series of objectives and functional statements that are attributed to the acceptable solutions.

The objective and functional statements of Article 9.10.14.5. used in this alternative solution as deliberated above, are defined as follows:

[F02, F03-OP3.1]

An objective of the Code is to limit the probability that, as a result of the design or construction of the *building*, adjacent *buildings* will be exposed to an unacceptable risk of damage due to fire. The risks of damage to adjacent *buildings* due to fire addressed in this Code are those caused by:

OP3.1: Fire or explosion impacting areas beyond the *building* of origin.

The objective above is achieved by measures that are intended to allow the *building* or its elements to perform the following functions:

F02: To limit the severity and effects of fire or explosions.

F03: To retard the effects of fire on areas beyond its point of origin.

The functional statements and objective used in this alternative solution are those from the construction requirements of a building requiring sprinkler protection. Functional statements of the Code are not in and of themselves quantitative measures of performance, but are considered to be satisfied by the literal solutions of Division B of the BCBC. Therefore, if it can be demonstrated that the proposed alternative solution can fulfill the functional statements, in a manner consistent with those of the acceptable solutions of Division B, the objective of the Code will have been achieved.

3.4 Proposed Mitigating Measures

The following mitigating measures and safety factors will achieve the above discussed life and fire objectives, and retard structural collapse of the proposed shipping containers:

- Each container has dimensions of 2.5 m × 6 m and will contain up to 750 kg of combustibles;
- The containers are arranged in nine rows with 6 m between each row;
- Analysis of burning conditions and fire performance; and
- All components of each container, including panels and the frame, are constructed of weathering steel.

3.5 Analysis and Discussion

The purpose of this alternative solution is to demonstrate that the shipping containers will provide the same level of fire and life safety as contemplated by Article

9.10.14.5. and that the performance of the shipping container during a fire emergency will not differ from a code-compliant structure.

Spatial separation requirements aim to reduce the risk of a fire spread between the adjacent buildings. The concern is that during a fire within one of the containers, the exterior steel wall will fail prematurely and the fire will spread to the adjacent storage container. As noted earlier, these containers are of the very small size in comparison to a typical building governed by the BCBC. The maximum possible combustible load within each of the buildings will be restricted by its size and the type of occupancy. The analysis conducted within the scope of this alternative solution will demonstrate that the combustible contents of a container will either burn out, or the fire will die out prior to the steel exterior wall failure.

The analysis will be supported by the study conducted by Randall Eberly of the U.S. Coast Guard Research and Development Center in 1977, in which intermodal shipping containers were tested with respect to fire performance. The full copy of the report is available to download for free off the Defense Technical Information Center (DTIC) website.

Two fire scenarios need to be reviewed in this analysis. First, is a fire scenario involving an ignition that occurs when the container doors are closed, and the second is when the container doors are open.

A fire with the doors in the closed position

The shipping containers are completely sealed to prevent cargo damage by atmospheric conditions, and consequently, have a limited amount of oxygen available to sustain a combustion process internally. When the doors are in the closed position, a fire within a container will be self-extinguished due to oxygen depletion. This assumption was supported in Eberly's research project. Eberly conducted four interior fire tests, and all four tests produced similar results; before flame spread to adjacent containers could occur, the interior fires became oxygen regulated, thereby ceasing combustion. The steel roof temperature did not exceed 180°C in either of the tests. As a result, it would not be likely for a fire to spread from one container to an adjacent container if the doors are closed.

A fire with the doors in the open position

Should the doors of a shipping container be open in the event of a fire, there will be an ample and constant supply of oxygen to sustain a fire. This scenario assumes that a fire will burn unattended and will completely consume the contents of the burning container.

The Engineering Standard on Calculating Fire Exposures to Structures, published in

2011 by the Society of Fire Protection Engineers (SFPE), provides methodologies for predicting thermal boundary conditions for fully developed fires to any structures. Information developed based on the methodologies outlined in the Standard may be used as input for thermal and structural response calculations. Essentially, the discussed SFPE Standard permits calculation of heat-flux boundary conditions and their duration. Based on this data, the impact that a fire will have on the walls and ceilings enclosing structures may be assessed.

The SFPE Engineering Standard on Calculating Fire Exposures to Structures provides two methods of fire exposure severity calculations for enclosure fires. The first method is called the Constant Compartment Temperature method, and the second is the Tanaka (Refined) method. The excerpt from the Standard discussing these two methods is included in **Appendix B** of this report. The first method assumes a compartment temperature during a fire of 1,200°C (post-flashover ventilation controlled fire) with the temperature decreasing at a decay rate of 7°C per minute after the burnout time has been reached. In accordance with the Tanaka method (second method), the compartment temperatures are calculated based on the interior material properties, the total surface area of the compartment, and the size of the openings. The particular interest for this alternative solution are formulas for calculating the burnout time, or in other words, the duration of the possible fire exposure of the steel container enclosure from a fire. Excerpt from the SFPE Standard is provided in **Appendix B** of this report. The first method is described in Section 5.2 and the second method is described in the equation in Section 5.3.

The key parameter is an energy load per unit floor area. A self-contained storage occupancy is classified by the BCBC as a Group F Division 3 occupancy (low-hazard industrial). In accordance with the definition of low-hazard industrial occupancy in Sentence 1.4.1.2.(1), an occupancy is classified as low-hazard industrial if the energy load per floor area unit does not exceed 1,200 MJ/m^2 or 50 kg/m^2 . The total energy load within a container is determined based on the container's floor area of 6 m by 2.5 m. The opening height and width is established as a whole container's facade. Detailed calculations are provided in **Appendix C** of this report. Based on these calculations, the combustible content of each container will burn within 24 min.

Eberly did not conduct any fire tests for interior fires with the door in the open position. However, an ability of the steel containers to withstand a complete burnout may be assessed based on the exterior fire tests. For this purpose, the tested containers were placed in the JP-5 pool fire source for 25 minutes. The walls of the containers in this project are constructed of heavy-gage steel, intended to withstand a structural load of several containers stacked on top of each other during shipping. Only one of the containers tested by Eberly was constructed of steel panels with a steel frame; Container #9. Based on the results of his experiments, Eberly concluded the structural failure of a steel container did not occur in any of the tests. However, he also concluded that steel containers do not act as a barrier to prevent the spread

of flame through a container stack. A JP-5 pool fire source could cause the potential ignition of combustible materials.

Based on the foregoing, the following can be concluded. The steel container walls may be assigned a fire-resistance rating of 25 minutes, which is sufficient to withstand the full burnout of the container's contents, but it cannot be considered a fire separation as required by the Code.

It is the opinion of the proponent that the proposed installation will achieve the code objective to prevent the flame spread between containers. In the reviewed tests, flames were impinging directly onto the exterior surface of a container causing its temperature rise, followed by the ignition of the materials inside the container. The proposed installation assumes that between the burning contents of one container and the contents of an adjacent container, there will be two exterior walls. The exterior wall of the burning container will maintain its structural integrity and prevent direct impingement of the flames onto the surface of the adjacent container. Hence, temperature rise of exterior surface will be less severe than in the tests conducted by Eberly for exterior fires.

The probability of a fire occurrence with the doors in the open position is very remote due to the nature of this facility, and the containers will not be left unattended with the doors open. During loading and unloading operations, the owner will always be in the vicinity of the storage container, and will be able to intervene with the local fire extinguisher.

3.6 Maintenance Requirements

A copy of this report will be maintained in the facility's office.

3.7 Conclusion

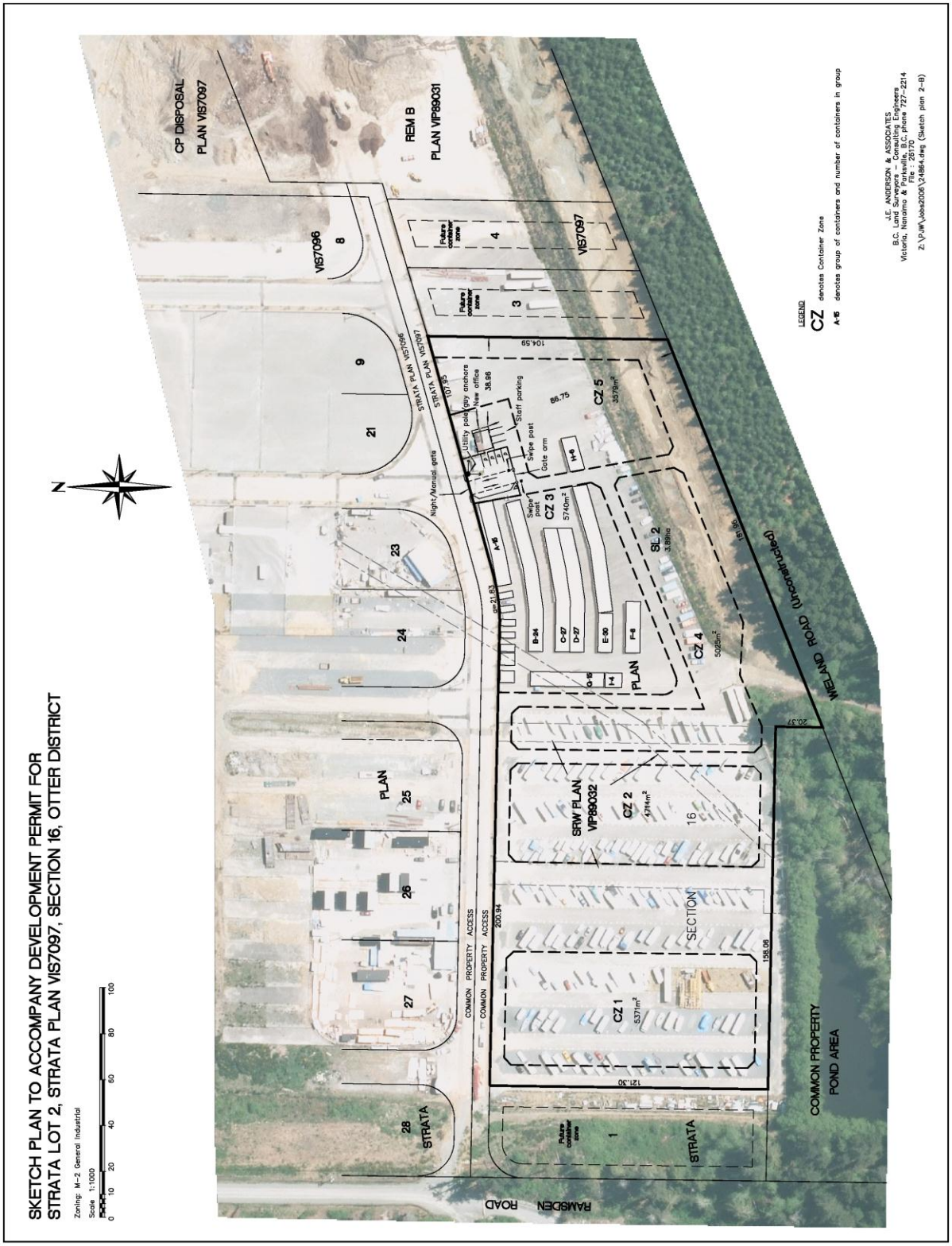
It is the opinion of the proponent that the proposed alternative solution described in this report will provide at least the same level of safety as contemplated by the BCBC. The proposed alternative solution features, where provided in accordance with this report, will perform functions F02, to limit the severity and effects of fire or explosions and F03, to retard the effects of fire on areas beyond its point of origin of fire, and the Code objectives attributed to Article 9.10.14.5., will have been satisfied.

Qualifications of the proponent can be verified on our website at www.gbacan.com.

APPENDIX A

Site Sketch

GBA


SKETCH PLAN TO ACCOMPANY DEVELOPMENT PERMIT FOR
STRATA LOT 2, STRATA PLAN VIS7097, SECTION 16, OTTER DISTRICT
Zoning: M-2 General Industrial
Scale 1:1000
0 10 20 40 60 80 100
N
CP DISPOSAL
PLAN VIS7097
REM B
PLAN VIP89031
VIS7096
VIS7097
8
9
21
23
24
25
26
27
28
STRATA
PLAN
4
3
1
STRATA
Future container zone
STRATA PLAN VIS7096
STRATA PLAN VIS7097
Night/Manual gate
Utility pole
gay anchore
New office
Staff parking
Swipe post
Gate arm
Swipe Stall
CZ 1
537m²
CZ 2
4714m²
CZ 3
5740m²
CZ 4
5028m²
CZ 5
3578m²
SL 2
3.889ha
SRW PLAN
VIP89032
SECTION
16
COMMON PROPERTY ACCESS
COMMON PROPERTY ACCESS
WIELAND ROAD (Unconstructed)
RAMSDEN ROAD
COMMON PROPERTY
POND AREA
LEGEND
CZ denotes Container Zone
A-S denotes group of containers and number of containers in group
J.E. ANDERSON & ASSOCIATES
B.C. Land Surveyors - Consulting Engineers
Victoria, Nanaimo & Parksville, B.C. phone 727-2214
File : 26170
Z:\P:\#\Jobs2006\24864.dwg (Sketch plan 2-B)

APPENDIX B

Excerpts form SFPE Engineering Standard

GBA

5.1.6.2 (C) The minimum permitted opening factor for use with these methods shall be not less than 0.0029 $m^{1/2}$, based on the smallest opening in the database.

5.1.6.3 The area (A_0) and Height (H_0) of the compartment openings shall be determined using the method described in 5.1.10.

5.1.7 Determination of Compartment Enclosure (A).

5.1.8 The compartment shall be selected as the space bounded by exterior sides and within fire-rated boundaries that are capable of containing a fire for the entire duration through burnout.

5.1.9 For areas where there are no fire-rated boundaries, the entire compartment shall be selected.

5.1.10 Determination of Opening Area (A_0) and Height (H_0)

5.1.10.1 If a compartment only has a single opening, then the area and height of that opening shall be used for A_0 and H_0.

5.1.10.2 (C) If there is more than one opening, then A_0 and H_0 shall be selected as the values that give the maximum compartment fire temperature and duration. An iterative process shall be used to show that the values selected for A_0 and H_0 yield the greatest thermal exposure profile for the exposed structure.

5.1.11 Determination of Interior Surface Material Properties

5.1.11.1 The interior surface material properties (k, ρ, and c) used in calculations shall be the properties of the construction materials of the enclosure.

where
k = thermal conductivity
ρ = density
c = specific heat

5.1.11.2 When more than one material is used to construct an enclosure, the properties for the material with the lowest product of k, ρ, and c shall be used.

5.2 Constant Compartment Temperature Method

5.2.1 This section provides details for computing the compartment time-temperature history where the compartment temperature is held constant. This time-temperature history is intended for use in quantifying the thermal boundary conditions during an enclosure fire.

5.2.2 (C) The compartment temperature shall be 1200°C for all times after ignition but before the burnout time, t_b.

5.2.2.1 A growth time shall be applied as necessary for numerical computations and other applications. The growth time shall not be included in the burnout time.

5.2.3 The temperature shall decrease to ambient conditions at a constant rate of 7°C/minute after the burnout time has been reached.

5.2.4 The burnout time is the length of time the compartment temperature is equal to 1200°C. It shall be computed using the following equation:

$$\tau_b = \frac{E \cdot A_f}{90 A_O \sqrt{H_O}}$$

where

τ_b = burnout time for the enclosure fire (minutes)
E = energy load per unit floor area of the enclosure (MJ/m²)
A_f = floor area of the enclosure over which combustibles are present (m²)
A_0 = opening area (m²)
H_0 = opening height (m)

5.3 Tanaka (Refined) Method

5.3.1 (C) The Tanaka method provides a means to calculate the ventilation-controlled post-flashover transient fire temperatures for the room of origin.

5.3.2 The temperature of the enclosure shall be calculated in accordance with equations 5.4.2.1 and 5.4.2.2.

$$T = \beta_{F,1}\left(2.50 + \beta_{F,1}\right)T_\infty + T_\infty \text{ , for } \beta_{F,1} \le 1.00$$

$$T = \beta_{F,1}\left(4.50 - \beta_{F,1}\right)T_\infty + T_\infty \text{ , for } \beta_{F,1} > 1.00$$

where

$$\beta_{F,1} = F_{O,F}^{\frac{1}{3}} \times \eta^{\frac{1}{6}}$$

Substituting $F_{O,F} = \frac{A_0\sqrt{H_0}}{A}$ and $\eta = \frac{t}{\kappa\rho c}$, $\beta_{F,1}$ can be simplified to:

$$\beta_{F,1} = \left(\frac{A_0\sqrt{H_0}}{A}\right)^{\frac{1}{3}}\left(\frac{t}{\kappa\rho c}\right)^{\frac{1}{6}}$$

where:

T = temperature of the enclosure (K)
T_∞ = 300 K
A_0 = area of opening (m^2)
H_0 = height of opening (m)
A = total surface area of room, excluding opening (m^2)
t = time (seconds)
k = thermal conductivity of enclosure lining (kW/m K)
ρ = density of enclosure lining (kg/m^3)
c = specific heat of enclosure lining (kJ/kg K)

5.3.3 The Tanaka calculations use Kawagoe and Sekine's method of predicting the mass burning rate, as follows:

$$\dot{m} = 0.1 A_0 \sqrt{H_0} \text{ (kg/s) (equation 5.3.4)}$$

where
A_0 = area of opening (m^2)
H_0 = height of opening (m)

5.3.4 The burnout time shall be computed using the following equation:

$$\tau_b = \frac{M}{\dot{m}}$$

where
M = mass of combustible material available for combustion (kg)
$\dot{m}$ = mass burning rate (kg/s)

APPENDIX C

Fire Load Calculation

GBA

Burnout Time Calculation

Constant Temperature Method

As per Article 5.2.4. of the SFPE Guide:

$$\tau_b = \frac{E \times A_f}{90 \times A_0 \times \sqrt{H_0}} = \frac{1200 \times 15}{90 \times 5.5 \times \sqrt{2.2}} = 24.5\ min;$$

Where

τ_b – burnout time for enclosure, min;

A_f - floor area of the container, A_f = W x L = 6 x 2.5 = 15 m^2;

H_0 - opening height, 2.2 m;

E - Energy Load per unit of floor area, 1200 MJ/m^2;

A_0 - Opening area, 5.5 m^2;

Tanaka Method

As per Article 5.3.3. of the SFPE Guide:

$$\dot{m} = 0.1 \times A_0 \times \sqrt{H_0} = 0.1 \times 5.5 \times \sqrt{2.2} = 0.8\ kg/s;$$

Where

$\dot{m}$ – mass burning rate, kg/s ;

A_f - floor area of the container, A_f = W x L = 6 x 2.5 = 15 m^2;

H_0 - opening height, 2.2 m;

A_0 - Opening area, 5.5 m^2;

As per Article 5.3.4. of the SFPE Guide:

$$\tau_b = \frac{M}{\dot{m}} = \frac{750}{0.8} = 938\,\text{sec} = 15.6\ min;$$

Where

τ_b – burnout time for enclosure, min;

M - Combustible Load, M = A_f x m = 15 m^2 x 50 kg/m^2 = 750 kg;

A_0 - Opening area, 5.5 m^2;

Appendix 5: Site Photos

Photo 1. View of north side of Strata Lot 2 looking southeast from the strata road.

Photo 2. View of boulevard landscaping and fencing along northern property line of Strata Lots 2, 3 and 4 looking east

Photo 3. View of boulevard landscaping and fending along northern property line of Strata Lots 1 and 2 looking west. Containers shown are located 0.7 m from rear lot line.

Photo 4. View of 8.8 m wide drive aisle adjacent to Row G.