DISTRICT OF WEST VANCOUVER
750 17TH STREET, WEST VANCOUVER BC V7V 3T3

COUNCIL REPORT

Date:	June 2, 2020
From:	Erik Wilhelm, Senior Community Planner
Subject:	Development Variance Permit for 4369 Erwin Drive
File:	05.1010.20/19-070.2020

RECOMMENDATION

THAT Proposed Development Variance Permit No. 19-070 regarding 4369 Erwin Drive to allow for a proposed new house and coach house, as described in the report dated June 2, 2020 regarding proposed Development Variance Permit No. 19-070 be considered at the July 20, 2020 Council meeting; and that notice be given of consideration of the proposed development variance permit.

1.0 Purpose

The purpose of this report is to provide information to Council regarding a proposed new house and coach house at 4369 Erwin Drive that requires variances due to flood construction level requirements, and to request scheduling of Council consideration of the application.

2.0 Legislation/Bylaw/Policy

Community Charter

For development sites that may be subject to flooding, such as 4369 Erwin Drive, Section 56 of the *Community Charter* authorizes the District's Chief Building Inspector to require a qualified professional report to certify the conditions under which the land may be used safely for the intended use. Furthermore, on this basis, a building permit may only be issued following the condition that the owner of the land covenants with the municipality to use the land in accordance with the conditions specified in the qualified professional's report.

Local Government Act

A development variance permit (DVP) may be issued by resolution of Council in accordance with Section 498 of the *Local Government Act*. The DVP is a permit that changes regulation(s) for a particular development site allowing development to proceed or exist in a manner otherwise not allowed by the zoning bylaw. A DVP cannot vary the use or density of land, or a floodplain specification.

Zoning Bylaw

The site is currently zoned Residential Single Family Dwelling Zone 4 (RS4).

3.0 Official Community Plan

The OCP recognizes that climate change impacts, such as sea level rise and more frequent extreme weather events, are occurring around the world. Policy 2.6.11 supports the development of updated shoreline protection strategies and flood construction level requirements to protect lands from sea level rise, reduce shoreline erosion, preserve and enhance habitat. The development proposal is consistent with the OCP.

4.0 Background

4.1 Previous Decisions

Although not specific to this site, Council approved a DVP on January 13, 2020 at 4358 Ross Crescent that allowed a number of variances due to flood construction level requirements.

4.2 History

A building permit application was originally submitted to redevelop 4369 Erwin Drive with a new single-family house and coach house. As the site is in a coastal area that may be subject to flooding, staff requested a report from a suitably qualified professional to consider flood construction levels and specify how the land and any buildings or other structures within the land would be constructed safely for the proposed residential use. Consideration of the qualified professional report is based on the Province's Flood Hazard Area Land Use Management Guidelines (the "Provincial Guidelines"), in particular sections 3.5 and 3.6, which deal with climate change and sea level rise expected by the year 2100. In addition, the report is to be prepared in accordance with the most recent edition of the Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC (published by the Association of Professional Engineers and Geoscientists of BC).

4.3 Developing a Flood Construction Level and Foreshore Development Permit Area for West Vancouver

With the increased risk of flooding due to climate change and sea level rise, staff are conducting analysis to develop policy and/or regulations to address the risk of coastal flood impacts. In collaboration with a coastal engineering firm commissioned by the District, staff is moving forward with coastal flood mapping and associated analysis that will potentially result in the development of a "Flood Construction Level Bylaw" and/or a "Foreshore Development Permit Area". Information on these matters is anticipated to be forwarded to Council for their consideration later in 2020.

4.4 Floodplain Legislation

Section 524 of the Local Government Act, "the Act", authorizes the District to designate, as a floodplain, land Council considers may be subject to flooding. Once the District designates land as a floodplain under section 524 of the Act, the District may also specify what is commonly known as a flood construction level for that land. In addition, or alternatively, the District can regulate development in areas prone to flooding by establishing one or more development permit areas under section 488 of the Local Government Act.

In the absence of a bylaw under section 524 of the Act, or a development permit area designation under section 488, there is no legislated "flood construction level" for any particular property in West Vancouver. However, this does not mean the District is obliged to approve permits for construction on land that might be subject to flooding. Section 56 of the Community Charter specifically authorizes the Chief Building Inspector to require "safe use" certifications. In the case of development variance permits, Council can require an applicant to provide some evidence, for example in the form of a professional certification, that the proposed construction is safe for the intended use. The District requires that homes are constructed that are not knowingly predisposed to flooding events and are safe for habitation.

5.0 Analysis

5.1 Discussion

Site and Context

The site is located in the Erwin Drive neighbourhood along the south side of Erwin Drive directly adjacent to the Burrard Inlet (Figure 1). The flat site is bounded by two single-family properties to the east and west with a number of significant cedar trees along Erwin Drive within the municipal boulevard. The site is currently vacant except for existing trees, fences, retaining wall structure and a garage located adjacent to Erwin Drive. Along the east property line is an existing mature cedar hedge.

Figure 1 – Context Map/Aerial

The subject site is relatively low lying and is currently subject to flooding due to storm events and sea level rise. As an example, Figure 2 shows the wave action and seawater pooling that occur on the property. The site is lower than neighbouring properties by approximately 3 - 4 ft. **Appendix B** provides a number of pictures showing the retaining walls located on the neighbouring property lines. There is an existing concrete foreshore wall south of the property (offsite & slated to remain) currently protecting the property from storm events (Figures 1 and 2).

Figure 2 – Photo of property during storm even (looking south)

The Proposal

The proposal includes a two-storey house (with swimming pool) and a one-storey coach house. Figure 3 illustrates the proposed siting of the primary house and coach house. The siting of the coach house and driveway was specially designed to maintain all significant trees in front of the property along Erwin Drive. Coach house development permits are delegated to the Director of Planning and Development Services. Subject to Council consideration of the DVP the coach house proposal will be considered by staff for approval.

The flood hazard protection measures outlined specifically for the site incorporate retention of the existing foreshore concrete wall which is contiguous along adjacent properties to the east and west, and raising of the grade of the property to construct the main levels of the primary house and coach house above the flood construction level to ensure safe use of the property.

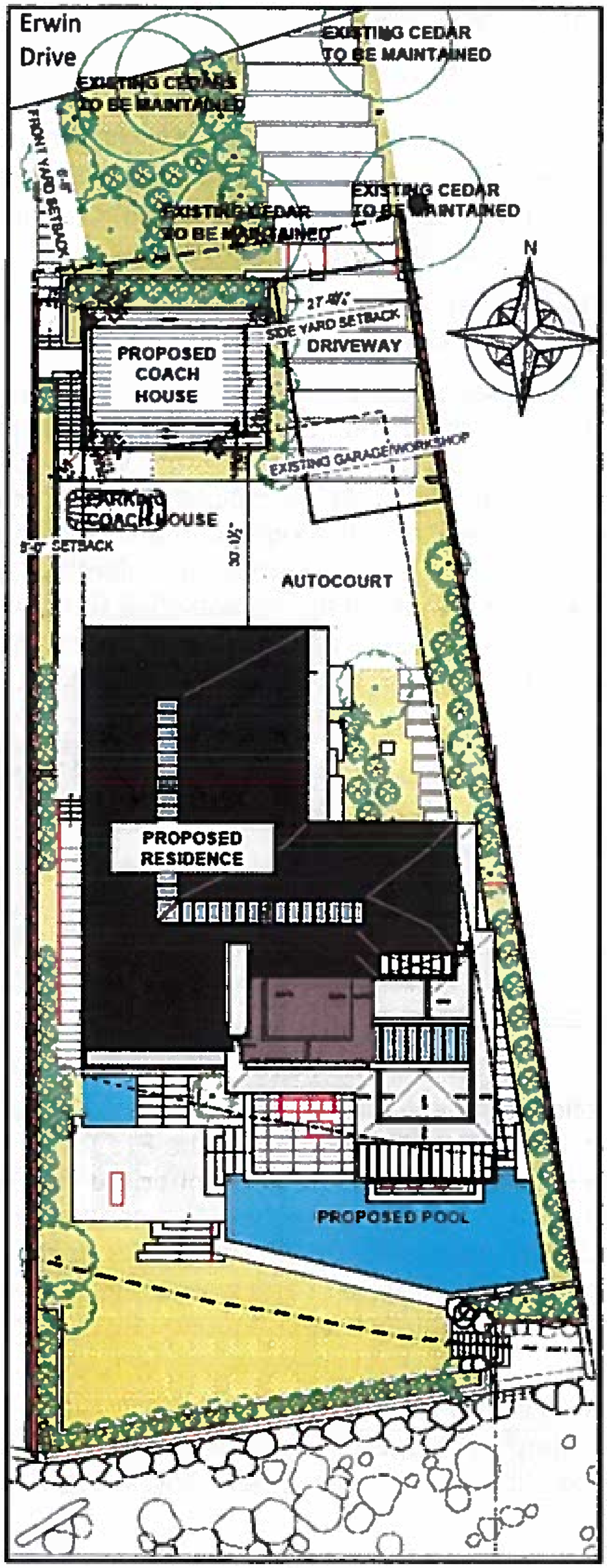

Figure 3 – Site Plan

Key features of the proposal include:

- a 4,786 sq. ft. two-storey house (excluding basement);
- a 403 sq. ft. single storey coach house (with crawl space) in the front yard;
- a "closed" foundation including a basement proposed below the flood construction level with construction requirements specified in the certified report to protect the space from flooding; and
- A proposed flood construction level of 5.83 m (19.13 ft.) for the primary house and 4.61 m (15.12 ft.) for the coach house.

In order to accommodate development of the site safe for the proposed uses and the corresponding recommended flood construction level the proposal includes retaining walls at the east and west edges of the site with terracing up to the main level of the house (See Figure 4). To mitigate the impact of increasing grade at the east and west edges of the site all retaining walls are designed to limit the exposed face to 4 ft. or less and landscape plantings are provided within the side yard setbacks with a width of approximately 8 ft. As well, the application maintains all trees within the boulevard effectively buffering the house from view from the street (Figure 3).

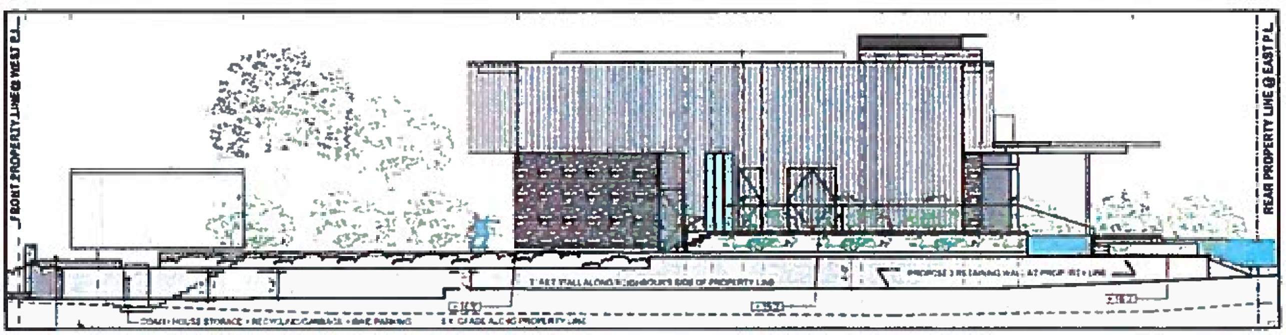

Figure 4 – West Elevation

The "closed" foundation including the basement is proposed as an exception to the requirements under sections 3.5 and 3.6 of the Provincial Guidelines. The Flood Hazard Assessment report attached as **Schedule B** to **Appendix C** outlines that this exception can be made where the underside of the wooden floor system is inset inside and below the top of concrete foundation (with the top of the concrete foundation above the FCL) and where suitable provisions are made to design the space to be "floodproof" such that flood waters are unable to enter (i.e. no openings).

Figure 5 provides an indication of how the house will look from Burrard Inlet. The image shows the existing hedge at the east edge of the property, the existing grades of adjacent/neighbouring retaining walls and the roof peak heights of adjacent houses.

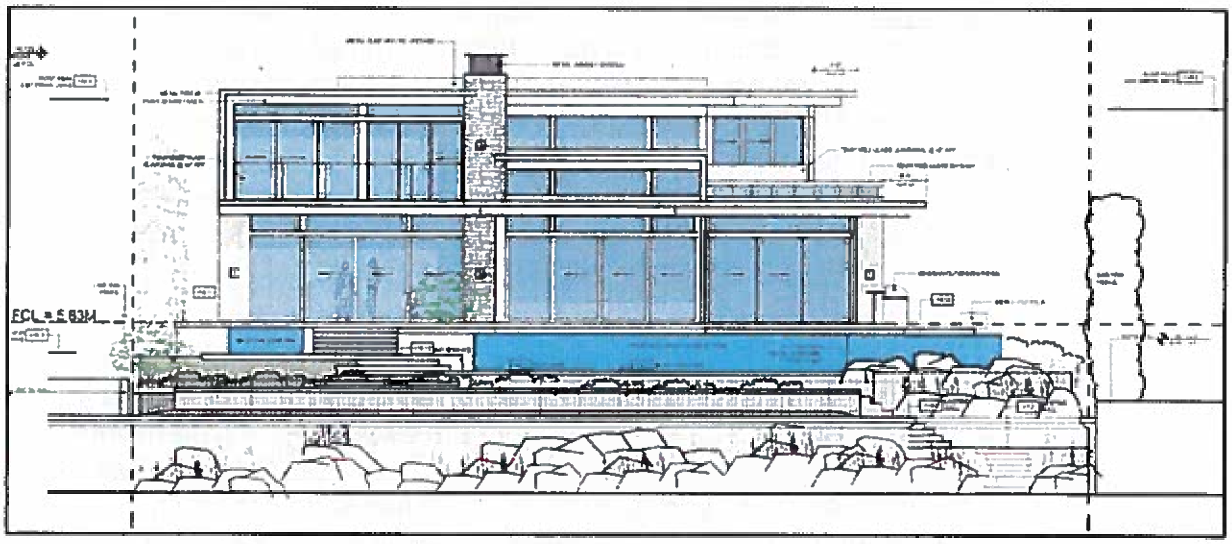

Figure 5 – South Elevation

Proposed Zoning Variances

The proposed zoning variances are as follows:

- Variances for calculation of average grade based on Flood Construction Level (5.83 m/19.13 ft.)
    - Single-Family House Height: The maximum building height in the zoning bylaw is 7.6 m (25 ft.) measured from the lower of average finished or natural grade[1]. The proposed house will be approximately 6.7 m (22 ft.) in height above the flood construction level at 5.83 m (19.13 ft.) geodetic elevation. This requires a variance for how building height is measured to be calculated using the flood construction level as average grade.
    - Coach House Height & Front Yard Setback: The maximum single-storey coach house height in the zoning bylaw is 4.57 m (15 ft.) measured from the lower of average finished or natural grade. The proposed variance would permit the coach house height to be calculated using the flood construction level at 4.61 m (15.12 ft.) as average grade. The Front yard variance would allow the coach house to be sited in the front yard with landscaping provided to effectively screen the view of the coach house from the street.
    - Highest Building Face Envelope: The maximum highest building face in the zoning by-law is 6.7 m (22 ft.). The proposed variance would permit the highest building face envelope to be calculated using the flood construction level at 5.83 m (19.13 ft.) geodetic elevation as average grade.

[1] If measured from existing grade, only a single storey house would be allowed on the property.

- Basement: A basement is defined in the zoning by-law as a storey, the level of which is located more than 0.3 m below the lower of average natural grade elevation or average finished grade elevation. The proposed house includes a basement level located below the flood construction level at 5.83 m (19.13 ft.) which is above natural grade. The proposed variance would permit the basement to be exempt from floor area calculations as it is located entirely underground and would not be visible at the new grade level.
- Retaining Walls: Retaining walls are measured from natural grade. For a waterfront site retaining walls are not permitted to exceed 4.0 ft. in height from natural grade within the extent of the waterfront yard. In order to accommodate terracing of the site along the west, east and waterfront edges up to the required flood construction level for the proposed house, retaining walls are proposed. The proposed variance would allow for the retaining walls as shown in the attached plans, however, they would be limited to 4.0 ft. or less in exposed face height.

Staff support the proposed variances for building height, highest building face envelope, coach house height and front yard, basement and retaining walls as the new flood construction level datum is necessary for calculating average grade in order to accommodate building higher in areas that may be subject to flooding. Staff note that the height of the proposed house is only marginally taller than the 2 adjacent houses to the east and west (0.5 m/1.6 ft. and 0.3m/0.9 ft., respectively). In addition, the variances will not unduly impact the privacy of each neighbour given the height of the existing hedge on the east side of the property and the absence of windows on the west side elevation (see DVP drawings – **Appendix C**). A summary of the development statistics, zoning bylaw compliance and variances is provided within **Appendix A**.

5.2 Sustainability

The OCP identifies numerous directions to enable the District to remain, and become more resilient from social, economic, housing, transportation, and environmental perspectives. The proposed variance, with associated raised flood construction level, further protects the subject property from future storm events and sea level rise. Effectively, approval of the DVP will make the subject site more resilient.

The DVP will also facilitate other aspects of sustainability:

- Tree retention: the siting of the coach house and garage were modified to protect and retain the large cedars within the boulevard along Erwin Drive.
- Step Code: The proposed house and coach house will be required to attain step code requirements as outlined in the building bylaw.

- Housing: The detached coach house will allow for a more affordable housing option for the occupant(s) and provides supplementary housing options for different life stages.

5.3 Public Engagement and Outreach

Notification

Should the proposal advance, owners and occupants of properties located within 50 metres of the subject site will be notified of the proposed Development Variance Permit in accordance with Development Procedures Bylaw No. 4940, 2017.

Website

In alignment with current practise, a description of the proposal is available online. Applicable dates will be updated should the proposal advance.

5.4 Other Communication, Consultation, and Research

Planning staff has consulted with District staff on the application and proposed conditions are included in the draft development variance permit addressing staff comments.

6.0 Options

6.1 Recommended Option

a. Set the date for consideration of the development variance permit and authorize the notification to be sent to neighbours within 50 metres.

6.2 Considered Options

b. Set an alternate date for consideration of the development variance permit (to be specified) and authorize the notification to be sent to neighbours within 50 metres; or

c. Request further information (to be specified); or

d. Reject the proposal.

7.0 Conclusion

If approved, the proposed development variance permit would accommodate redevelopment of the site including considerations for development in an area that may be subject to flooding. The proposal is supported by the OCP that provides direction to proactively plan for coastal flooding of sites adjacent to the foreshore. The proposal is based on coastal engineering specifications of the flood hazard report submitted as part of the application and are intended to mitigate the impacts of coastal flooding.

Although the proposed house would be marginally taller than surrounding properties, the proposal mitigates any potential impacts with the incorporation of limited side yard windows and with the use of existing and new landscaping to provide privacy for the eastern and western neighbours. As well, the proposed house and coach house are screened from the street with retention of the existing boulevard trees. Staff support the proposal and recommend that Council schedule the Development Variance Permit for consideration.

Author: Erik Wilhelm, Senior Community Planner

Concurrence: Heather Keith, Environmental Protection Lead

Concurrence: Michelle McGuire, Manager of Current Planning an Urban Design

Appendices:

A. Project Profile
B. Site Photographs
C. Proposed Development Variance Permit No. 19-070

Appendix A – Project Profile

Project:	**4369 Erwin Drive**
Application:	Development Variance Permit No. 19-070
Applicant:	Tara Haddad
Architect:	Hlynsky + Davis Architects Inc.
Address:	4369 Erwin Drive
Legal Description:	Lot A, Block 7, District Lot 582, Plan 6662
PID:	010-826-947
OCP Policy:	2.6.11
Zoning:	RS4 (Single Family Dwelling 4)
Heritage Register:	N/A
Summary:	A 2-storey plus basement single family dwelling with swimming pool and detached coach house

	BYLAW RS4	PROPOSED	VARIANCE	COMMENTS/NOTES
Site Area	836 m²	1167.6 m²	n/a	Complies (oversized)
Site Width	22.9 m	19.7 m	n/a	Legal (historic) non-conforming
Site Coverage	350.28 m² (maximum of 30% of lot area)	348.8 m²	n/a	Complies
Front Yard Permeability	Maximum of 50%	47%	n/a	Complies
Floor Area Ratio	408.66 m² (maximum 0.35 of lot area)	400[2]	n/a	Complies
Setbacks – House:				
Front Yard (Erwin Dr.)	9.1 m	18.4 m	n/a	Complies
Waterfront Yard	9.1 m	11.28 m	n/a	Complies
Side Yards (West)	1.97 m (10% of lot width)	2.44 m	n/a	Complies
Side Yards (East)	1.97 m (10% of lot width)	2.54 m	n/a	Complies
Side Yards (Combined)	4.93 m (25% of lot width)	4.98 m	n/a	Complies
Setbacks – Coach House:				
Front Yard (Erwin Dr.)	9.1 m	2 m	7.1 m	Significant landscape buffer from street provided
Side Yards (West)	1.97 m (10% of lot width)	2.44 m	n/a	Complies
Side Yards (East)	1.97 m (10% of lot width)	8.59 m	n/a	Complies
Side Yards (Combined)	4.93 m (25% of lot width)	11.03 m	n/a	Complies
Height:				
Building Height	7.6 m	7.6 m	Measured from FCL*	FCL proposed to be used for average grade
No. of Storeys	2	2	n/a	Complies
Highest Building Face Envelope	6.7 m	6.7 m	Measured from FCL*	FCL proposed to be used for average grade
Parking spaces	1	2	n/a	Complies

*Flood Construction Level at 5.83 m (19.13 ft.) as determined by Coastal Engineer report.

[2] Basement level would be 100% exempt when grade measured from FCL.

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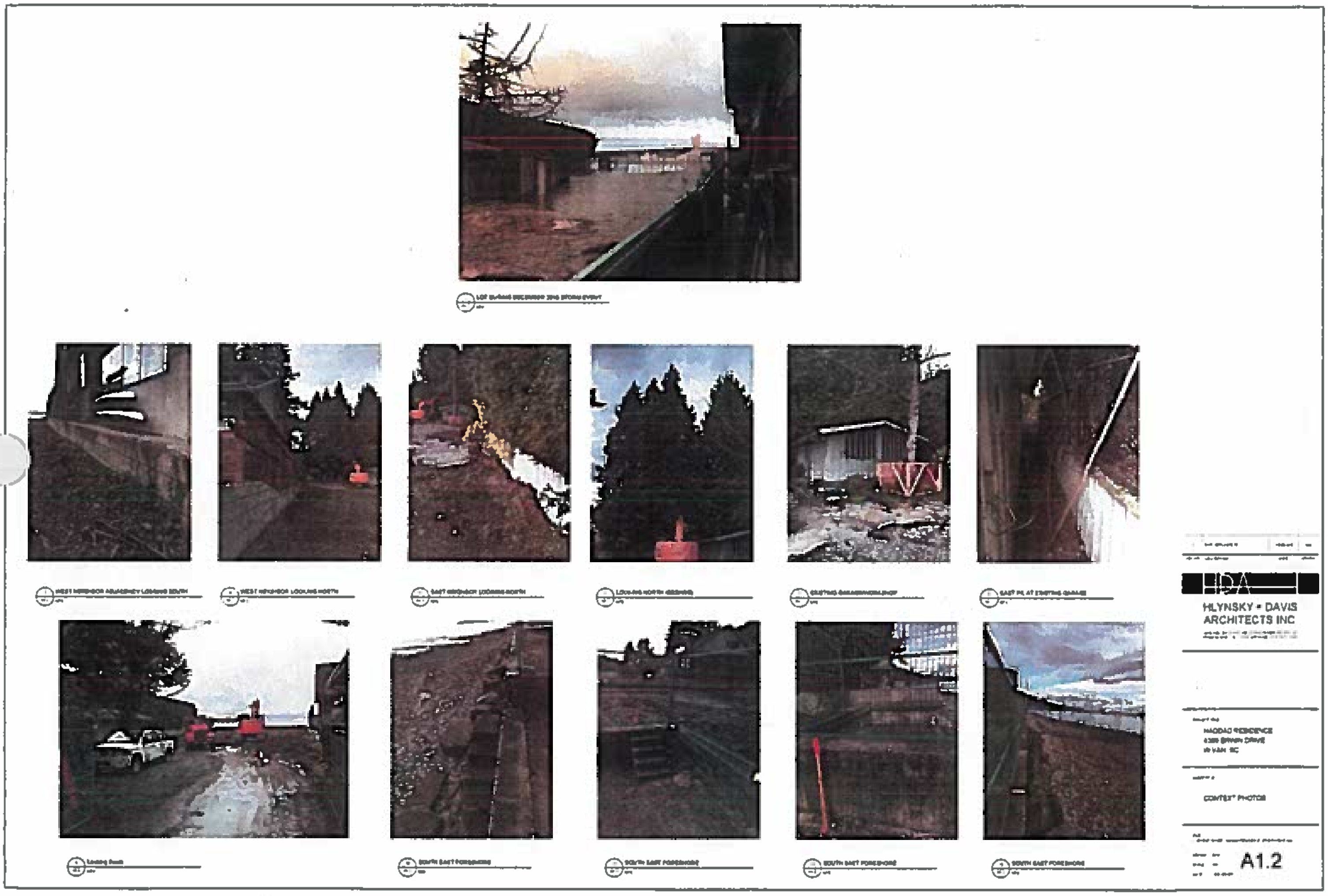
Appendix B



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APPENDIX C

District of West Vancouver

Proposed Development Variance Permit No. 19-070

Current Owner: Tara Haddad

This Development Variance Permit applies to:

Civic Address: 4369 Erwin Drive

Legal Description: 010-826-947
Lot A, Block 7, District Lot 582, Plan 6662
(the "Lands")

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1. For the purposes of this Development Variance Permit, the Lands shall be developed in substantial compliance with the drawings attached and dated August 13, 2019, approved by Council, attached as Schedule A, and specifically in compliance with the regulations and variances listed hereunder.

2. Zoning Bylaw No. 4662, 2010 is varied and supplemented for this development proposal in accordance with the following regulations:

   (a) Section 204.07 (RS4 Front Yard) is varied to allow the required front yard for the coach house to be reduced from 9.1 m to 2 m.

   (b) Section 120.17 (Average Grade Calculation for Building and Structure Height) is varied to calculate maximum building height using the flood construction level at 5.83 m as average grade.

   (c) Section 110 (basement definition) is varied to allow the basement to be defined as a storey, the floor of which is located below the flood construction level at 5.83 m.

   (d) Section 130.051 (1) (f) (i) is varied to calculate maximum building height for the coach house using the flood construction level at 4.61 m as average grade.

   (e) Section 130.1 (2) (c) (Highest Building Face Envelope) is varied to allow maximum highest building face to be calculated using the flood construction level at 5.83 m as average grade.

   (f) Sections 120.22 (Retaining Wall Grade Line and Buildup of Grade) and 130.13 (Waterfront Yard Requirement) are varied to allow retaining wall heights as shown in Schedule A, except that no retaining wall shall exceed 1.2 m in exposed face height.

3. The proposed structures and site landscaping must generally be constructed and finished in substantial compliance with attached Schedule "A".

4. Prior to issuance of a Building Permit, a suitably qualified professional will identify conditions as enabling the safe use of the basement and land for the use intended with consideration to coastal flooding hazards. A section 219 covenant, in accordance with the Land Titles Act, shall be registered against the certificate of title for the Lands certifying that the land will be used in accordance with the conditions specified in the report attached to this permit as Schedule B.

5. Prior to issuance of a Building Permit, a design for the basement, below the FCL, must be submitted by a qualified professional to certify that the basement is "floodproof" as per recommendations outlined in Schedule B.

6. Prior to the issuance of a Building Permit and as security for the due and proper completion of the landscaping as set forth in Section 3 of this Development Variance Permit, the Owner shall:

   (a) provide a landscape cost estimate acceptable to Director of Planning and Development Services;

   (b) provide a planting list consistent with the landscape plan in Schedule A acceptable to Director of Planning and Development Services;

   (c) provide security in the amount of 125% of the landscape cost estimate to the District in the form of cash or an unconditional, irrevocable auto-renewing letter of credit issued by a Canadian chartered bank or credit union; and

   (d) maintain the security for a minimum of one year after completion of the landscaping, and not prior to the date on which the District authorizes in writing the release of the security.

7. Prior to issuance of an Occupancy Permit, the applicant must complete the following:

   (a) Provide the District Facilities Department an "as-built" BCLS Survey to capture all foreshore infrastructure south of the site; and

   (b) Initiate a new foreshore encroachment agreement with the District.

8. This Development Variance Permit lapses if construction has not substantially started, with respect to this permit under an issued Building Permit, within 24 months of issuance.

THE COUNCIL OF WEST VANCOUVER APPROVED THIS PERMIT BY RESOLUTION PASSED ON .

MAYOR

MUNICIPAL CLERK

FOR THE PURPOSES OF SECTION 8, THIS PERMIT IS ISSUED ON

Schedules:

A – Development Plans for 4369 Erwin Drive prepared by Hlynsky and Davis Architects and Paul Sangha Creative dated August 13, 2019.

B – Flood Hazard Assessment for 4369 Erwin Drive prepared by NHC dated stamped May 19, 2020.

SCHEDULE A

DRAWING LIST

A1.1	RENDERS
A1.2	CONTEXT PHOTOS
A1.4	SITE PLAN
A1.5	AVERAGE GRADE
A2.1	LOWER FLOOR PLAN
A2.2	MAIN FLOOR PLAN
A2.3	UPPER FLOOR PLAN
A2.4	ROOF PLAN
A4.1	NORTH ELEVATION - COACH HOUSE
A4.2	NORTH ELEVATION
A4.3	EAST ELEVATION
A4.4	SOUTH ELEVATION
A4.5	WEST ELEVATION
A5.1	SECTION - ENTRY
LDP-1.01	LANDSCAPE MASTER PLAN
LDP-4.01	PERMIT PLANTING PLAN

HADDAD RESIDENCE 4369 ERWIN DRIVE

HLYNSKY + DAVIS
ARCHITECTS INC

HADDAD RESIDENCE
4369 ERWIN DRIVE
W VAN BC

RENDERS

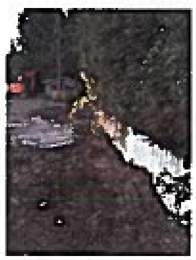
A1.1

CONTEXT VIEW

LOT DURING DECEMBER [illegible] STORM EVENT

WEST NEIGHBOR ADJACENCY LOOKING SOUTH

WEST NEIGHBOR LOOKING NORTH



EAST NEIGHBOR LOOKING NORTH

SOUTH EAST FORESHORE ENCROACHMENT

EXISTING GARAGE/WORKSHOP

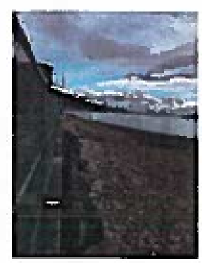
EAST PL AT EXISTING GARAGE

SOUTH EAST FORESHORE ENCROACHMENT

SOUTH EAST FORESHORE ENCROACHMENT

SOUTH EAST FORESHORE ENCROACHMENT

SOUTH EAST FORESHORE ENCROACHMENT



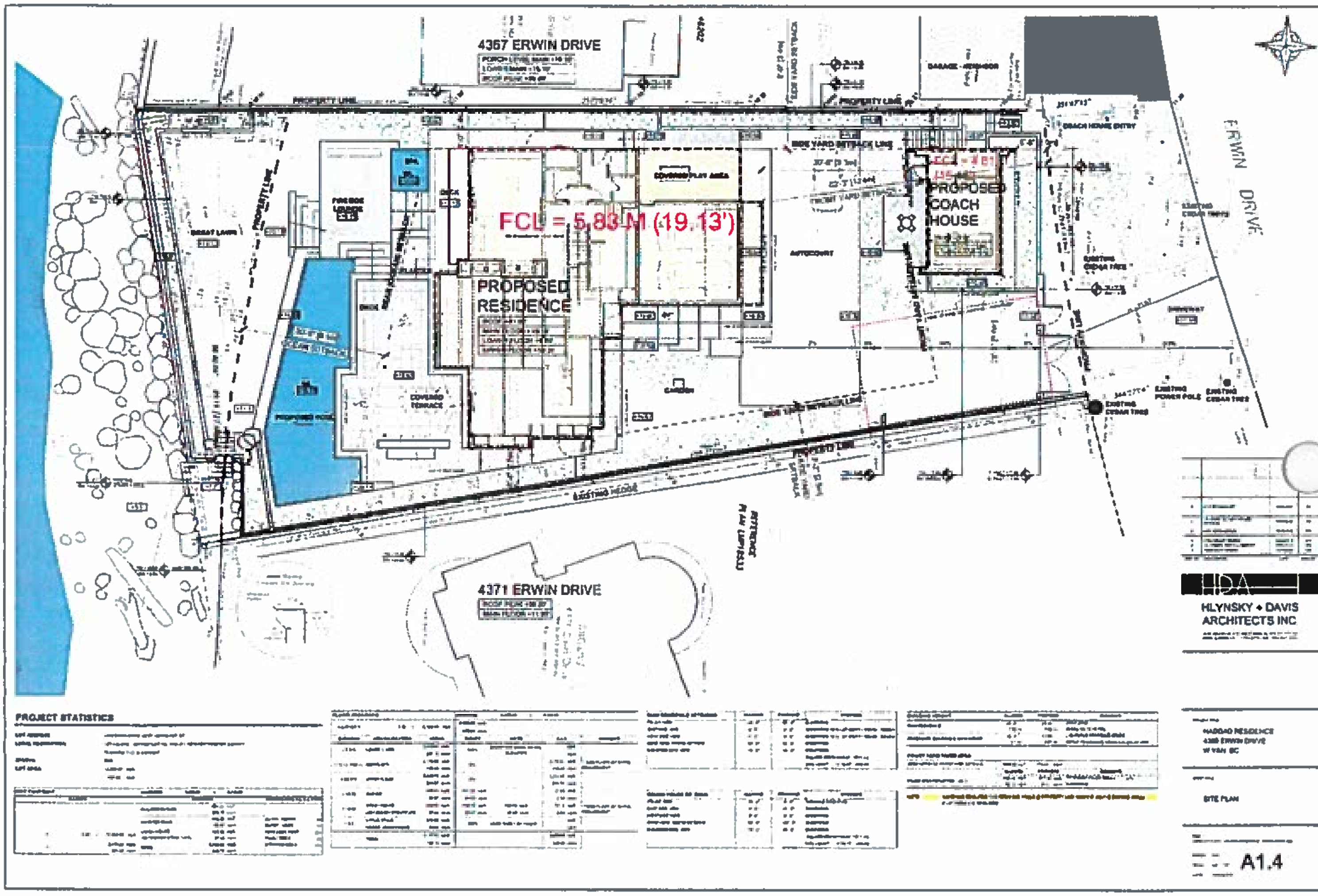
SOUTH EAST FORESHORE ENCROACHMENT

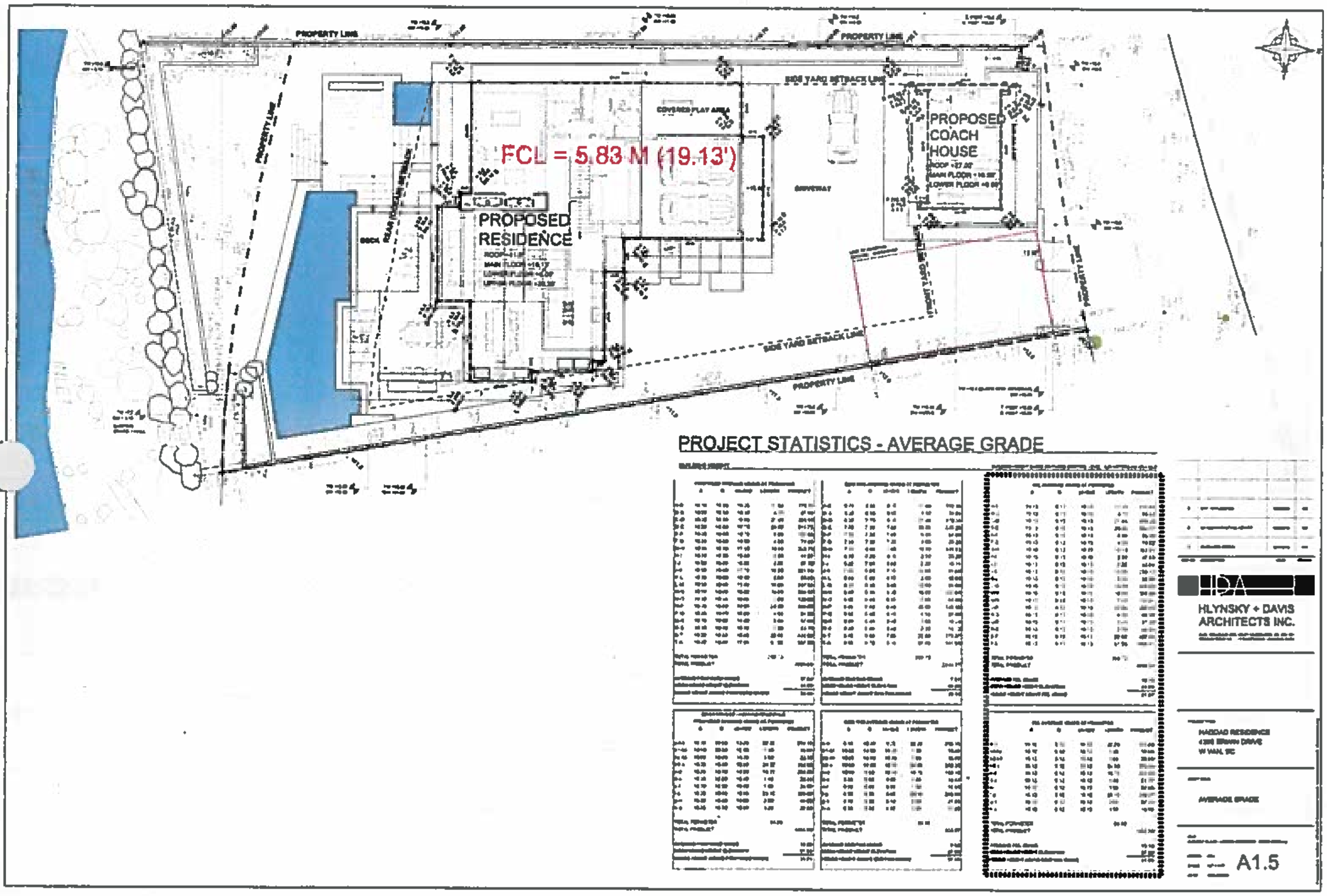
HLYNSKY + DAVIS
ARCHITECTS INC

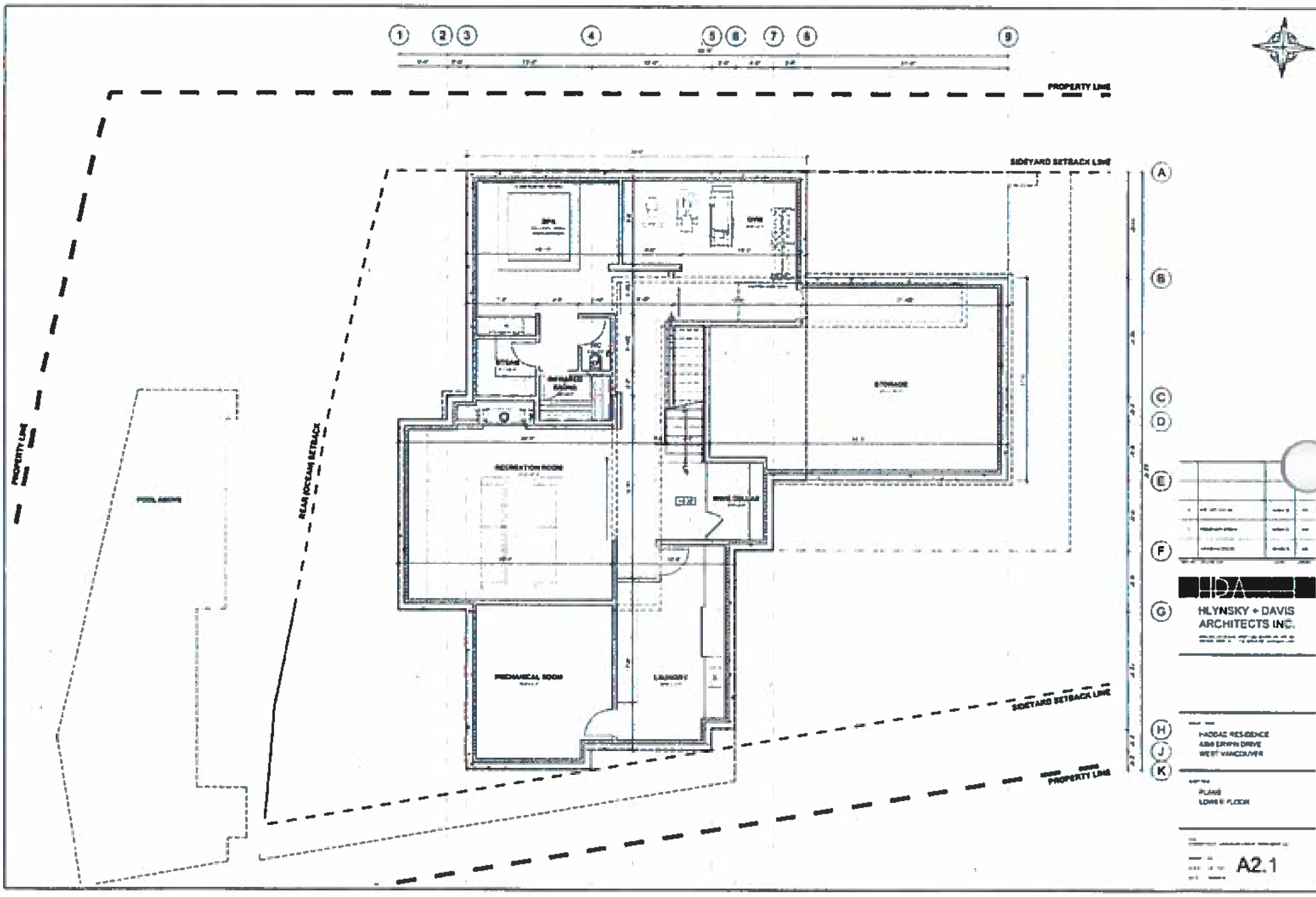
HADDAD RESIDENCE
[illegible] DRIVE
W VAN, BC

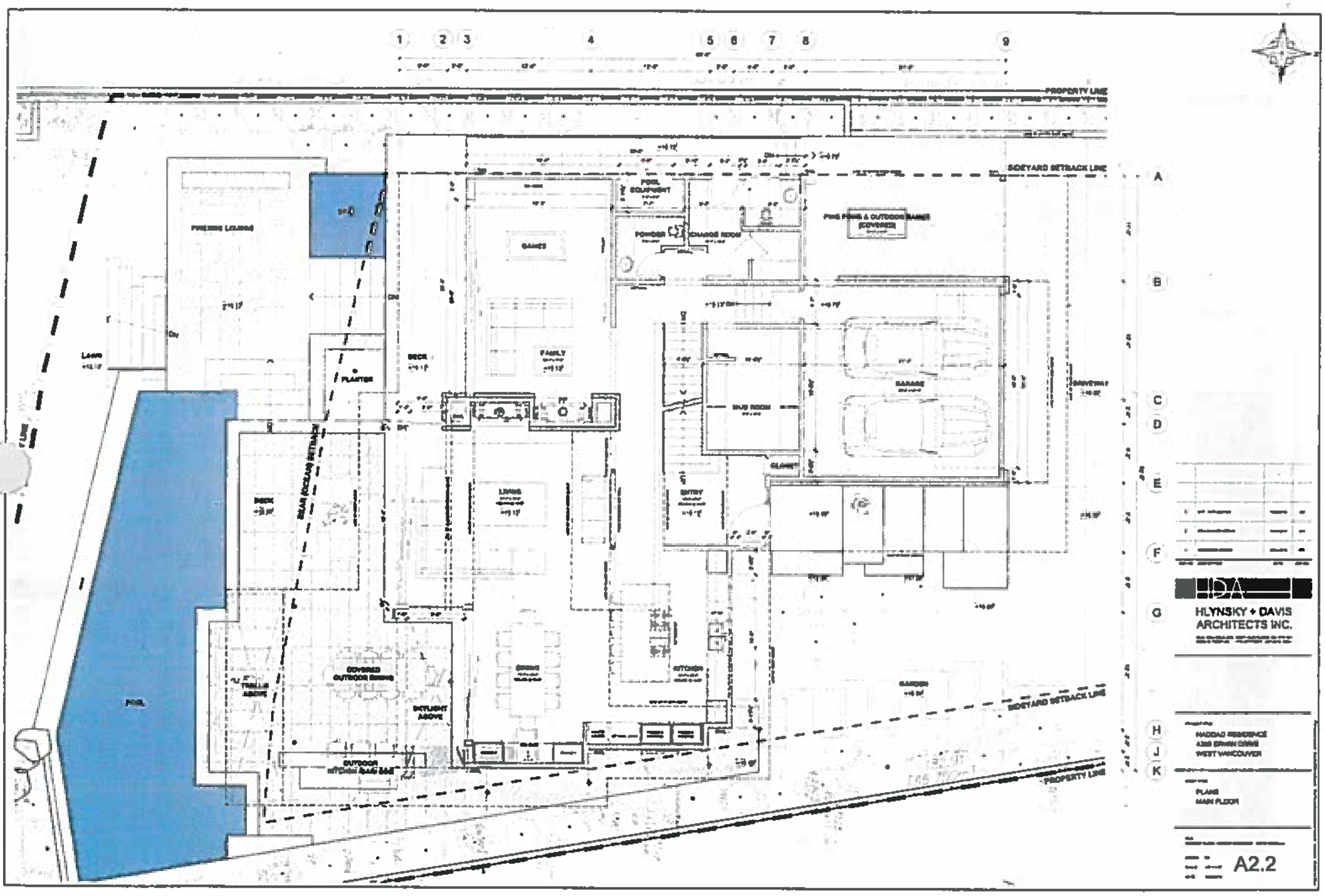
CONTEXT PHOTOS

A1.2

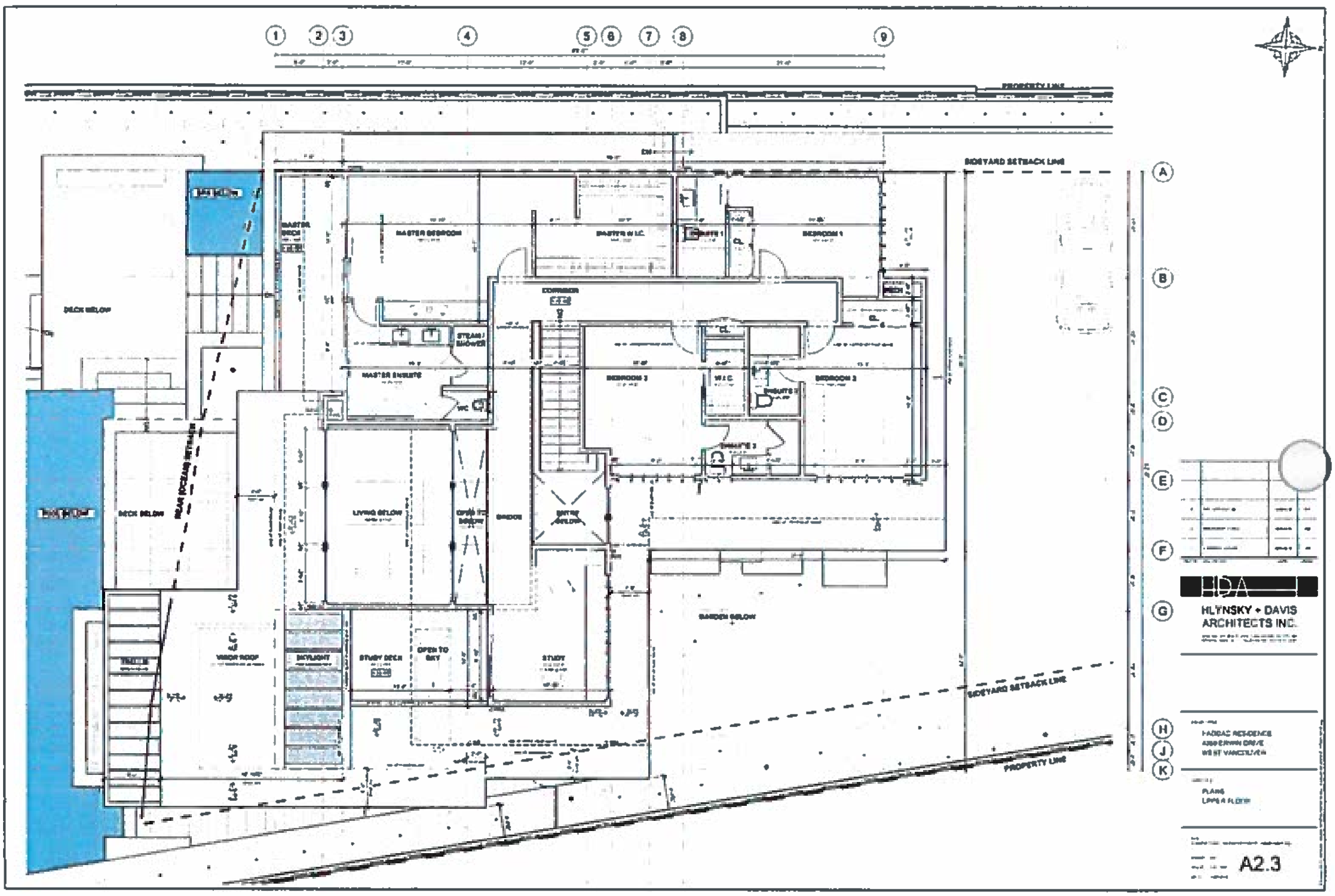

4367 ERWIN DRIVE
PROPERTY LINE
FCL = 5.83 M (19.13')
PROPOSED RESIDENCE
PROPOSED COACH HOUSE
ERWIN DRIVE
4371 ERWIN DRIVE
EXISTING HEDGE
HLYNSKY + DAVIS ARCHITECTS INC
PROJECT STATISTICS
A1.4


PROPERTY LINE
FCL = 5.83 M (19.13')
PROPOSED RESIDENCE
PROPOSED COACH HOUSE
SIDE YARD SETBACK LINE
PROJECT STATISTICS - AVERAGE GRADE
HLYNSKY + DAVIS ARCHITECTS INC.
A1.5

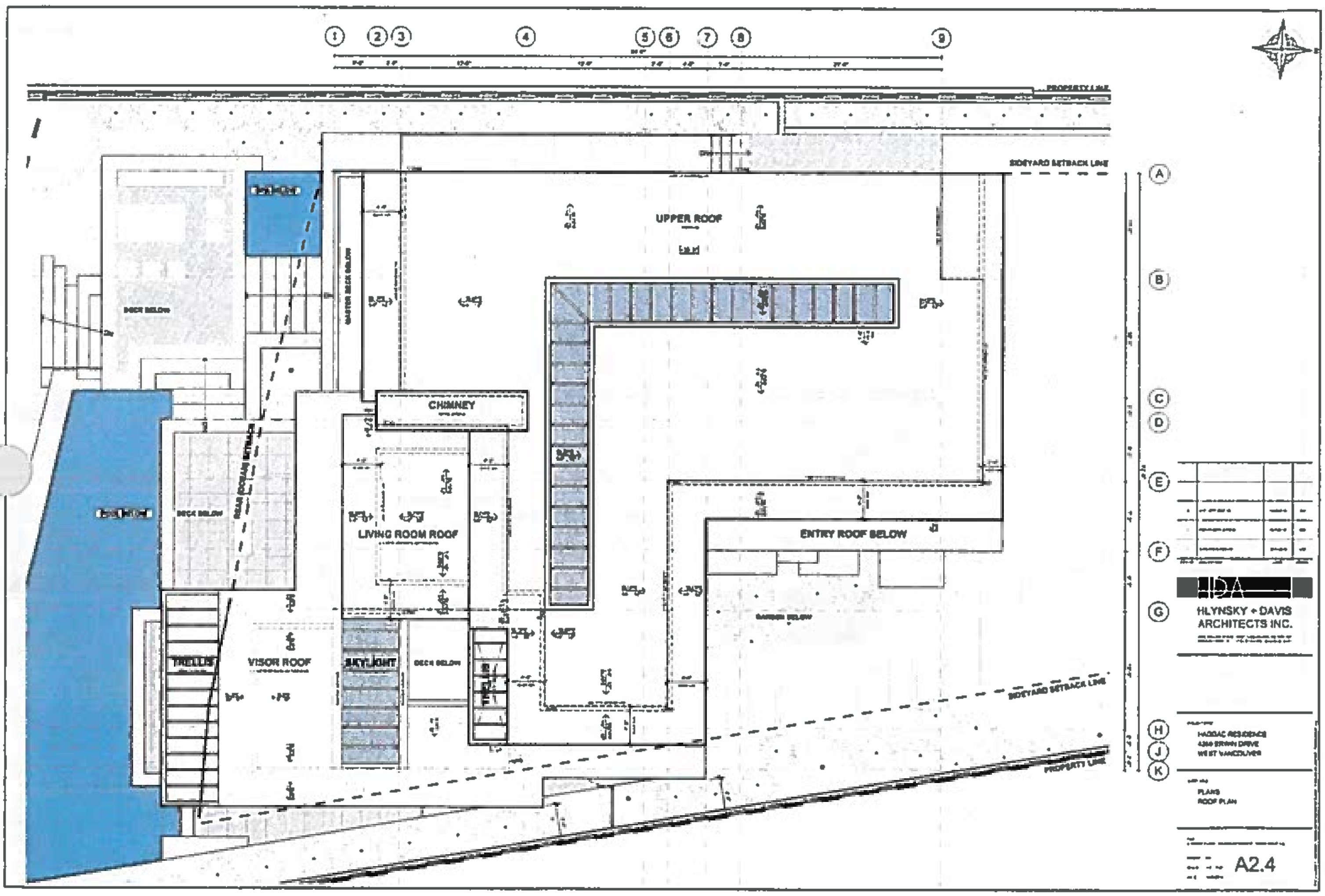

PROPERTY LINE
SIDEYARD SETBACK LINE
SPA
GYM
STEAM
STORAGE
RECREATION ROOM
WINE CELLAR
POOL ABOVE
REAR (OCEAN) SETBACK
MECHANICAL ROOM
LAUNDRY
HLYNSKY + DAVIS
ARCHITECTS INC.
PLANS
A2.1



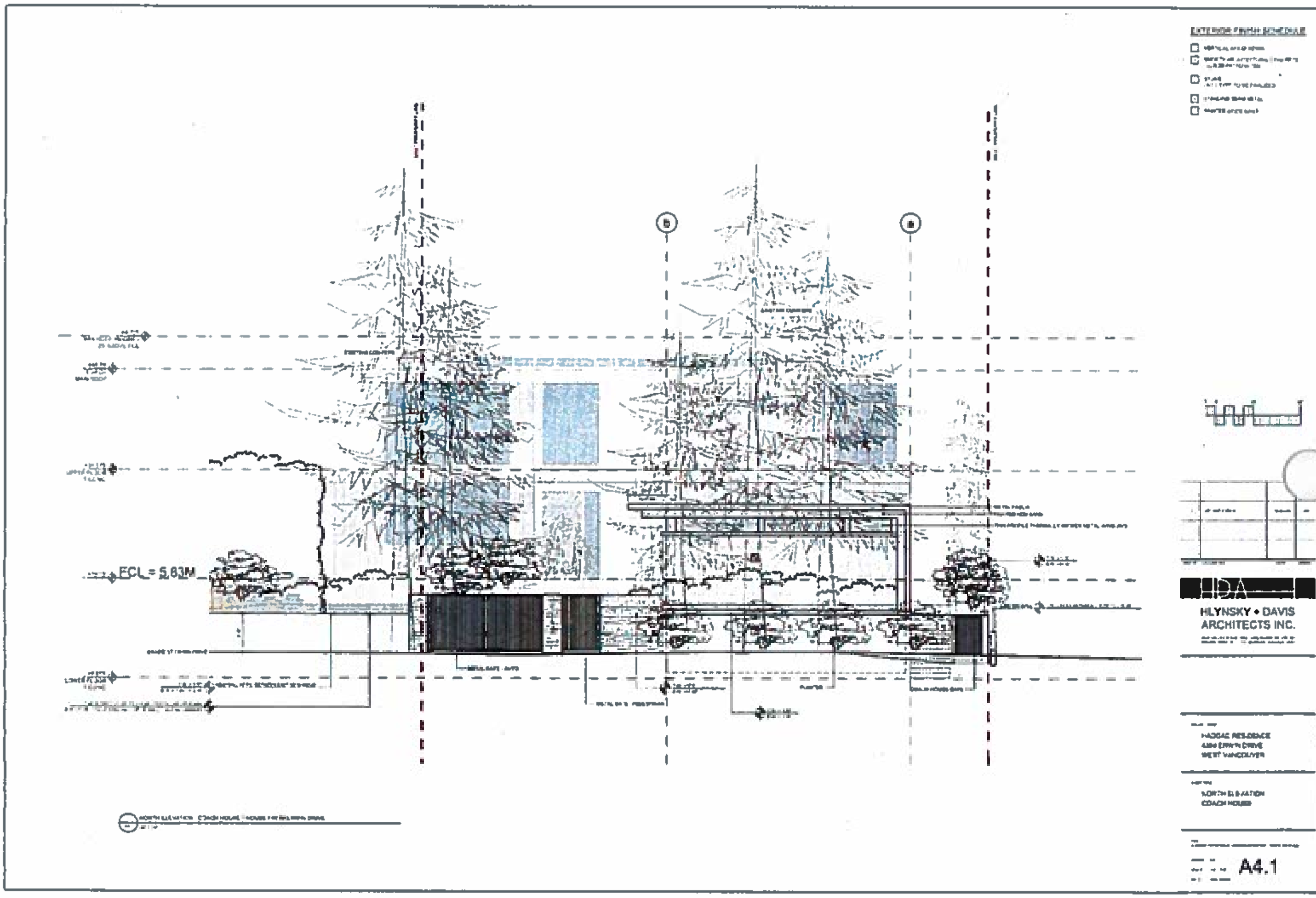
PROPERTY LINE
SIDEYARD SETBACK LINE
GARAGE
POOL
HLYNSKY + DAVIS
ARCHITECTS INC.
PLANS
MAIN FLOOR
A2.2

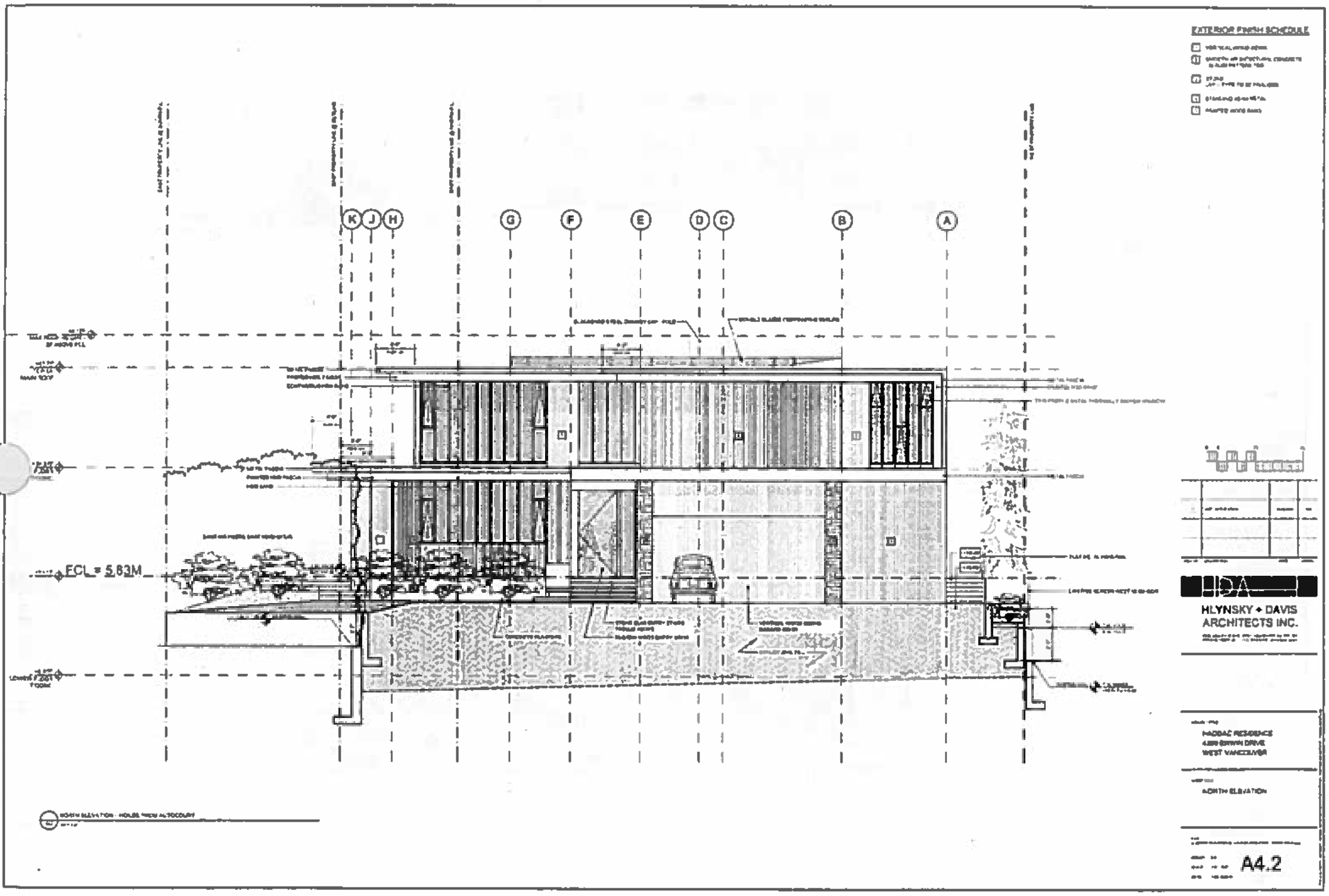


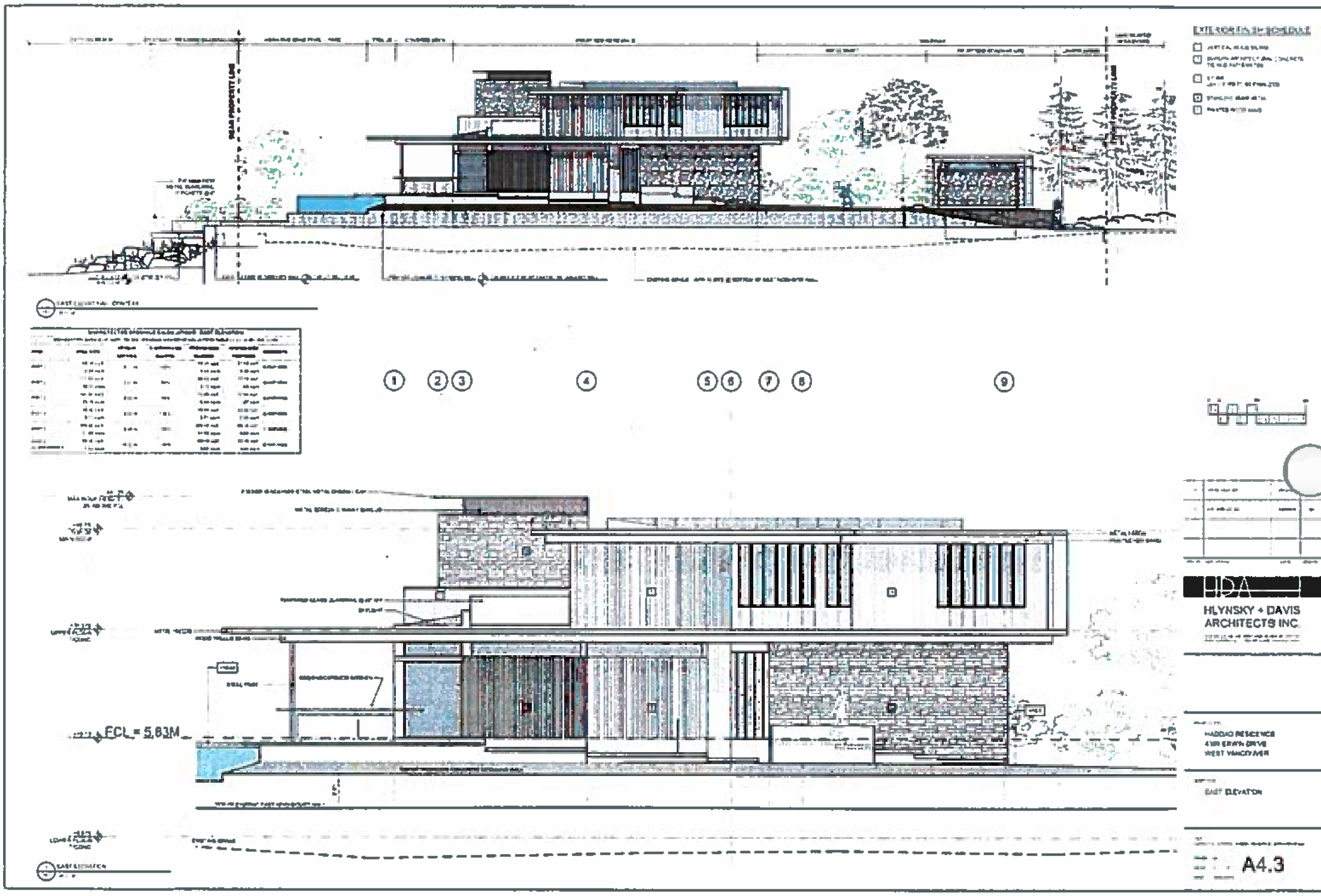
PROPERTY LINE
SIDEYARD SETBACK LINE
MASTER BEDROOM
MASTER W.I.C.
BEDROOM 1
CORRIDOR
MASTER ENSUITE
BEDROOM 2
BEDROOM 3
DECK BELOW
LIVING BELOW
OPEN TO BELOW
BRIDGE
ENTRY BELOW
GARDEN BELOW
STUDY DECK
OPEN TO SKY
STUDY
SKYLIGHT
HLYNSKY + DAVIS
ARCHITECTS INC.
A2.3



PROPERTY LINE
SIDEYARD SETBACK LINE
UPPER ROOF
CHIMNEY
LIVING ROOM ROOF
ENTRY ROOF BELOW
VISOR ROOF
TRELLIS
SKYLIGHT
DECK BELOW
HLYNSKY + DAVIS
ARCHITECTS INC.
PLANS
ROOF PLAN
A2.4


ECL = 5.83M
HLYNSKY • DAVIS
ARCHITECTS INC.
NORTH ELEVATION
COACH HOUSE
A4.1


EXTERIOR FINISH SCHEDULE
K J H G F E D C B A
ECL = 5.83M
HLYNSKY + DAVIS
ARCHITECTS INC.
WEST VANCOUVER
NORTH ELEVATION
A4.2


EXTERIOR FINISH SCHEDULE
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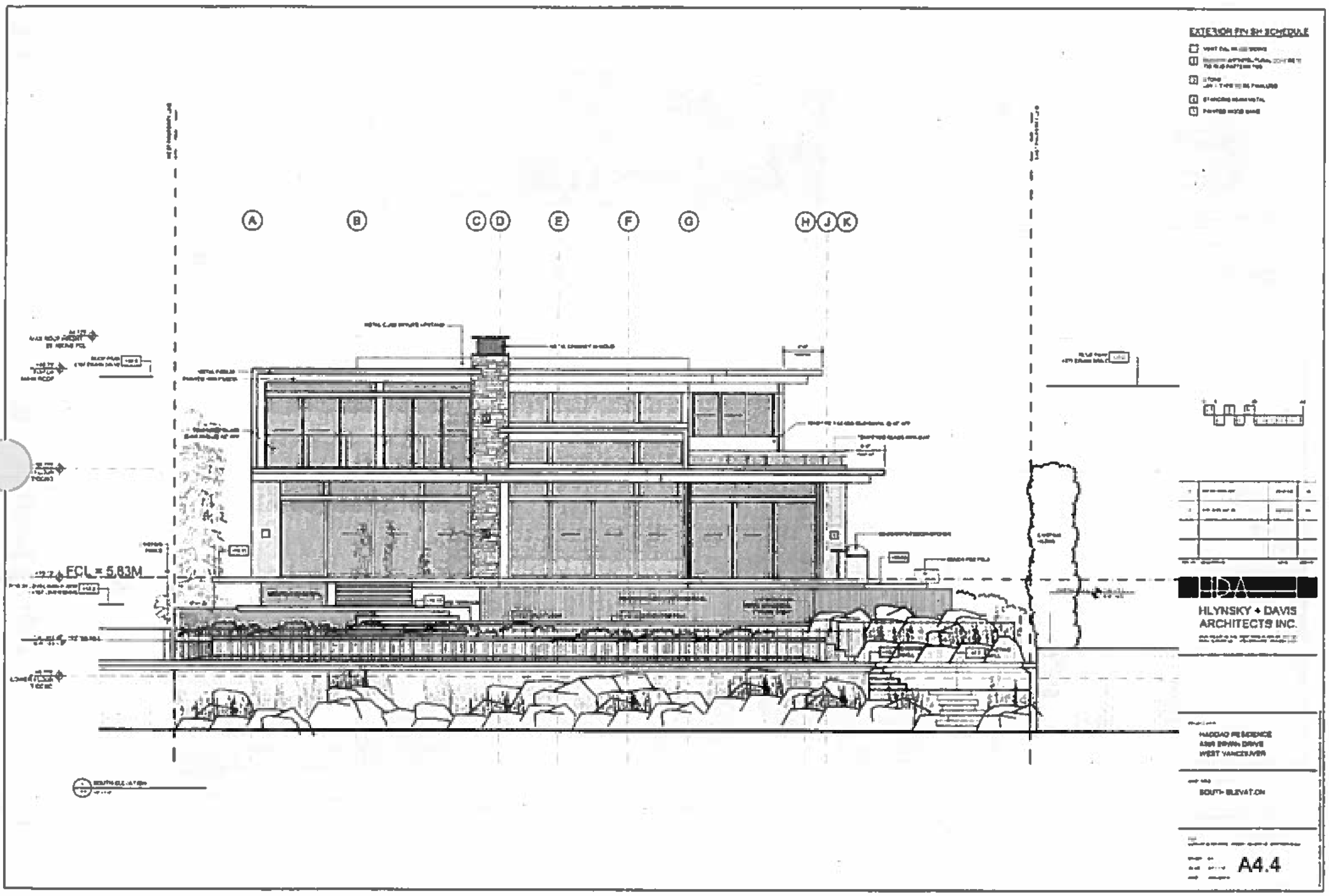
ARCHITECTS INC.
EAST ELEVATION
A4.3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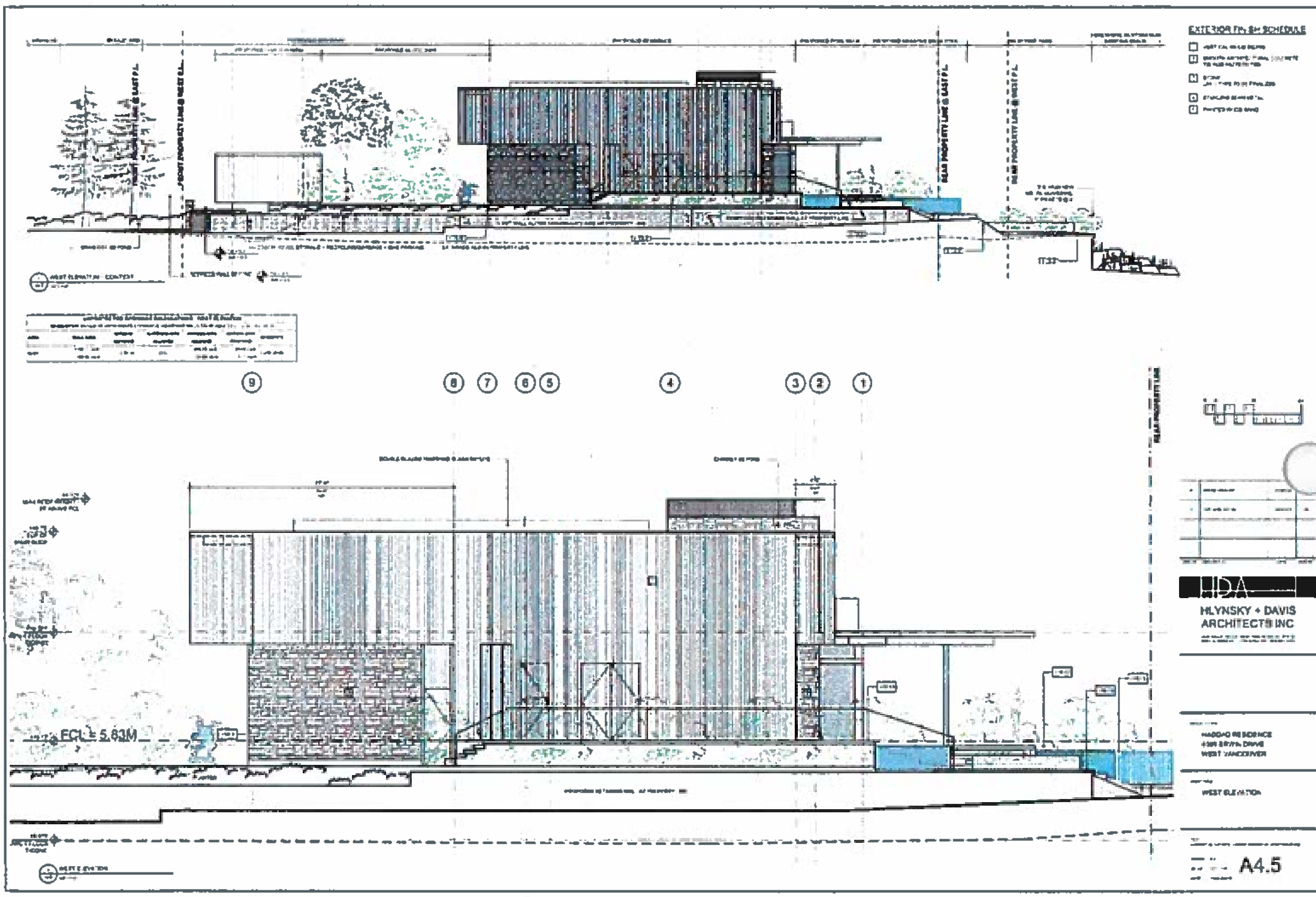
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HLYNSKY + DAVIS
ARCHITECTS INC
WEST ELEVATION
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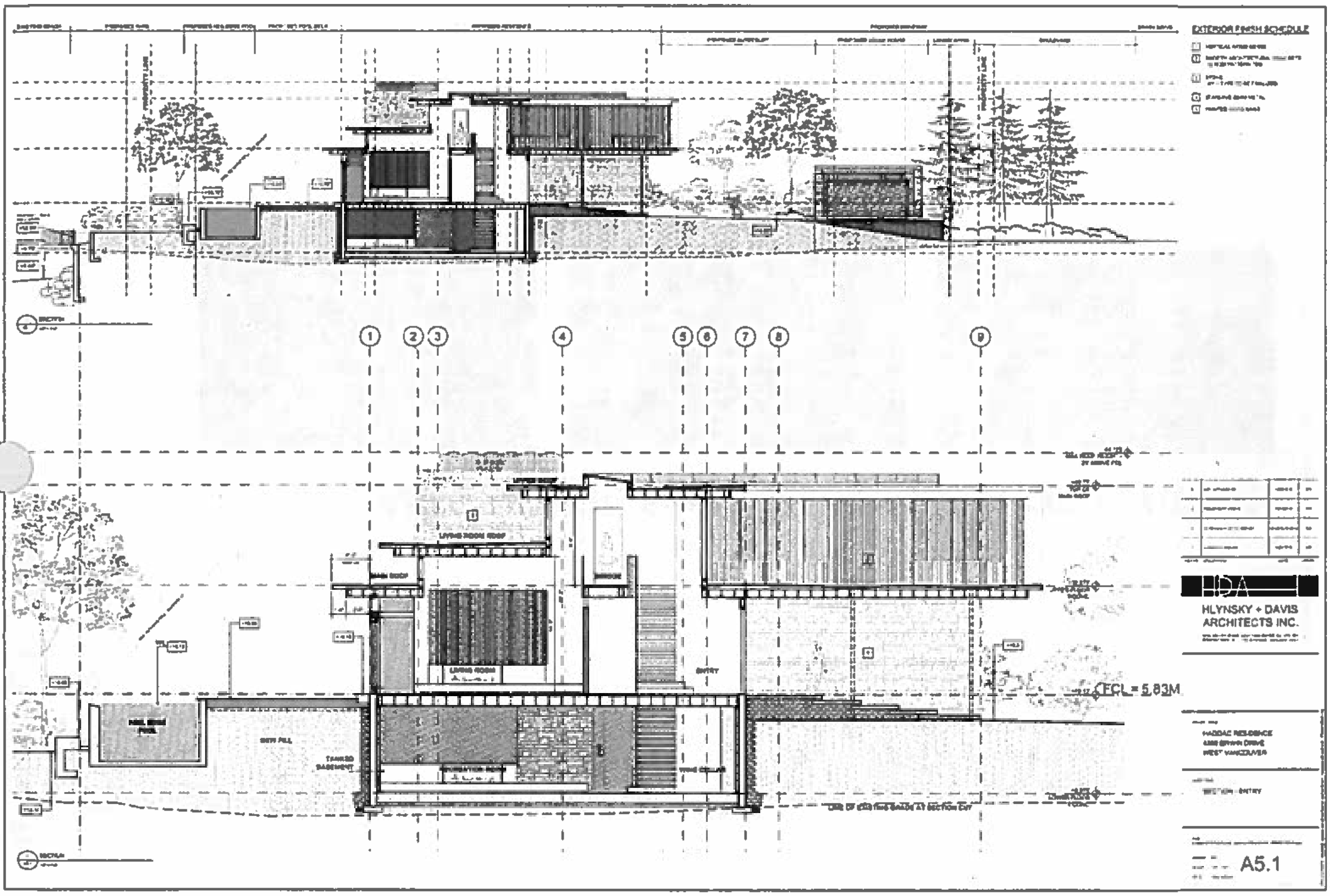
EXTERIOR FINISH SCHEDULE
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LIVING ROOM ROOF
LIVING ROOM
ENTRY
FCL = 5.83M
HLYNSKY + DAVIS
ARCHITECTS INC.
A5.1

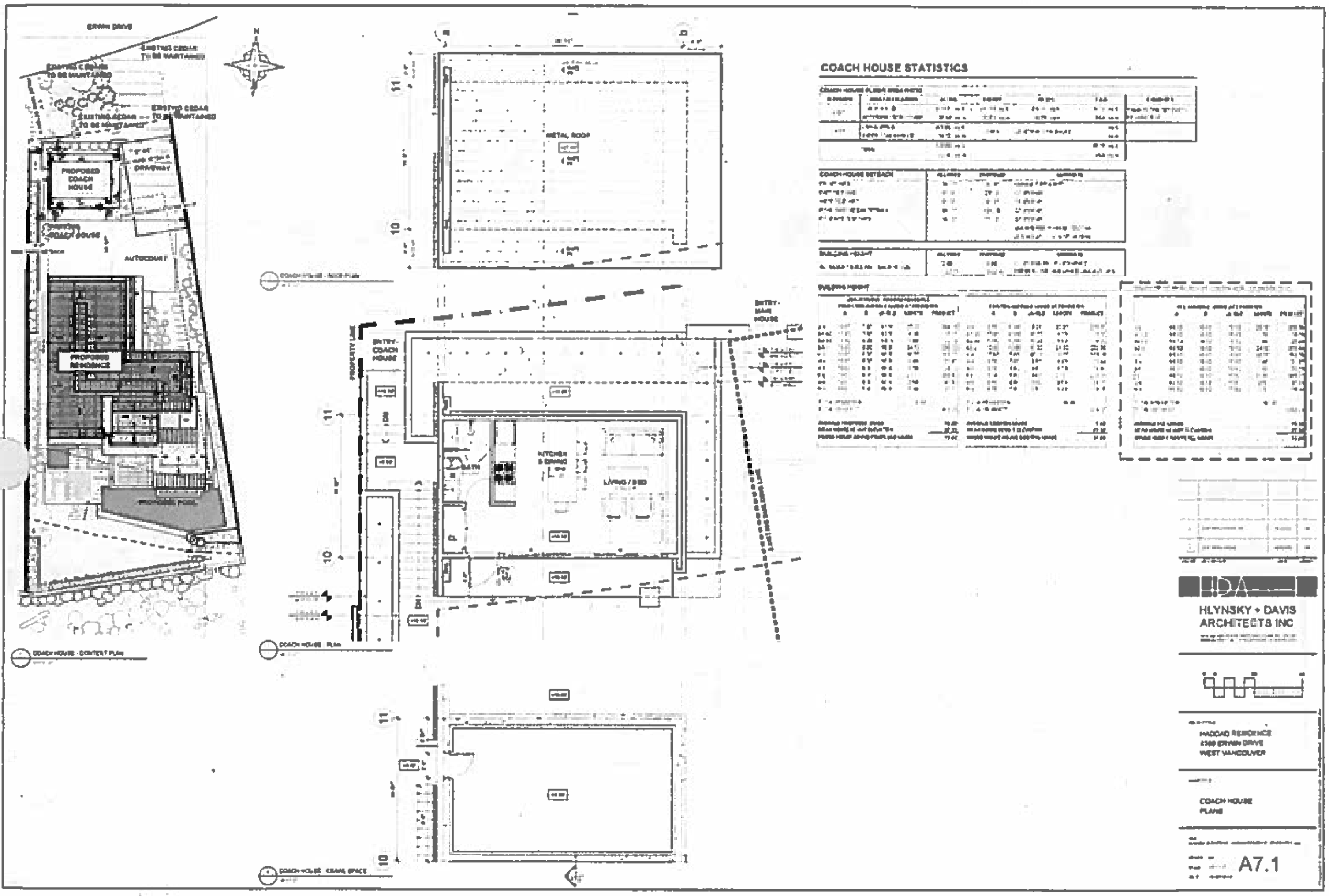
HADDAD COACH HOUSE 4369 ERWIN DRIVE

MLYNSKY + DAVIS
ARCHITECTS INC

HADDAD RESIDENCE
4369 ERWIN DRIVE
WEST VANCOUVER

COACH HOUSE
RENDERS

A7.0


COACH HOUSE STATISTICS
ERWIN DRIVE
EXISTING CEDAR TO BE MAINTAINED
PROPOSED COACH HOUSE
DRIVEWAY
EXISTING COACH HOUSE
AUTOCOURT
PROPOSED RESIDENCE
PROPOSED POOL
COACH HOUSE - CONTEXT PLAN
METAL ROOF
COACH HOUSE - ROOF PLAN
ENTRY - COACH HOUSE
ENTRY - MAIN HOUSE
PROPERTY LINE
BATH
KITCHEN & DINING
LIVING / BED
COACH HOUSE - PLAN
COACH HOUSE - CRAWL SPACE
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ERWIN DRIVE
WEST VANCOUVER
COACH HOUSE PLANS
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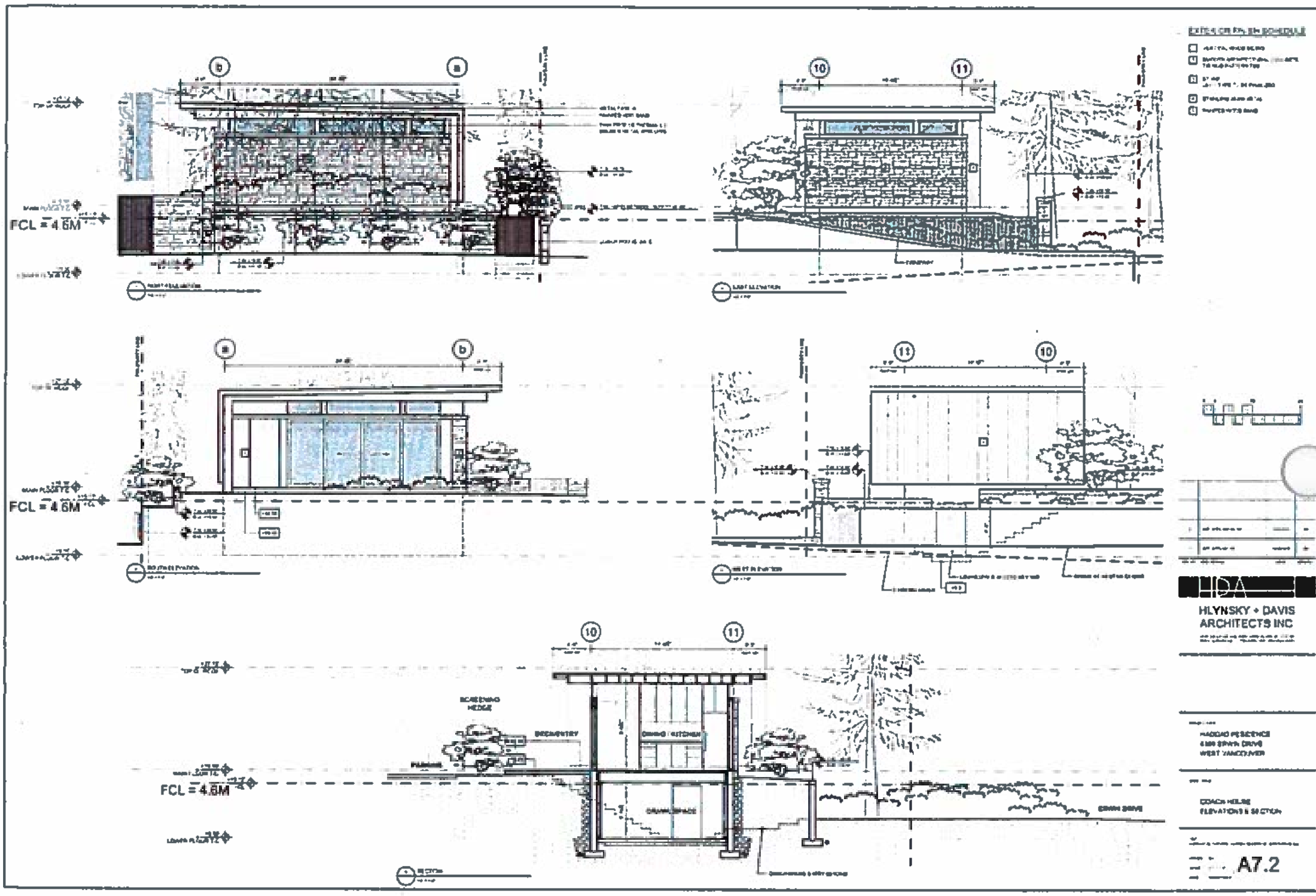
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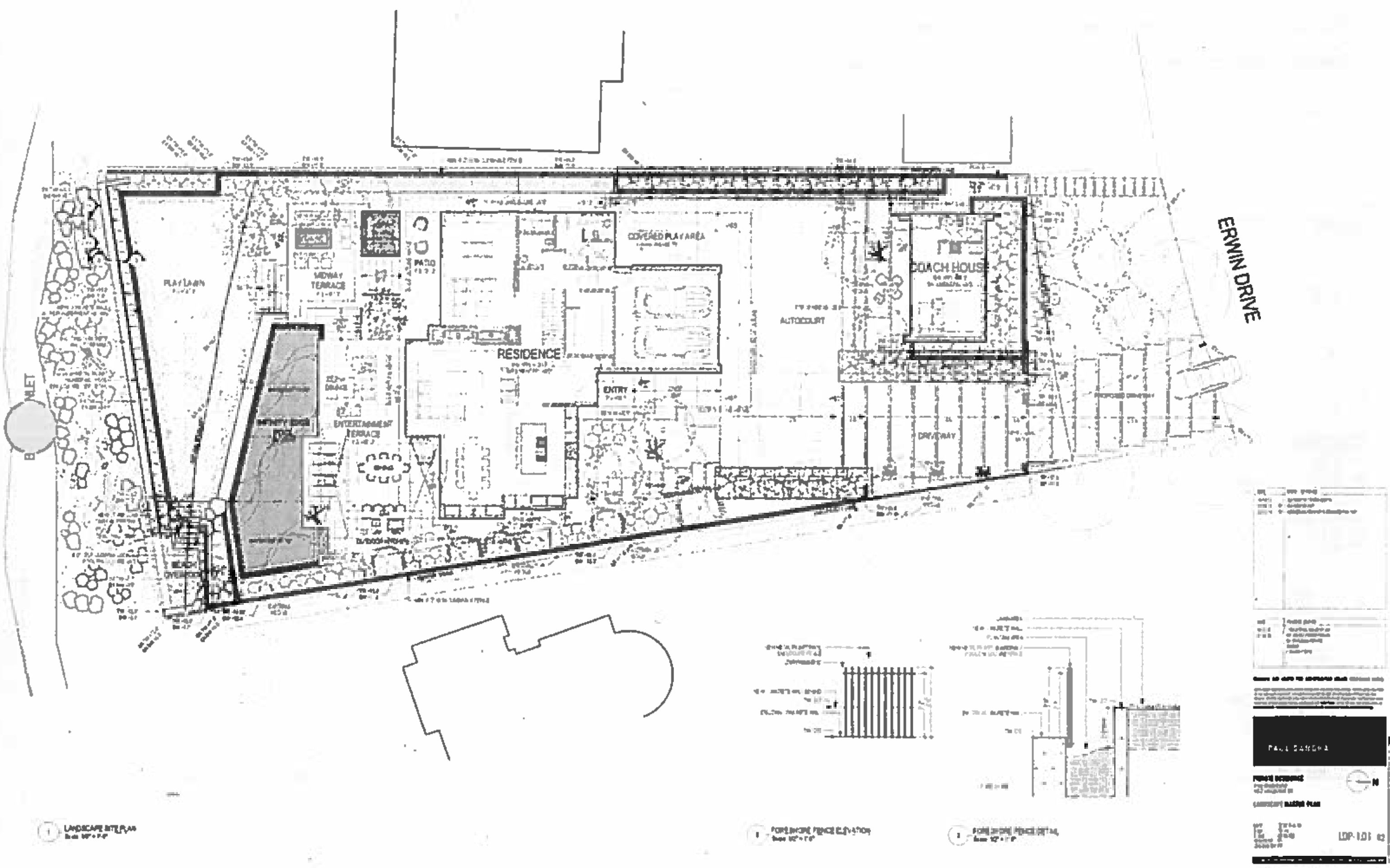
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COACH HOUSE
RESIDENCE
COVERED PLAY AREA
AUTOCOURT
DRIVEWAY
ENTRY
PATIO
MIDWAY TERRACE
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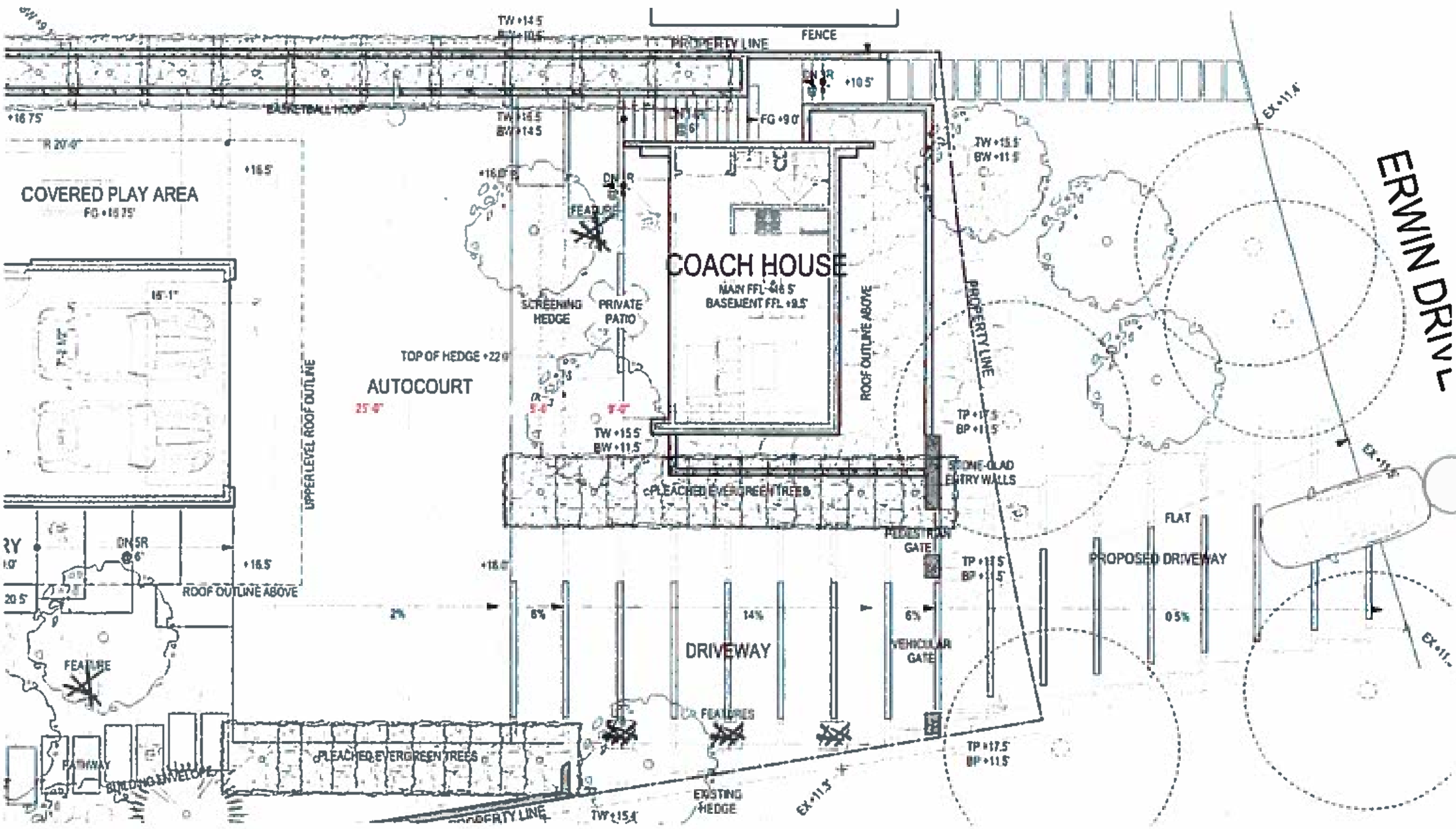
ENTERTAINMENT TERRACE
INFINITY EDGE POOL
LANDSCAPE SITE PLAN
FORESHORE FENCE ELEVATION
FORESHORE FENCE DETAIL
LDP-1.01



PAUL SANGHA CREATIVE

SK-01 REVISED COACHHOUSE

30 Gostick Place | North Vancouver, BC V7M 3G3 | 604.980.6011 | www.nhcweb.com

nhc
northwest hydraulic consultants

SCHEDULE B

Project. Ref 3004523
Dated: 2020 May 19

Tara Haddad
[redacted]
West Vancouver, BC, [redacted]

Attention: Tara Haddad
Via email: [redacted]

Re: **4369 Erwin Drive, West Vancouver, BC**
Lot A, Block 7, District Lot 582, Group 1, New Westminster District,
Plan 6662, P.I.D. 010-826-947
Flood Hazard Assessment – s219 Covenant Cover Letter

Hlynsky and Davis Architects Inc. have designed a single family home to be constructed at 4369 Erwin Drive, West Vancouver (Lot A, Block 7, District Lot 582, Group 1, New Westminster District, Plan 6662). The property is located on the north shore of Burrard Inlet within the District of West Vancouver (DWV). The property is potentially at risk to coastal flood hazards from Burrard Inlet as well as riverine flood hazards from Cypress Creek. Northwest Hydraulic Consultants Ltd. (NHC) has previously conducted a flood hazard assessment to identify and assess these hazards, as well as issued a follow-up report to clarify proposed changes to the design of the property with respect to the calculated Flood Construction Level (FCL). The purpose of this document is to provide a covering letter to NHC's previous reports for the purposes of meeting the DWV requirements for a s219 Covenant Letter that would be attached to the subject property. This letter also confirms that we have reviewed the record Drawing Set and find that it conforms to the drawings attached to our previous reports in those details that pertain to calculation of the FCL.

Summary of Reports and Drawings

The issued reports and drawings are attached for reference as follows:

Attachment A – Flood Hazard Assessment – Final Report for 4369 Erwin Drive, West Vancouver, BC (issued 26 February 2019)

Attachment B – Flood Hazard Assessment – Final Report (Revised) for 4369 Erwin Drive, West Vancouver, BC; Removal of option to lower the FCL through construction of a wall across the seaward side of the property and to provide specific direction for application of the coastal FCL to the coach house (issued 22 March 2019)

Attachment C – Hlynsky+Davis Architects Inc. Drawing Set for Haddad Residence at 4369 Erwin Drive, West Vancouver (Revision 3, DVP Application, issued 13 August 2019)

Each of the above referenced reports includes reference drawings as an attached appendix. For the purposes of this s219 Covenant Letter, the Drawing Set in Attachment C applies.

Flood Hazard Assessment (Attachment A)

The flood hazard assessment issued 26 February 2019 and included as **Attachment A** summarises the analysis undertaken to assess coastal hazards, including high tides, storm surges, and wind-driven waves, and provides recommendations for the adoption of an FCL under three scenarios: a) existing conditions for the year 2019 ocean levels; b) the proposed residence under future conditions to the year 2100; and c) the proposed residence with the inclusion of a secondary wall near the foreshore under future conditions to the year 2100. These are summarised in Table 6 of that report.

The report also includes ten recommendations for the safe use of the property, which are articulated in Section 5 of that report. There is an additional recommendation concerning the responsibilities of the owner to monitor and inspect the property for erosion and beach degradation twice a year to allow further investigation and mitigation if either become a problem in the future.

The drawing set attached as Appendix B to this report is superseded by the drawing set that is attached to the 22 March 2019 report.

Flood Hazard Assessment – Final Report (Revised) (Attachment B)

A *revised* flood hazard assessment issued 22 March 2019 and included as **Attachment B** was issued to clarify that the proposed wall along the seaward side of the property that had earlier been considered to reduce the overall FCL was no longer to be included in the site plans, thus removing the option to reduce the FCL at the main house. In addition, this revised letter provided clarification of the FCL to be considered at the coach house, located at the back of the property. The purpose of the 22 March 2019 report was to revise the flood hazard report issued on 26 February 2019, confirming that the applicable FCL for the main residence would be 5.83 m GSC and that the FCL applicable to the coach house would be 4.61 m GSC. All conditions and recommendations contained in the flood hazard assessment report remain in effect. The drawings upon which this *revised* flood hazard assessment are based are summarised in Table 1.

Table 1 **Reference drawing set included as Appendix A in Attachment B**

Drawing No.	Revision	Drawing Name	Date Issued
A1.2	1	Site Plan	30 October 2018
A2.1	1	Plans Lower Floor	30 October 2018
A2.2	1	Plans Main Floor	30 October 2018
A2.3	1	Plans Upper Floor	30 October 2018

Review of Record Drawing Set (Attachment C)

A record Drawing Set (issued as DVP Application, Revision 3 on 13 August 2019) was reviewed by NHC for the purposes of confirming that details pertaining to the determination of the FCL that were included in the drawing set summarised in Table 1 remained unchanged. There were relatively small changes made with respect to the location of the wall and elevation of the lawn fronting the house. NHC has conducted calculations to confirm that these changes to not materially alter the recommended FCLs for the property. Therefore, with respect to the location and elevation of the secondary wall, and elevation of the ground floor of the dwelling and coach house, we have determined that this drawing set conforms to those drawings included in NHC's previous reports (as outlined above) upon which we relied to calculate the FCL.

CERTIFICATION

The 2100-year design FCL for the project site was calculated for the secondary wall. The FCL elevation is calculated to be 5.83 m GSC for the main house and 4.61 m GSC for the coach house and utilized for this project site.

The subject property may be safely used for the use intended – being the construction of a single-family residence substantially as depicted in the reference Drawing Set prepared by Hlynsky and Davis Architects Inc. (Architectural Drawing Set issued as DVP Application, Revision 3 on 13 August 2019), and attached as **Attachment C** to this certification – if all of the flood hazard conditions outlined in Section 5 of the *revised* flood hazard assessment issued 22 March 2019 are met (per **Attachment B**).

We hope this letter meets your current needs. If you have any questions don't hesitate to contact Edwin Wang or Derek Ray by phone 604-980-6011 or email (ewang@nhcweb.com | dray@nhcweb.com).

Sincerely,

Northwest Hydraulic Consultants Ltd.

Prepared by:	Reviewed by:
PROFESSIONAL ENGINEER, PROVINCE OF BRITISH COLUMBIA, E. C. WANG # 29366 — May 19, 2020	PROFESSIONAL GEOSCIENTIST, PROVINCE OF BRITISH COLUMBIA, D. A. RAY — May 19, 2020
Edwin Wang, P.Eng. Senior Hydrotechnical Engineer	Derek Ray, P.Geo. Principal

DISCLAIMER

This document has been prepared by Northwest Hydraulic Consultants Ltd. for the benefit of Tara Haddad for specific application to the Flood Hazard Assessment at 4369 Erwin Drive. The information and data contained herein represent Northwest Hydraulic Consultants Ltd. best professional judgment in light of the knowledge and information available to Northwest Hydraulic Consultants Ltd. at the time of preparation and was prepared in accordance with generally accepted engineering practices.

Except as required by law, this report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by Tara Haddad, its officers and employees. Northwest Hydraulic Consultants Ltd. denies any liability whatsoever to other parties who may obtain access to this report for any injury, loss or damage suffered by such parties arising from their use of, or reliance upon, this report or any of its contents.

ATTACHMENT A

Flood Hazard Assessment – Final Report for 4369 Erwin Drive, West Vancouver, BC (issued 26 February 2019)

- Superceded -

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nhc
northwest hydraulic consultants ltd

NHC Ref. No. 3004525

26 February, 2019

Tara Haddad
[redacted]
West Vancouver, BC, [redacted]

Attention: Tara Haddad
Via email: [redacted]

Re: **Flood Hazard Assessment – Final Report**
4369 Erwin Drive, West Vancouver, BC

Dear Ms. Haddad,

This letter report summarizes the flood hazard assessment (FHA) study conducted by Northwest Hydraulic Consultants Ltd. (NHC) in support of building permit for the proposed 4369 Erwin Drive development located within the District of West Vancouver (DWV).

1 INTRODUCTION

A single-family home is being proposed for 4369 Erwin Drive (Lot A, Block 7, District Lot 582, Group 1, New Westminster District, Plan 6662). The property is located on the north shore of Burrard Inlet within the DWV (**Figure 1**). Cypress Creek flows drains the steep slopes of the coastal North Shore mountains to outlet to Burrard Inlet near the project site. The property is potentially at risk to coastal flood hazards from Burrard Inlet as well as riverine flood hazards from the Cypress creek. NHC has conducted a flood hazard assessment to identify and assess these hazards. This report presents this assessment, the findings, and recommended measures to mitigate the hazard.

The objective of this assessment is to identify and evaluate the flood hazards that may affect the safe development and use of the property with respect to the proposed development and decide if development is possible to an acceptable safety threshold, either without or with mitigation. The currently accepted safety threshold in British Columbia is 0.5% annual exceedance probability (AEP) up to the year 2100. The 0.5% AEP event is often referred to as the 200-year event as such an event is expected, on average, to occur or be exceeded, once every 200 years.

The report has been structured by presenting referenced guidelines, site observations, coastal assessment, and concluding with findings and recommendations. The risk of flooding from the local Cypress Creek, located 250 m west of the study site, is considered to be of less risk than the coastal flood hazard and therefore the assessment has focused on the coastal derived hazards.

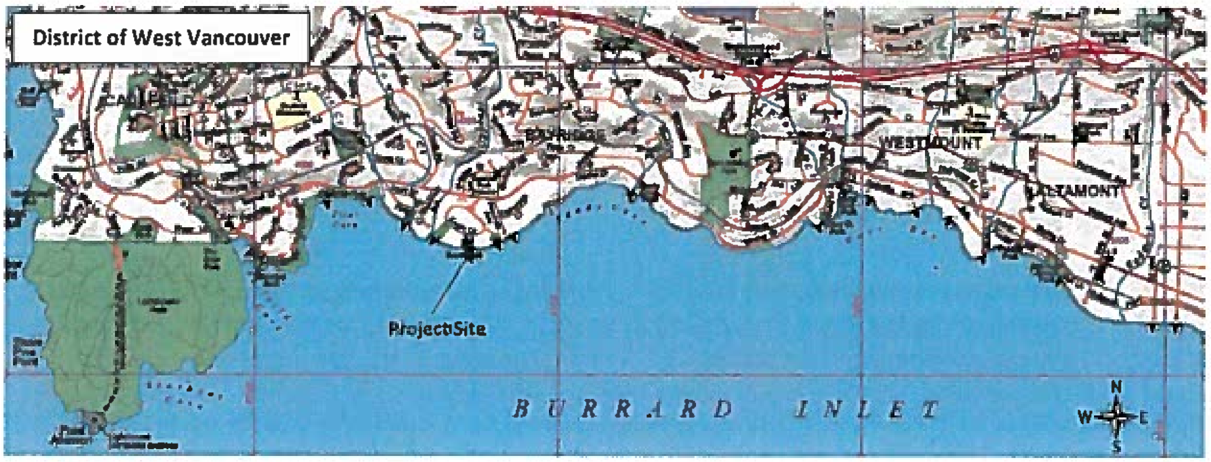

Figure 1. Location map of study site.

1.1 Existing FHA Covenants

DWV requires all applicants applying for a building permit to construct buildings in coastal areas to provide a site specific FHA report, prepared by a qualified professional, that confirms the land may be used safely for the use intended.

The report prepared by a qualified engineer must:

- Be prepared in accordance with the most recent edition of the Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC published by Engineers and Geoscientists of BC (EGBC, 2018);
- Be prepared by a qualified registered engineer;
- Be accompanied by the Flood Hazard and Risk Assurance Statement (Appendix A); and
- Identify all floor areas proposed to be constructed below the 4.5 m Geodetic Survey of Canada Datum (GSCD or GD) and specify use of these areas.

2 REFERENCED GUIDELINES

The following guidelines and regulations were reviewed as part of our investigation of the possible hydrotechnical hazards that could threaten the study property.

- Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC (EGBC, 2018)
- Flood Hazard Area Land Use Management Guidelines (BCMFLNRD, 2018)
- Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Draft Policy Discussion Paper (BC Ministry of Environment, 2011a)
- Coastal Floodplain Mapping – Guidelines and Specifications (BC Ministry of Environment, 2011b)

- Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Guidelines for Management of Coastal Flood Hazard Land Use (BC Ministry of Environment, 2011c)

3 SITE DESCRIPTION

A site investigation was conducted on January 25th, 2019, by a geomorphologist and coastal engineers from NHC to examine the foreshore morphology as well as to identify the condition of existing foreshore structures, and surrounding beach materials. The weather throughout the site inspection was mostly sunny and relatively calm. The tide level at Point Atkinson was about -0.9 m Geodetic Datum (GD) during the site inspection, which permitted a reasonable extent of the inter-tidal foreshore to be visually inspected.

The foreshore of the property is marked by a retaining wall (**Figure 2**) with a crest elevation at El. 3.2 m GD. Large boulders were placed in front of the retaining wall and act as toe protection. The existing foreshore (**Figure 3**) transitions into a gravel and cobble beach sloping at roughly 2.5% slope (40H:1V). The beach faces towards the south-west but is exposed to waves from the west, south, and east.

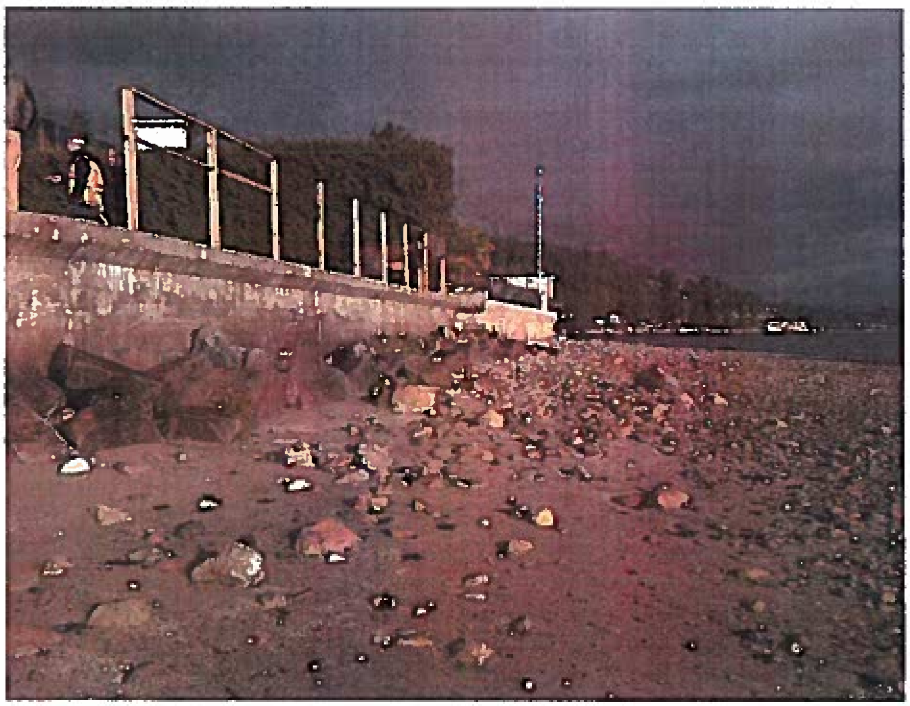

Figure 2. Existing retaining wall and riprap protection.

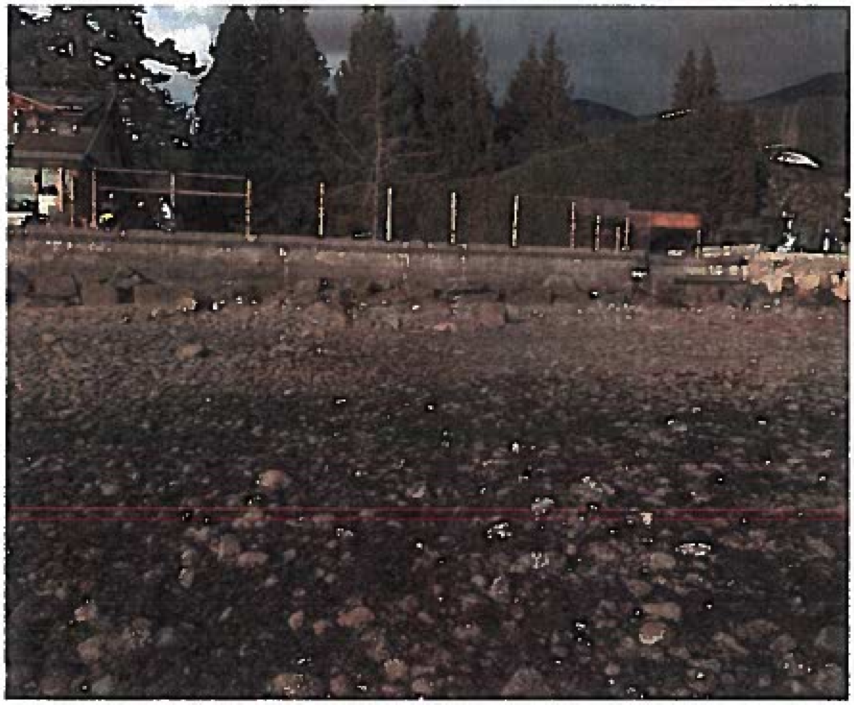
Figure 3. Existing foreshore substrate distribution.

The neighbouring property to the west consists of a similar sized and shaped concrete wall with glass panels installed at the top and similar toe protection features to those at the subject property (**Figure 4**). The neighbouring property to the east also consists of a retaining wall with glass panels installed at the top (**Figure 5**). The site visit occurred roughly one month after a large storm event (December 20th, 2018). Damages to the glass panels at the neighbouring properties were observed. It was also indicated by the project architect, Mr. Gord Hlynsky, at the time of the site visit that the study site and the neighbouring properties were flooded during the event.

Figure 4. Neighbouring property west of the study site.

Figure 5. Neighbouring property east of the study site.

The Cypress Creek channel draining to Burrard Inlet is located about 250 m west of the property. Cypress Creek flow is confined within a channel of relatively high banks; however, the land feature through which the creek drains to the ocean (and upon which the subject property is located) is an alluvial fan and therefore subject to flooding laterally from the creek. The channel transitions from roughly 15% grade upstream of the railway crossing (480 m upstream) to 5% at the Marine Drive crossing (200 m upstream), and roughly 2% as it approaches Burrard Inlet. The closest crossing, Marine Drive, is provided by a clear span bridge. The deep open channel at this crossing reduces the probability of debris blockages, and overland flooding impacting the site from this creek. Therefore, the property is at less risk of flooding from the Cypress Creek compared to the coastal hazard.

4 COASTAL FLOOD HAZARD ANALYSIS

Coastal flood hazards are primarily dictated by flood inundation, but can include overflow and spray, shoreline erosion and scour, beach degradation and aggradation, or physical loading from hydraulic forces or wood debris. Flood inundation is the focus of this coastal assessment. Other coastal hazards are of less concern for this assessment based on initial review, that is:

- Overflow and spray can be assessed and addressed through site drainage design following site design.
- Evidence of limited shoreline aggradation was identified during the site inspection in the proximity of the existing vertical concrete wall. No scour was identified along the toe of the wall. However, the existing toe protection does not appear to be properly designed and constructed. Further wave action could damage the existing toe protection and the toe of the wall. It is recommended that the property owner monitor and inspect the property for erosion and beach degradation twice a year to allow further investigation and mitigation if either become a problem in the future.

Canadian Hydrographic Service Chart 3495 (**Table 1**) presents the local tides at Point Atkinson, which is 1.8 km west of the study site. The existing top of wall at the study site is at 3.2 m GD. Coastal flood levels due to tide, storm surge, wave effects and long-term changes in global and local sea level are expected to be higher than this elevation which could lead to flood inundation.

Table 1. Tidal heights, extremes, and mean water level at Point Atkinson.

Sea State	Tide Elevation (m Geodetic Datum)
Higher High Water, Large Tide (HHWLT)	2.0
Higher High Water, Mean Tide (HHWMT)	1.3
Mean Water Level (MWL)	0.0
Lower Low Water, Mean Tide (LLWMT)	-2.0
Lower Low Water, Large Tide (LLWLT)	-3.1

4.1 Coastal Flood Level

To reduce the likelihood of damage from coastal flood inundation, the coastal flood level was assessed and used to derive a minimum construction level – the flood construction level (FCL). The FCL provides a level of mitigation to limit the likelihood of flooding for homes located along the coast or rivers and creeks. The FCL is generally based on an event with an AEP of 0.5%, often referred to as the 200-year event; since on average it would be expected to occur or be exceeded once every 200-years. In addition, due to changing conditions (primarily human induced global climate change) future conditions are considered up to the expected life of the project; often considered as the year-2100 (roughly 80 years from present).

The BC Ministry of Environment's published Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use (BC Ministry of Environment, 2011b) and the BC Ministry of Forests, Natural Resource Operations and Rural Development's amendment (BCMFLNRD, 2018) present two approaches for determining the 200-year FCL: 1) combined method and 2) probabilistic method. Parameters that sum up FCL for each method are illustrated in **Figure 6** and **Figure 7**.

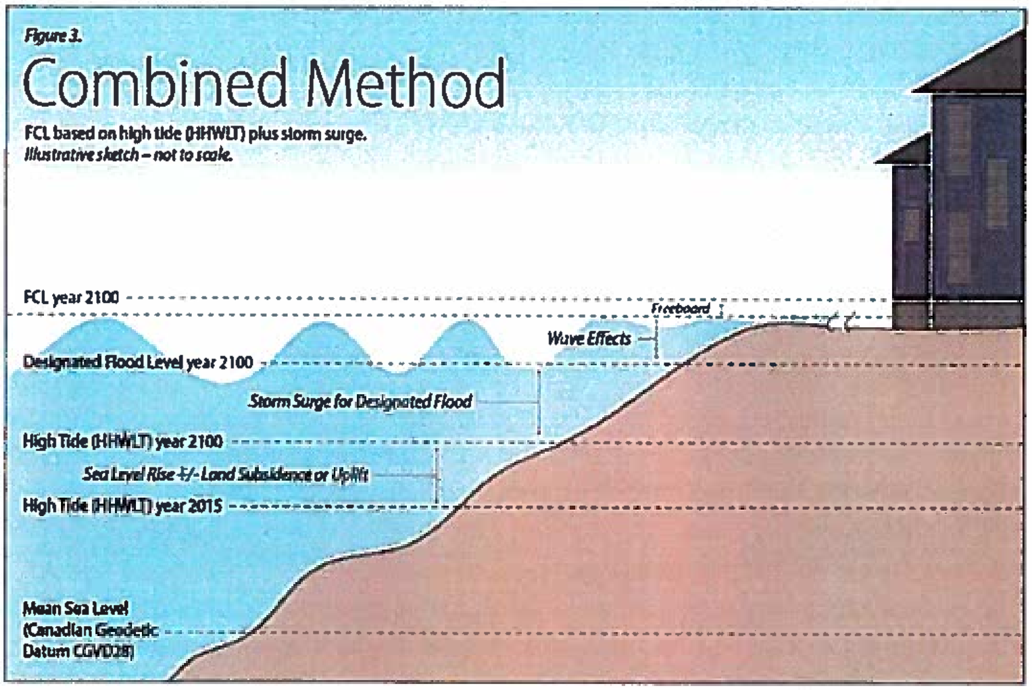

Figure 6. FCL based on combined method (BCMFLNRD, 2018).

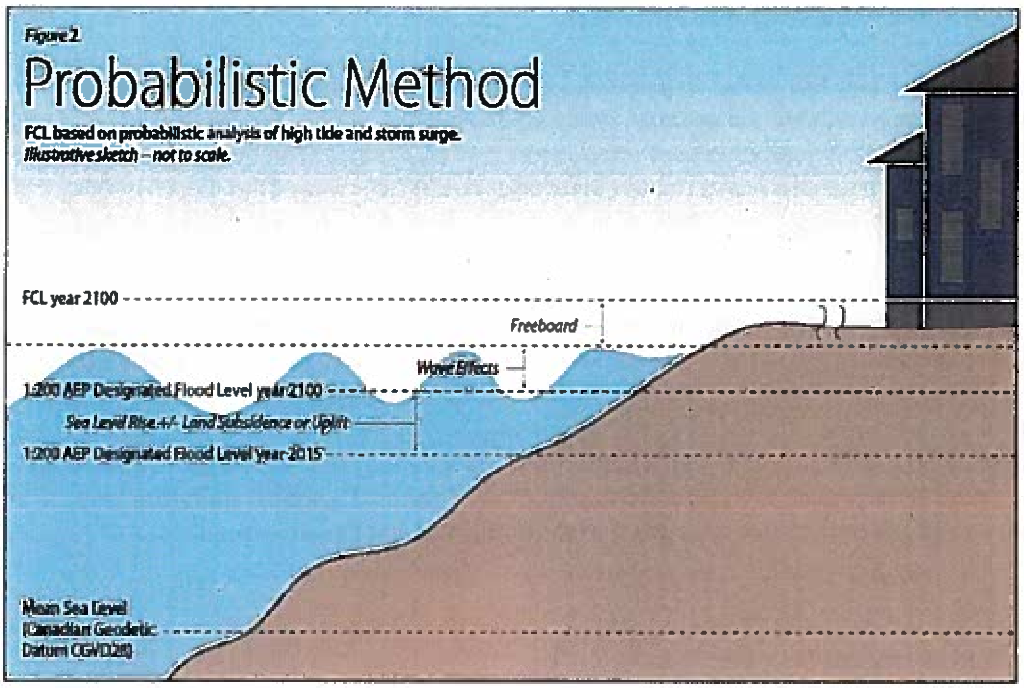

Figure 7. FCL based on probabilistic analysis (BCMFLNRD, 2018).

The combined method is based on the combined effects of HHWLT tide, storm surge, wave run-up, and sea level rise (SLR). This approach generally results in a conservative calculation of a design flood level, as it is often applied ignoring the probability of the various design events cooccurring (the probability that a 200-year storm surge co-occurs during HHWLT and 200-year wave event is closer to a 4,000-year event, AEP of 0.025%, instead of 200-year event, AEP of 0.5%). For this assessment the joint probability approach has been applied.

4.2 Coastal Flood Construction Level Assessment

The coastal flood construction level (FCL) using the probabilistic approach is the sum of:

- 1-in-200 AEP total water level as determined by probabilistic analyses of tides and storm surge;
- Allowances for future SLR to the year 2100
- Allowance for regional uplift or subsidence to the year 2100
- Estimated wave effects associated with the designated storm with an 1-in-200 AEP
- Freeboard

Each of these components are described in the following sections.

Predicted changes in storm intensity and frequency over the next 81 years, which could influence storm surge and wave effects, are highly variable and inconclusive. Such influence has not been incorporated in this analysis.

4.2.1 Joint Occurrence of Storm Surge and Tides

Coastal flood levels for the 1-in-200 AEP was developed by applying the Empirical Simulation Technique (EST) on the long term observed data (66 years) at Point Atkinson (NHC, 2008). The EST method is recommended by the Coastal Hydraulics Laboratory (of the US Army Corps of Engineers) and FEMA for frequency related studies. The analysis determined that the 1-in-200 AEP water level is 2.89 m GD.

4.2.2 Sea Level Rise

Global climate change is expected to result in increased sea levels resulting from melting of global ice and increased ocean volume due to rising water temperature. Typically, projects are considered to have a service life of roughly 80-years, resulting in designs often considering projections to the year-2100. The BC Provincial Sea Dike Guidelines (BC Ministry of Environment, 2011c) recommends that SLR associated with global climate change will result in a base water level 1 m above that seen in the year 2000 by the year-2100. The rate of SLR is projected to increase as the climate warms (**Figure 8**). Therefore, any increase incorporated in the past 18 years is expected to be minimal and hence ignored.

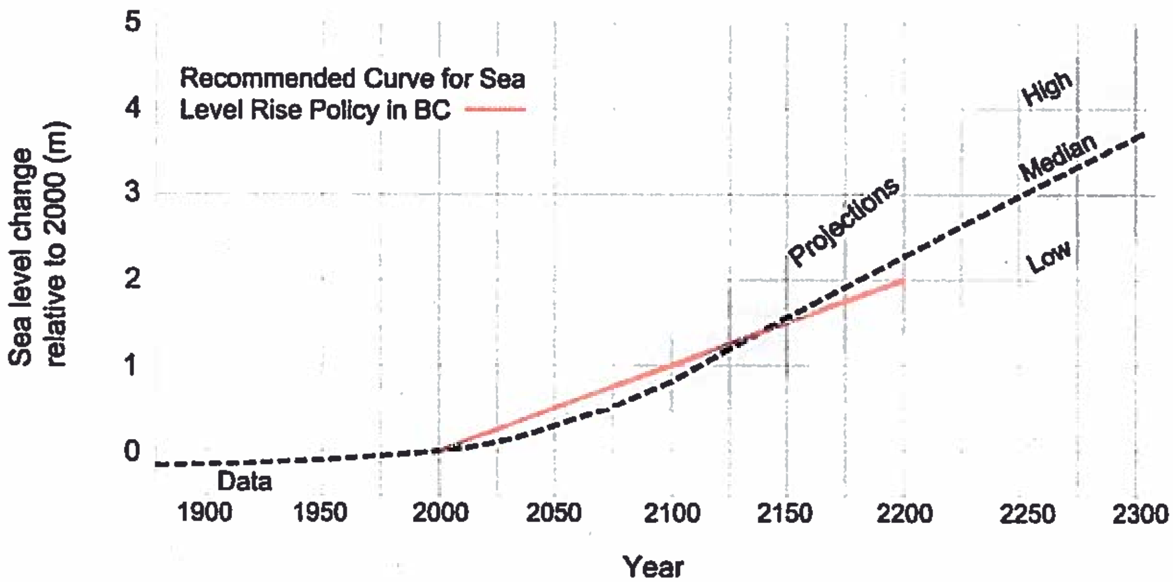

Figure 8. Projected climate change (BC Ministry of Environment, 2011c).

Note that the recommended SLR for planning and design in BC was based on a 2008 study by Fisheries and Oceans Canada (Thomson et al., 2008) and MOE (Bornhold, 2008). The authors of those works acknowledge the design SLR for BC is greater than the global mean SLR projected by the IPCC AR4 (2007) for the year 2100 (roughly 40 cm greater). However, more recent studies, such as IPCC AR5 (2014), suggests global mean SLR of up to 1 m or more by the year 2100. These values were based on the Paris Accord being adopted and adhered to, which appears not to be the case.

Other studies have investigated the potential effect of a collapse of the Antarctic ice sheet and have shown that such an event would result in far greater SLR, with estimates that are orders of magnitude larger than the 1 m to 2 m projected over then next 80-180 years. Recent changes in estimates of global mean SLR to the year 2100 or 2200 have not yet been addressed in the context of coastal BC, but based on recent conversations with FLNRORD, the province is amidst a study of SLR to update the 2011 design values. This study is not expected to be complete until April 2019.Despite the 1 m adopted by this flood hazard assessment, residents along the coast should therefore be aware that SLR could be substantially greater over the next 80-years, which may require raising, reconstruction, or relocation.

4.2.3 Local Subsidence

In addition to a rising sea, downward movement of the ground (subsidence) or upward movement (uplift) will influence the local relative sea level. Provincial guidelines (BC Ministry of Environment, 2011c) for local uplift are based on regional estimates and are less applicable than a more site-specific data source (Mazzotti et al., 2009), which suggests that subsidence for this location is on the order of -1 ± 0.5 mm/yr (**Figure 9**). To the year 2100, this translates to a lowering of 0.12 m.

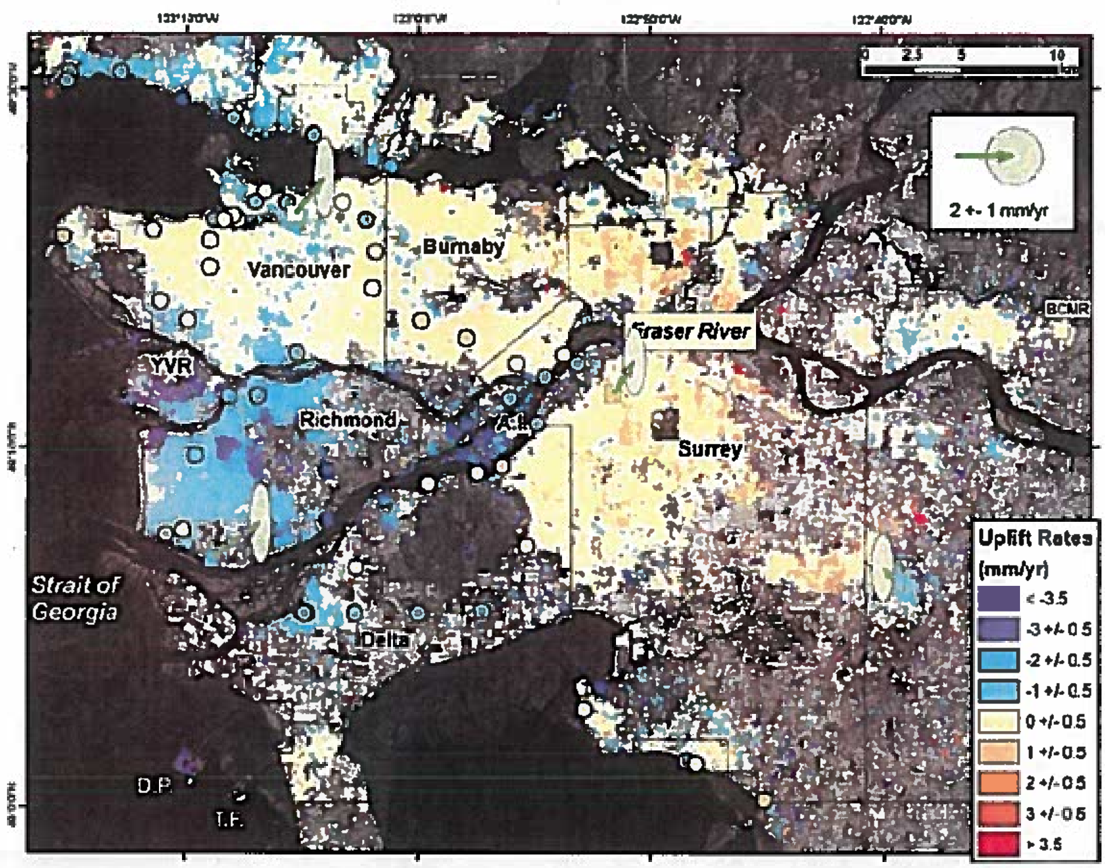

Figure 9. Local subsidence, shown as rate of uplift (Mazzotti et al., 2009).

4.2.4 Wind Analysis

There is one Meteorological Service of Canada (MSC) station in the vicinity of the study area that has a long-term record suitable for wind analysis: Point Atkinson. Twenty years of hourly wind data was used for the study, as summarized in **Table 2**.

Table 2. Point Atkinson station information.

Station	Station ID	Station Location	Period
Point Atkinson	1106200	480768 E 5464953 N	1997–2018

*No data is available for the period between 1959 and 1961.

The local wind climate can be visualized using a wind rose plot, utilizing arrows at the cardinal and inter-cardinal compass points to show the direction from which the winds blow and the magnitude and frequency for a given period. A wind rose showing the direction and magnitude of the winds at Point Atkinson is shown in **Figure 10.**

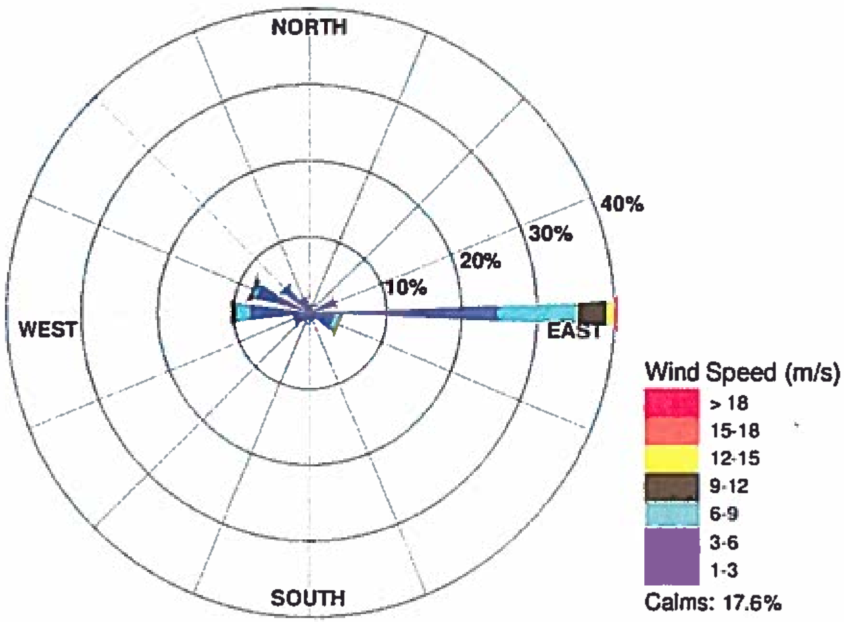

Figure 10. Wind rose based on data from Point Atkinson.

The wind rose shows that wind experienced at Point Atkinson is most frequently from the east and secondly from the west. Frequency analysis was conducted on the Point Atkinson data to obtain the wind speed for the design easterly and westerly storm events. The results are summarized in **Table 3** with the westerly winds being slightly stronger than from the east for the same return frequency.

Table 3. Design wind speeds – Point Atkinson.

Event	Easterly		Westerly	
	Speed (m/s)	Speed (km/hr)	Speed (m/s)	Speed (km/hr)
1-in-5 year	20.4	73	21.0	76
1-in-10 year	20.9	75	22.3	80
1-in-50 year	22.2	80	25.2	91

The guideline suggests that the wave effect is to be based on the 0.5% AEP storm event. However, NHC considers that establishing the FCL based 0.5% AEP storm event occurring with 0.5% AEP water level (tide and surge) to be overly conservative. For this study, the 50-year (2% AEP) storm events were used to for the flood hazard assessment instead of the 200-year (0.5% AEP) storms.

4.2.5 Nearshore Wave Modelling Analysis

A nearshore wave model (Simulating Waves Nearshore or SWAN) of the Strait of Georgia and Burrard Inlet was developed to model wave generation and propagation from deep water into coastal areas and shorelines. SWAN incorporates physical processes such as wave propagation, wave generation by wind, white-capping, shoaling, wave breaking, bottom friction, sub-sea obstacles, wave setup and wave-wave interactions in its computations (Booij, N. et al., 2004). SWAN version 41.20 was used for this study.

Two model grid resolutions were used for the analysis: a fine grid model of the approaches at Burrard Inlet was nested in a coarse grid model of the Strait of Georgia. The coarse grid measures about 113 km southwest to northeast, and 253 km northwest to southeast, with each grid cell measuring 500 m by 500 m. The fine grid measures about 9 km east to west, and 8 km north to south, with each grid cell measuring 50 m by 50 m. The model's bathymetric grids were generated from digitized Canadian Hydrographic Charts and NOAA 3 arc-second resolution data.

The 50-year event (2% AEP) for each design wind directions (westerly and easterly) were used to drive the SWAN model. For each event, a spatially varying Strait of Georgia wind field was developed and applied to both the coarse and fine grid models. The regional wind stations used to generate the spatially varying wind field are presented in **Table 4**.

Model results showing the 50-year waves from the west and east are presented in **Figure 11, Figure 12** and **Table 5**. Wave height is shown by colour shading, wave direction and relative heights are shown by vectors. The largest waves to reach the project site are from the east. The design significant wave height and mean wave period at the study area are from the east at 1.75 m and 4.64 seconds respectively.

Table 4. Regional wind data sources.

Station	Station ID	Period	Location
Entrance Island	EC ID 1022689	1994 – 2018 (Present)	49°12'31.195" N 123°48'38.001" W
Ballenas Island	EC ID 1020590	1994 – 2018 (Present)	49°21'01.000" N 124°09'37.000" W
Nanaimo Airport	EC ID 1025370	1954 – 2013	49°03'16.000" N 123°52'12.000" W
Nanaimo Airport	EC ID 1025365	2014 – 2018 (Present)	49°03'16.000" N 123°52'12.000" W
Sandheads CS	EC ID 1107010	1994 – 2018 (Present)	49°06'21.225" N 123°18'12.123" W
Saturna Island CS	EC ID 1017101	1994 – 2018 (Present)	48°47'02.067" N 123°02'41.082" W
Sisters Island	EC ID 2027403	1995 – 2018 (Present)	49°29'11.800" N 124°26'05.800" W
Victoria Int'l Airport	EC ID 1018620	1953 – 2013	48°38'50.010" N 123°25'33.000" W
Victoria Int'l Airport	EC ID 1018621	2013 – 2018 (Present)	48°38'50.000" N 123°25'33.000" W
Kelp Reefs	EC ID 1013998	1997 – 2018 (Present)	48°32'51.700" N 123°14'13.320" W
Halibut Bank	C46146	1992 – 2018 (Present)	49°20'24.000" N 123°43'48.000" W
Sentry Shoal	C46131	1992 – 2018 (Present)	49°54'36.000" N 124°59'24.000" W
Pat Bay	C46134	2001 – 2016	48°38'60.000" N 123°30'00.000" W

Table 5. Simulation results of design waves near project site

Event	Easterly Event		Westerly Event	
	Hs (m)	T (s)	Hs (m)	T (s)
1-in-50 year	1.75	4.64	1.61	6.22

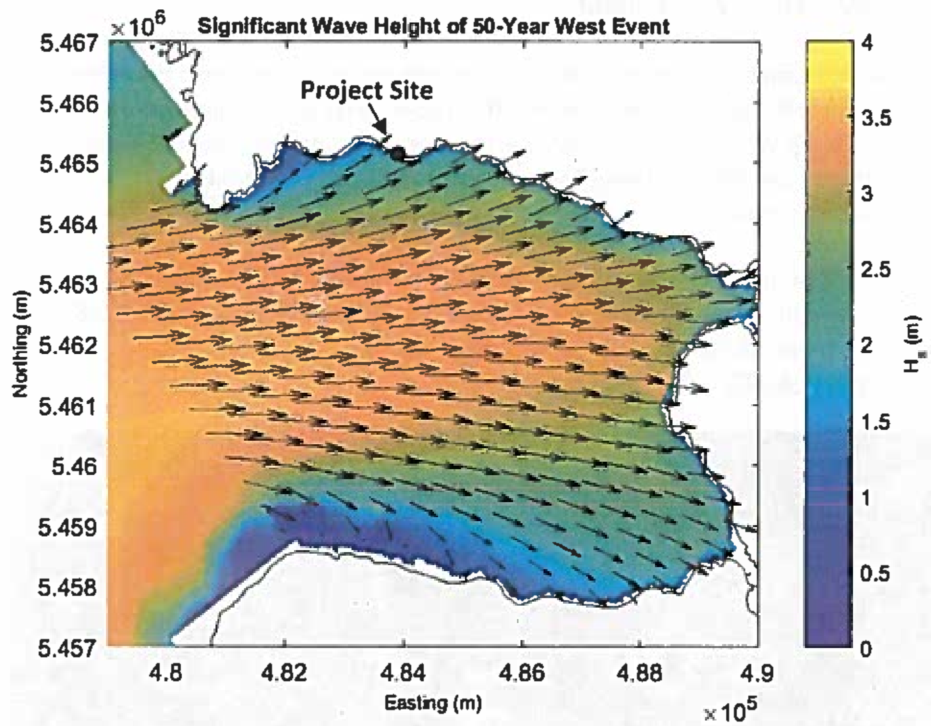

Figure 11. Significant wave height (Hs) and direction for simulated 50-year westerly event.

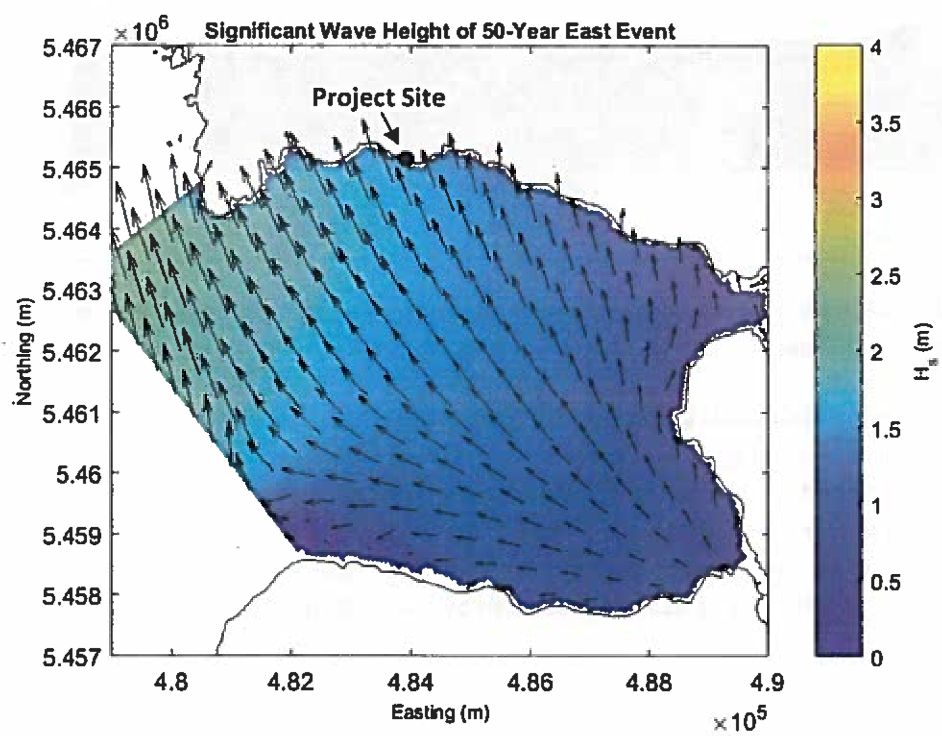

Figure 12. Significant wave height (Hs) and direction for simulated 50-year easterly event.

4.2.6 Wave runup and Wave Effect Assessment

Wave runup at the shoreline determines the extent over which waves act. Wave runup is therefore an important parameter to determine flood inundation extents from coastal storms. To determine the maximum wave runup, a Simulating Waves till Shore (SWASH) numerical model was developed to simulate the wave transformation, breaking and overflow on the shoreline (The SWASH team, 2018). For this study, SWASH version 5.01 was used.

To illustrate the effectiveness of the model to this type of application, **Figure 13** shows an example of the SWASH model results against the observed nearshore process during the December 20th, 2018 storm event in West Vancouver. A 20-second long model simulation video can be viewed at https://www.youtube.com/watch?v=qXIFPvBgeII.

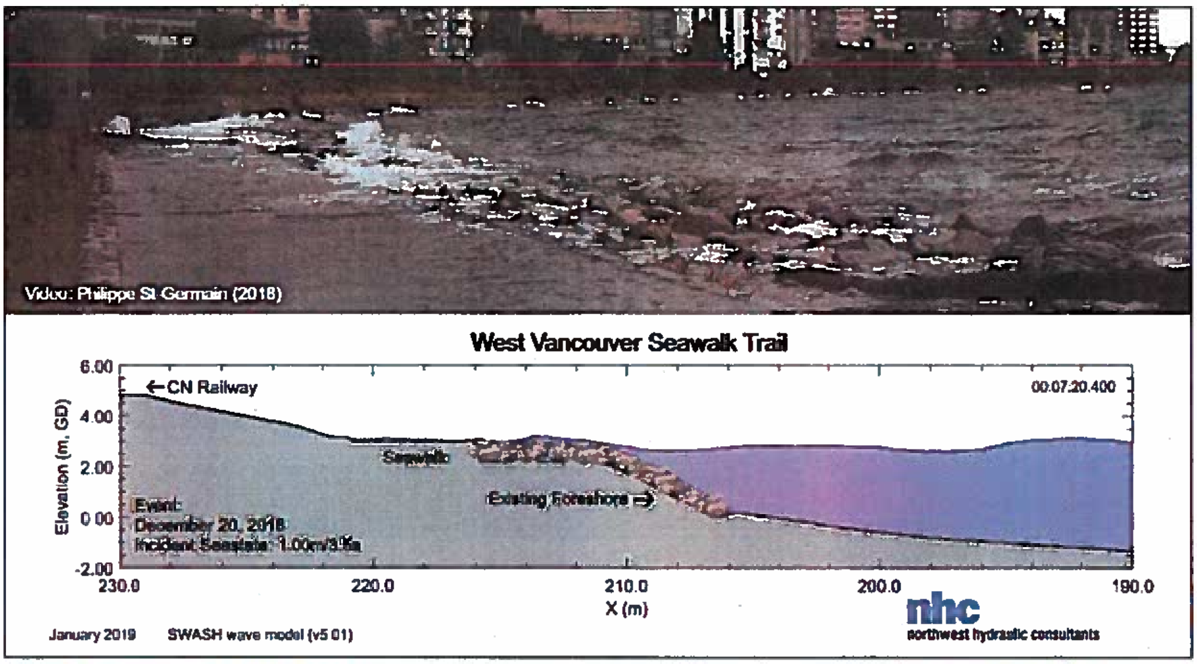

Figure 13. Numerical simulations of wave propagation and overtopping - December 20, 2018 storm event in West Vancouver.

Several simulations were performed as part of the wave runup analysis. A general profile of the study site was created using the architectural drawings provided by the client (**Appendix B**), the foreshore survey data collected during the site visit, and bathymetry data used in the SWAN model. Limited information with respect to the length of certain structural components was provided and therefore some assumptions have had to be made. The proposed upland profile consists of the lawn area extending from the existing concrete wall (3.85 m GD) followed by a fireside lounge (4.63 m GD) and deck area (5.55 m GD).

Figure 14 shows a snapshot of the SWASH model output for the proposed design under the future design water level conditions. The result shows that the wave runups were calculated to be 1.4 m and

1.2 m under the current and future design water levels, respectively. The different wave runup values correspond to different DWL and foreshore geometry.

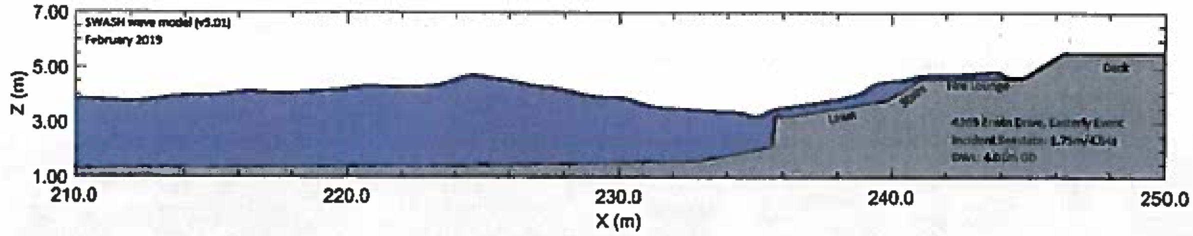

Figure 14. SWASH wave overtopping sample results - proposed property conditions.

Given the low elevation of the lawn and beach garden proposed, a soft engineering solution is expected to have a limited effect on wave runup. To reduce the wave runup and hence the FCL, NHC proposes that a secondary concrete wall be constructed between the outdoor area and the existing concrete wall, along the proposed pool and fireside lounge. Occasional spray and overtopping of the wall is expected and proper drainage behind the secondary wall should be provided.

Figure 15 shows a snapshot of the SWASH model output for the proposed alternative design under the future design water level conditions. No drainage was incorporated behind the secondary wall in the model and some ponding from overtopping flow was observed. Assuming that the area behind the wall is provided with drainage, the FCL can be reported with respect to the ground elevation (4.57 m GD) of the area behind the wall, plus freeboard.

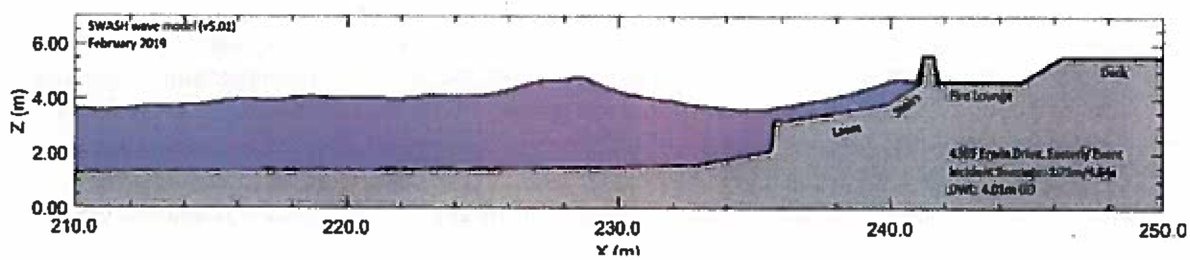

Figure 15. SWASH wave overtopping sample results - proposed alternative design with protection wall.

4.2.7 Freeboard

The freeboard is applied to account for temporal and spatial variances in wave climate and surge, as well as precision of the calculation overall. Freeboard for infrastructure according to the amendment to the Flood Hazard Area Land Use Management Guidelines (BCMFLNRD, 2018) is 0.6 m when using the probabilistic approach.

4.2.8 Flood Construction Level

Table 6 summarizes the resulting FCL for the current condition and that predicted for the year 2100. The results summarised in the far-right column apply to the condition that is to be expected if a secondary wall is constructed as described in **Section 4.2.6**.

Table 6. Flood construction levels.

FCL Input	Year 2019 Elevation (m)	Year 2100 Elevation (m) Proposed Residence	Year 2100 Elevation (m) Secondary Wall
Tide + storm surge (joint probability)	2.89	2.89	-
+ wave effect	1.38	1.22	-
+ Design sea level rise (to year 2100)	0	1.0	-
+ Subsidence (to year 2100)	0	0.12	-
Coastal flood level	4.27	5.23	4.57[1]
+ Freeboard (m)	0.6	0.6	0.6
Flood construction level	**4.87**	**5.83**	**5.17**

Notes:
[1]CFL based on the ground elevation behind the wall.

4.3 Tsunami Hazard

In addition to wave and storm events, high water and coastal property inundation could potentially occur from a tsunami event. Previously denoted as tidal waves, the Japanese term tsunami, is now used to denote long period waves (5 to 60 minutes) that radiate out from the rapid displacement of a large volume of water. The initial displacement can result from an earthquake, landslide, volcanic eruption, glacier calving, or impact from a meteorite. However, major tsunami events generally are a result of earthquakes that produce substantial vertical movement of the sea floor in sufficiently shallow water.

Assessment of tsunami hazards are beyond the scope of this project; however, previous studies suggest that the tsunami wave height reaching Vancouver Harbour would be roughly 10% of the tsunami wave height observed at Tofino on the west coast of Vancouver Island (Spaeth and Berkman, 1967) and that run up from a tsunami is expected to be less than 2 m on the North Shore from a tsunamis originating from the Pacific Ocean (Clague et al., 2005). Such an event would be extremely large on the west coast of Vancouver Island assuming the attenuation through the strait is roughly 10%.

The expected maximum tsunami run-up of less than 2 m would be for events far less frequent than the 200-year event, and when added to mean water high high tide (MWHHT), sea level rise, and subsidence, is still below the coastal derived FCL minus freeboard (El. 4.42 m versus El. 5.23 m).

5 SUMMARY AND RECOMMENDATIONS

A hydrotechnical flood hazard assessment was conducted for the subject property at 4369 Erwin Drive. . It has been found that flooding originating from Burrard Inlet is the governing hazard. From this study, the following recommendations are made for safe use of the property:

1) The 2100-year design FCL for the project site was found to be 5.83 m GD for the proposed development, and 5.17 m GD should the protection option of a secondary concrete wall be adopted.
2) Building entrances and windows to habitable space should be at or above the FCL.
3) The underside of any wooden floor system, or the top of any concrete floor system used for habitation should be above the FCL. An exception to this recommendation for wooden floor systems can be made if the underside of the wooden floor system is inset inside and below the top of concrete foundation, in which case the top of concrete foundation should be above the FCL.
4) No enclosed space to be used for habitation or storage of goods that can be damaged by floodwaters should be below the FCL. An exception to this recommendation can be made if suitable provisions are made to design the space below the FCL such that flood waters cannot enter the space; for instance, a 'floodproof' basement is designed and certified by a qualified engineer.
5) All main electrical and mechanical infrastructure are to be above the FCL. Any electrical supply below the FCL (i.e. outlets or lighting) should be protected by GFCI (ground fault circuit interruption) located above the FCL. Mechanical infrastructure may be located within a floodproof enclosed space below the FCL if the provisions of Recommendation #4 (above) are met.
6) The residence is set back from the edge of water a minimum of 15 m. Additional set back improves options to address further increases in SLR that may occur as well as shoreline erosion if it becomes a problem in the future.
7) If the site is landscaped with isolated low lying ground between the properties boundary with Burrard Inlet and the proposed residence, than stormwater drainage is designed to accommodate potential spray and overtopping.
8) Any ingress or egress routes existing above the FCL are adequate for evacuation during a flood with loss of electrical power.
9) From all areas below the FCL (i.e. underground parking) an unobstructed means of pedestrian ingress and egress is provided above the FCL, suitable for use under loss of electrical power.
10) Final building plans should be reviewed by qualified registered engineer to ensure they meet the recommendations presented within this FHA.

In addition, it is recommended that the property owner monitor and inspect the property for erosion and beach degradation twice a year to allow further investigation and mitigation if either become a problem in the future.

This flood hazard assessment was conducted following EGBC 2018 Class 1 flood hazard assessment guidelines. A summary of the EGBC criteria for such an assessment is presented in **Table 7**. Hazards other than flood hazards from Burrard Inlet and the adjacent creeks, such as geotechnical, fire, and wildlife hazards have not been assessed as part of this assessment. Stormwater and sediment management has not been designed or assessed through this study and may also impose hazards if not adequately addressed.

Table 7. Summary of EGBC typical Class 1 flood hazard assessment methods and deliverables

EGBC Flood Hazard Assessment Component	Notes
Typical hazard assessment methods and climate/environmental change considerations	
Site inspection and qualitative assessment of flood hazard	Completed by NHC 2019
Identify any very low hazard surfaces in the consultation area (i.e., river terraces)	Completed by NHC 2019
Estimate erosion rates along river banks	River erosion not applicable to site. Coastal erosion not evident.
1-D or possibly 2-D modelling, modelling of fluvial regime and future trends in river bed changes, erosion hazard maps, possibly paleoflood analysis	2-D coastal modelling completed by NHC 2019
Identify upstream or downstream mass movement processes that could change flood levels (e.g., landslides leading to partial channel blockages, diverting water into opposite banks)	N/A – erosion risk deemed low
Conduct simple time series analysis of runoff data, review climate change predictions for study region, include in assessment if considered appropriate	N/A – erosion risk deemed low
Quantify erosion rates by comparative air photograph analysis	N/A – erosion risk deemed low
Typical deliverables	
Letter report or memorandum with at least water levels and consideration of scour and bank erosion	Completed
Cross-sections with water levels, flow velocity and qualitative description of recorded historic events, estimation of scour and erosion rates where appropriate with maps showing erosion over time	N/A – erosion risk deemed low
Maps with area inundated at different return period, flow velocity, flow depth, delineation of areas prone to erosion and river bed elevation changes, estimates of erosion rates	Areas and elevations inundated during the 200-year return period design event described

6 CLOSURE

We hope this work and report meets your current needs. If you have any questions don't hesitate to contact Derek Ray or Edwin Wang by phone 604-980-6011 or email (dray@nhcweb.com | ewang@nhcweb.com).

Sincerely,

Northwest Hydraulic Consultants Ltd.

Prepared by:

Feb 26, 2019

Adrian Simpalean, MASc.
Hydrotechnical Analyst

Reviewed by:

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Feb 26, 2019

Derek Ray, P.Geo.,
Principal Coastal Geomorphologist

PROFESSIONAL PROVINCE OF E. C. WANG # 29366 BRITISH COLUMBIA ENGINEER

Feb 26, 2019

Edwin Wang, P.Eng.,
Hydrotechnical Engineer

DISCLAIMER

This document has been prepared by **Northwest Hydraulic Consultants Ltd.** for the benefit of **Tara Haddad** for specific application to the **Flood Hazard Assessment at 4369 Erwin Drive, West Vancouver.** The information and data contained herein represent **Northwest Hydraulic Consultants Ltd.** best professional judgment in light of the knowledge and information available to **Northwest Hydraulic Consultants Ltd.** at the time of preparation, and was prepared in accordance with generally accepted engineering practices.

Except as required by law, this report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by **Tara Haddad**, its officers and employees. **Northwest Hydraulic Consultants Ltd.** denies any liability whatsoever to other parties who may obtain access to this report for any injury, loss or damage suffered by such parties arising from their use of, or reliance upon, this report or any of its contents.

REFERENCES

BC Ministry of Environment (2011a). *Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Draft Policy Discussion Paper.*

BC Ministry of Environment (2011b). *Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Guidelines for Management of Coastal Flood Hazard Land Use.*

BC Ministry of Environment (2011c). *Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Sea Dike Guidelines.*

BCMFLNRD (2018). *Flood Hazard Area Land Use Management Guidelines Sea Level Rise Amendment.*

Booij, N., Haagsma, Ij.G., Holthuijsen, L.H., Kieftenburg, A.T.M.M., Ris, R.C., van der Westhuysen, A.J., and Zijlema, M. (2004). *SWAN User Manual SWAN Cycle III Version 40.41.* Delft University of Technology, The Netherlands.

Bornhold, B. D. (2008). *Projected sea level changes for British Columbia in the 21st Century.* Province of British Columbia, Victoria, BC. 10 pp.

Clague et al. (2005). *Tsunami Hazard to North and West Vancouver, British Columbia.* Centre for Natural Hazard Research, Simon Fraser University. 25 pp.

EGBC (2018). *Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC.*

IPCC (2007). *Contribution of Working Groups I, II and III to the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change. Core Writing Team, Pachauri, R.K. and Reisinger, A. (Eds.). Geneva, Switzerland.* 104 pp.

IPCC (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland.* 151 pp.

Lambert, A., Mazzotti, S., Van der Kooij, S., and Mainville, A. (2008). *Subsidence and relative sea level rise in the Fraser River delta, Greater Vancouver, British Columbia, from combined geodetic data* (Open File 5698). Geological Survey of Canada. 44 pp.

The SWASH team (2018). *SWASH (Simulating WAves till SHore) User Manual version 5.01A.*

Thomson, R. E., Bornhold, B. D., and Mazzotti, S. (2008). *An examination of the factors affecting relative and absolute sea level in Coastal British Columbia.* Canadian Technical Report of Hydrography and Ocean Sciences. 49 pp.

Appendix A

Flood Hazard and Risk Assurance Statement

APPENDIX J: *FLOOD HAZARD AND RISK ASSURANCE STATEMENT*

Note: This Statement is to be read and completed in conjunction with the "*APEGBC Professional Practice Guidelines - Legislated Flood Assessments in a Changing Climate*, March 2012 ("*APEGBC* Guidelines") and is to be provided for *flood assessments* for the purposes of the *Land Title Act*, Community Charter or the *Local Government Act*. Italicized words are defined in the *APEGBC* Guidelines.

To: The *Approving Authority* Date: 2019-02-26

Planning, Permit, and Properties, District of North Vancouver

4369 Erwin Drive, West Vancouver, BC V7V 3A7

Jurisdiction and address

With reference to (check one):

- ☐ Land Title Act (Section 86) – Subdivision Approval
- ☐ Local Government Act (Sections 919.1 and 920) – Development Permit
- ☑ Community Charter (Section 56) – Building Permit
- ☐ Local Government Act (Section 910) – Flood Plain Bylaw Variance
- ☐ Local Government Act (Section 910) – Flood Plain Bylaw Exemption

For the Property:

Lot A, Block 7, District Lot 582, Group 1, New Westminster District, Plan 6662

Legal description and civic address of the Property

The undersigned hereby gives assurance that he/she is a *Qualified Professional* and is a *Professional Engineer* or *Professional Geoscientist*.

I have signed, sealed and dated, and thereby certified, the attached flood assessment report on the Property in accordance with the APEGBC Guidelines. That report must be read in conjunction with this Statement. In preparing that report I have:

Check to the left of applicable items

✓ 1. Collected and reviewed appropriate background information

✓ 2. Reviewed the proposed *residential development* on the Property

✓ 3. Conducted field work on and, if required, beyond the Property

✓ 4. Reported on the results of the field work on and, if required, beyond the Property

✓ 5. Considered any changed conditions on and, if required, beyond the Property

6. For a *flood hazard* analysis or *flood risk* analysis I have:
   - ✓ 6.1 reviewed and characterized, if appropriate, floods that may affect the Property
   - ✓ 6.2 estimated the *flood hazard* or *flood risk* on the property
   - ✓ 6.3 included (if appropriate) the effects of climate change and land use change
   - ✓ 6.4 identified existing and anticipated future *elements at risk* on and, if required, beyond the Property
   - ✓ 6.5 estimated the potential *consequences* to those *elements at risk*

7. Where the *Approving Authority* has adopted a specific level of *flood hazard* or *flood risk* tolerance or return period that is different from the standard 200-year return period design criteria[1], I have
   - ✓ 7.1 compared the level of *flood hazard* or *flood risk* tolerance adopted by the *Approving Authority* with the findings of my investigation
   - ✓ 7.2 made a finding on the level of *flood hazard* or *flood risk* tolerance on the Property based on the comparison
   - ✓ 7.3 made recommendations to reduce the *flood hazard* or *flood risk* on the Property

---

[1] *Flood Hazard Area Land Use Management Guidelines* published by the BC Ministry of Forests, Lands , and Natural Resource Operations and the 2009 publication *Subdivision Preliminary Layout Review – Natural Hazard Risk* published by the Ministry of Transportation and Public Infrastructure. It should be noted that the 200-year return period is a standard used typically for rivers and purely fluvial processes. For small creeks subject to debris floods and debris flows return periods are commonly applied that exceed 200 years. For life-threatening events including debris flows, the Ministry of Transportation and Public Infrastructure stipulates in their 2009 publication *Subdivision Preliminary Layout Review – Natural Hazard Risk* that a 10,000-year return period needs to be considered.

8. Where the *Approving Authority* has **not** adopted a level of *flood risk* or *flood hazard* tolerance I have:

NA 8.1 described the method of *flood hazard* analysis or *flood risk analysis* used

NA 8.2 referred to an appropriate and identified provincial or national guideline for level of *flood hazard* or *flood risk*

NA 8.3 compared this guideline with the findings of my investigation

NA 8.4 made a finding on the level of *flood hazard* of *flood risk* tolerance on the Property based on the comparison

NA 8.5 made recommendations to reduce *flood risks*

N/A 9. Reported on the requirements for future inspections of the Property and recommended who should conduct those inspections.

Based on my comparison between

Check one

- ☐ the findings from the investigation and the adopted level of *flood hazard* or *flood risk* tolerance (item 7.2 above)
- ☑ the appropriate and identified provincial or national guideline for level of *flood hazard* or *flood risk* tolerance (item 8.4 above)

I hereby give my assurance that, based on the conditions contained in the attached flood assessment report,

Check one

- ☐ for subdivision approval, as required by the *Land Title Act* (Section 86), "that the land may be used safely for the use intended".

  Check one
  - ☐ with one or more recommended registered *covenants*.
  - ☐ without any registered *covenant*.

- ☑ for a development permit, as required by the *Local Government Act* (Sections 919.1 and 920), my report will "assist the local government in determining what conditions or requirements under [Section 920] subsection (7.1) it will impose in the permit".
- ☐ for a building permit, as required by the Community Charter (Section 56), "the land may be used safely for the use intended".

  Check one
  - ☑ with one or more recommended registered *covenants*.
  - ☐ without any registered *covenant*.

- ☐ for flood plain bylaw variance, as required by the *Flood Hazard Area Land Use Management Guidelines* associated with the *Local Government Act* (Section 910), "the development may occur safely".
- ☐ for flood plain bylaw exemption, as required by the *Local Government Act* (Section 910), "the land may be used safely for the use intended".

Derek Ray

Name (print)

[signature]

Signature

2019-02-26

Date

Address

30 Gostick Place, North Vancouver, BC V7M 3G3

604-980-6011

Telephone

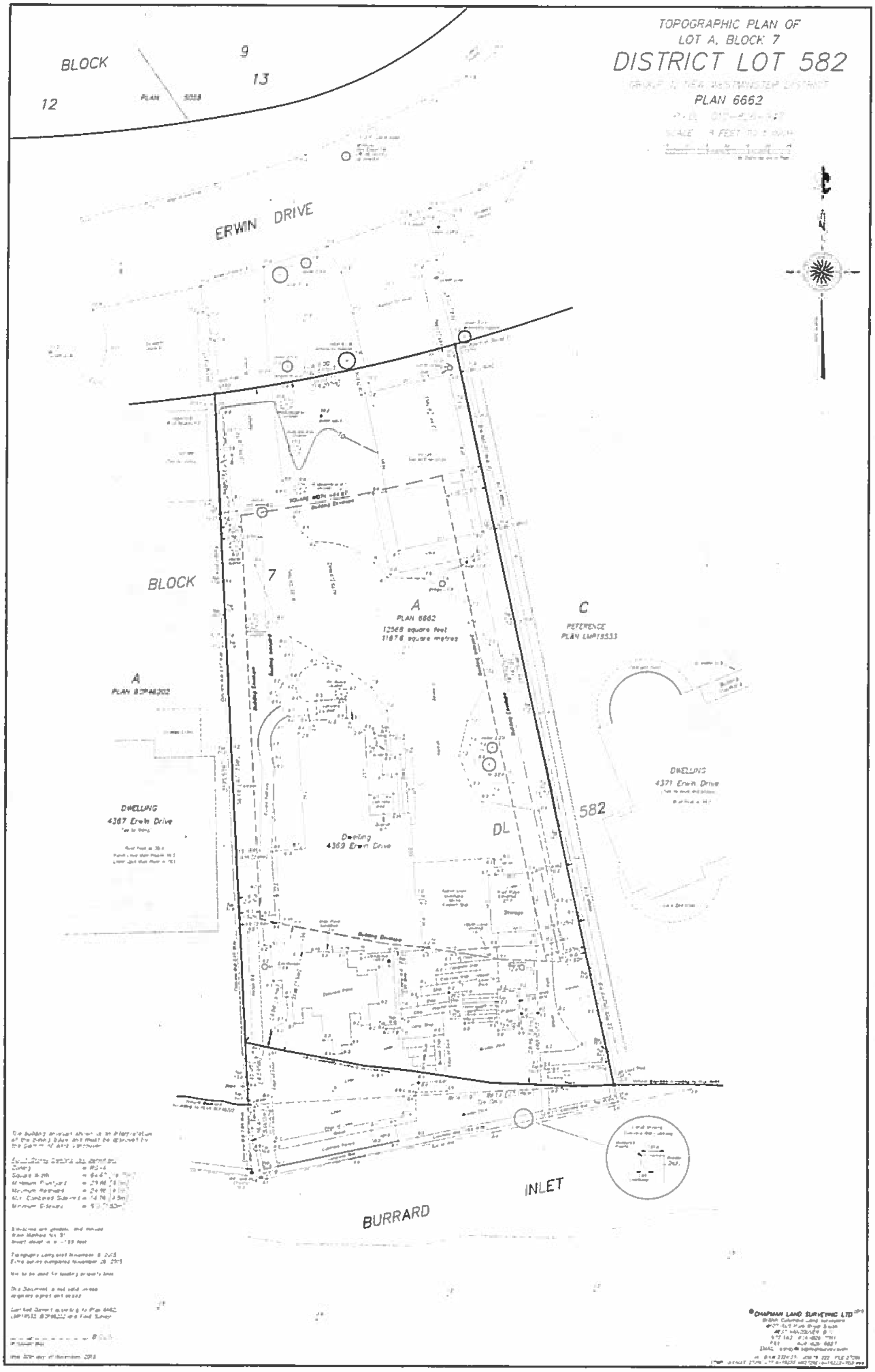
(Affix Professional seal here)

If the *Qualified Professional* is a member of a firm, complete the following.

I am a member of the firm Northwest Hydraulic Consultants Ltd. (NHC)
(Print name of firm)
and I sign this letter on behalf of the firm.

Appendix B

Received Design Drawings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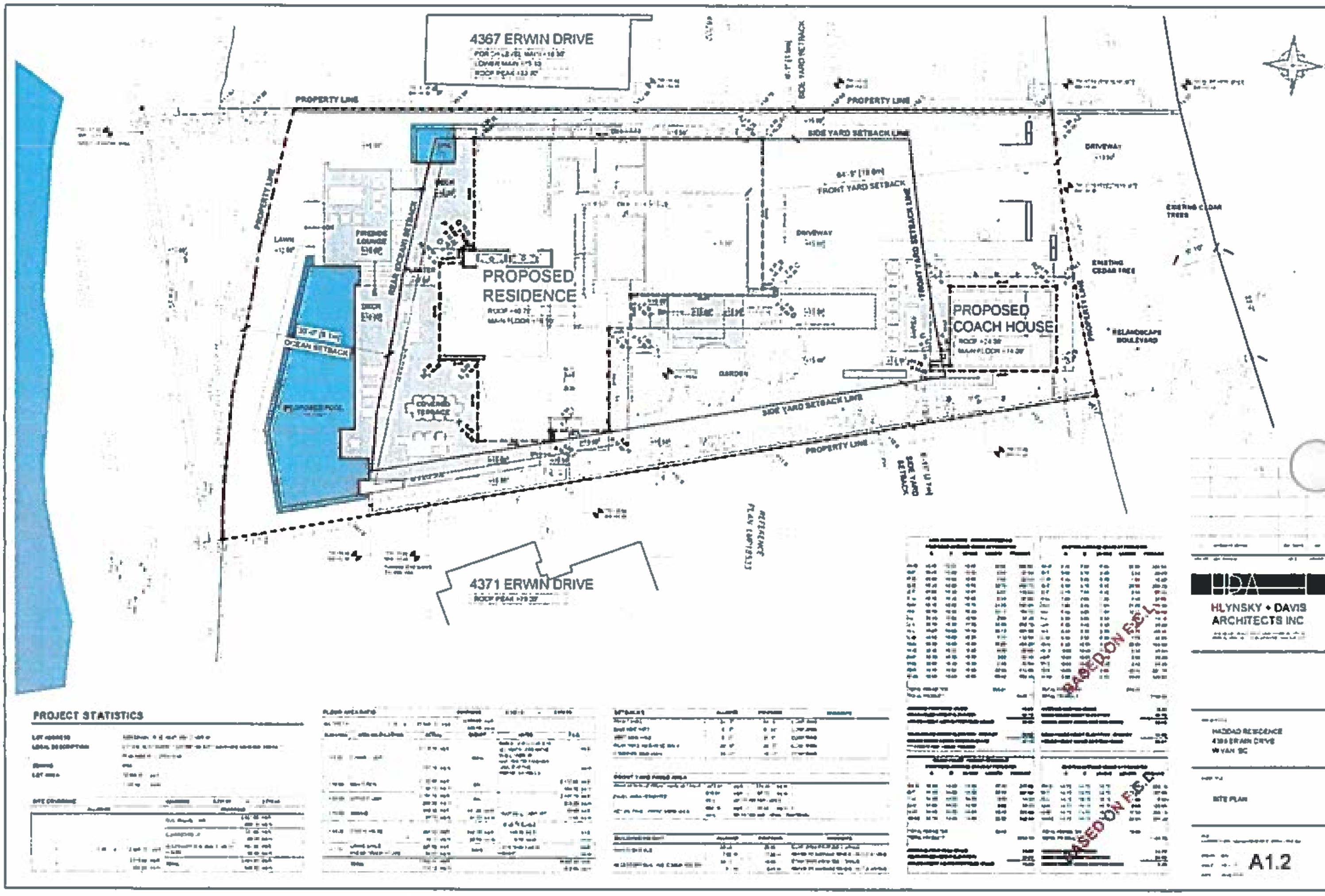
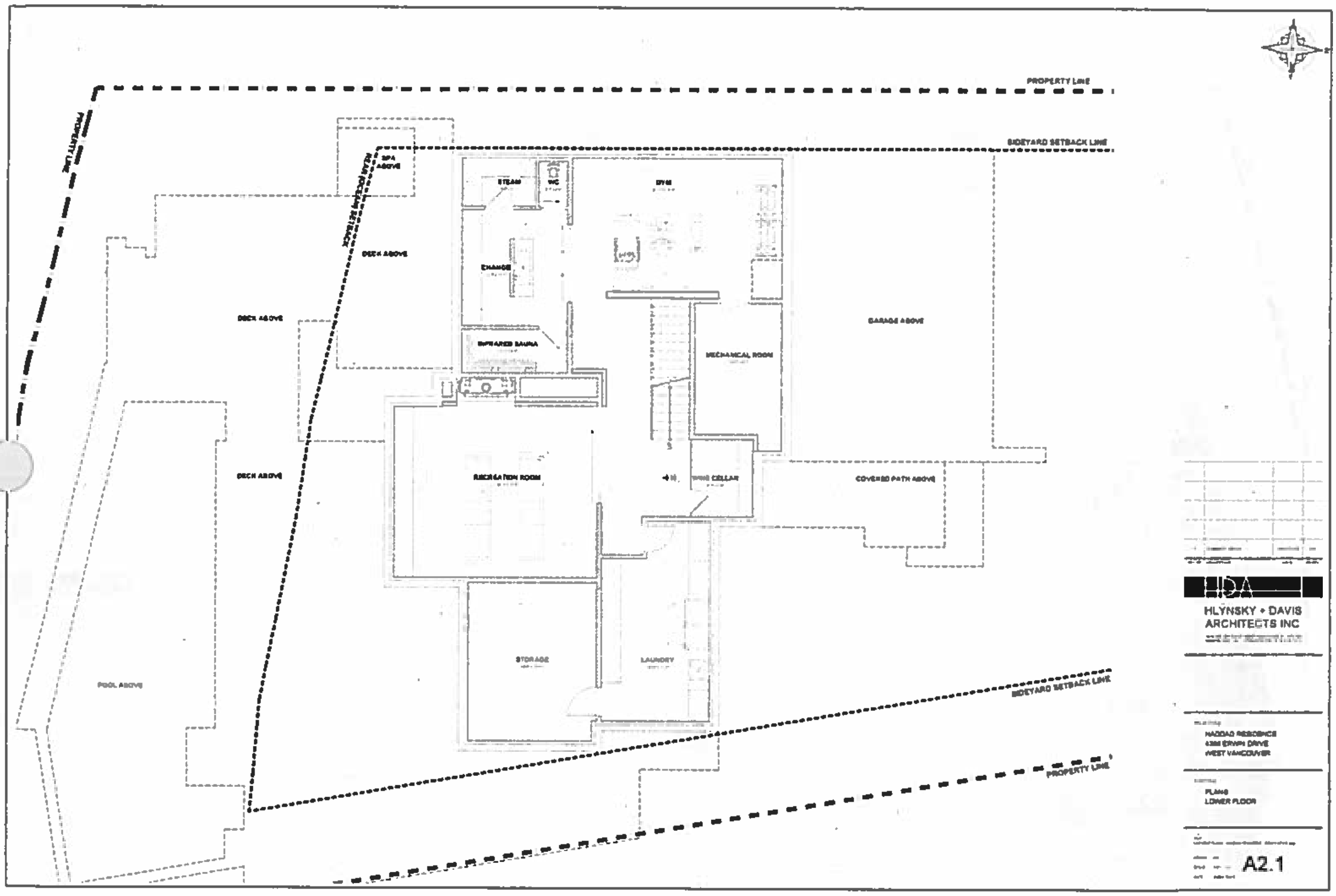
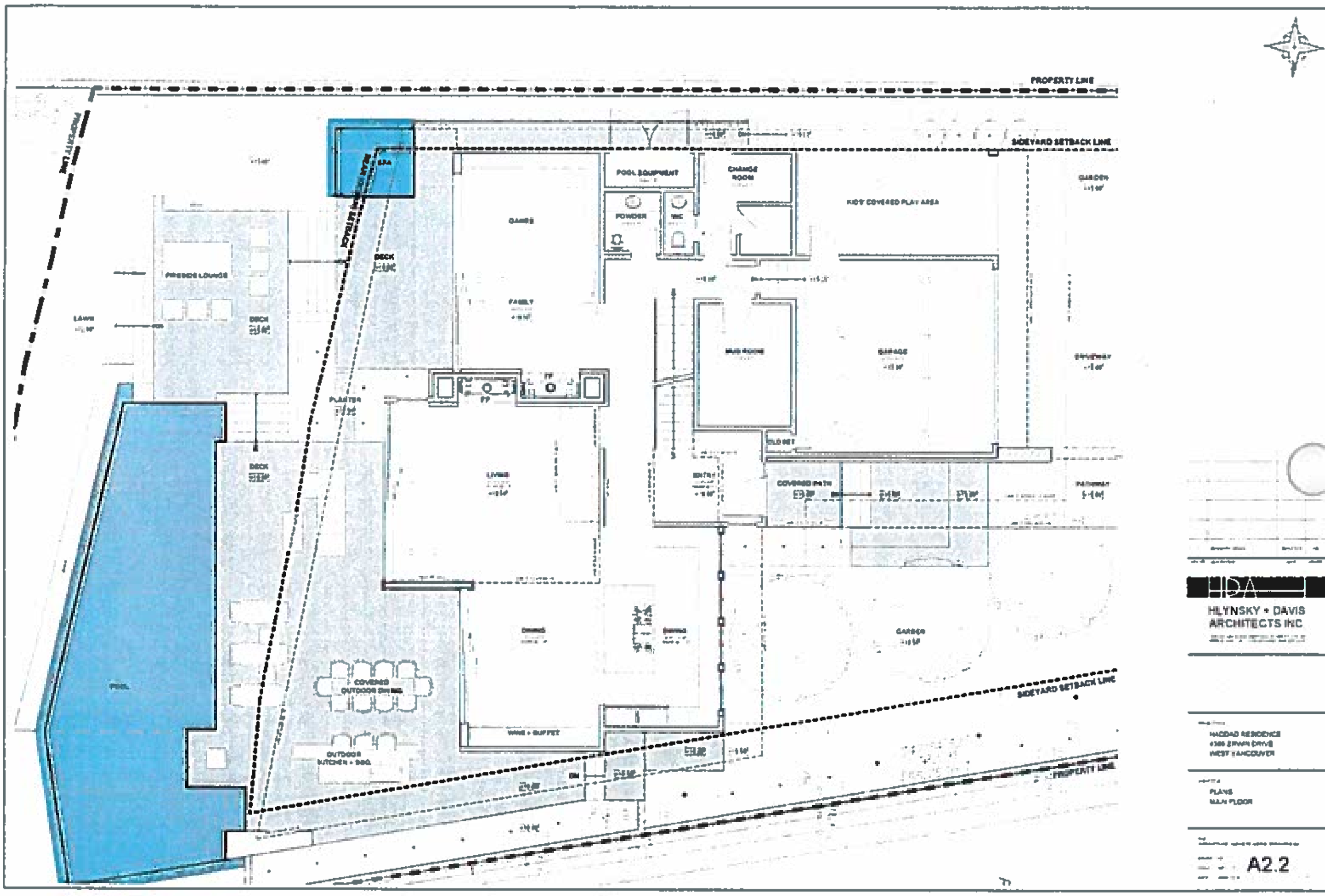
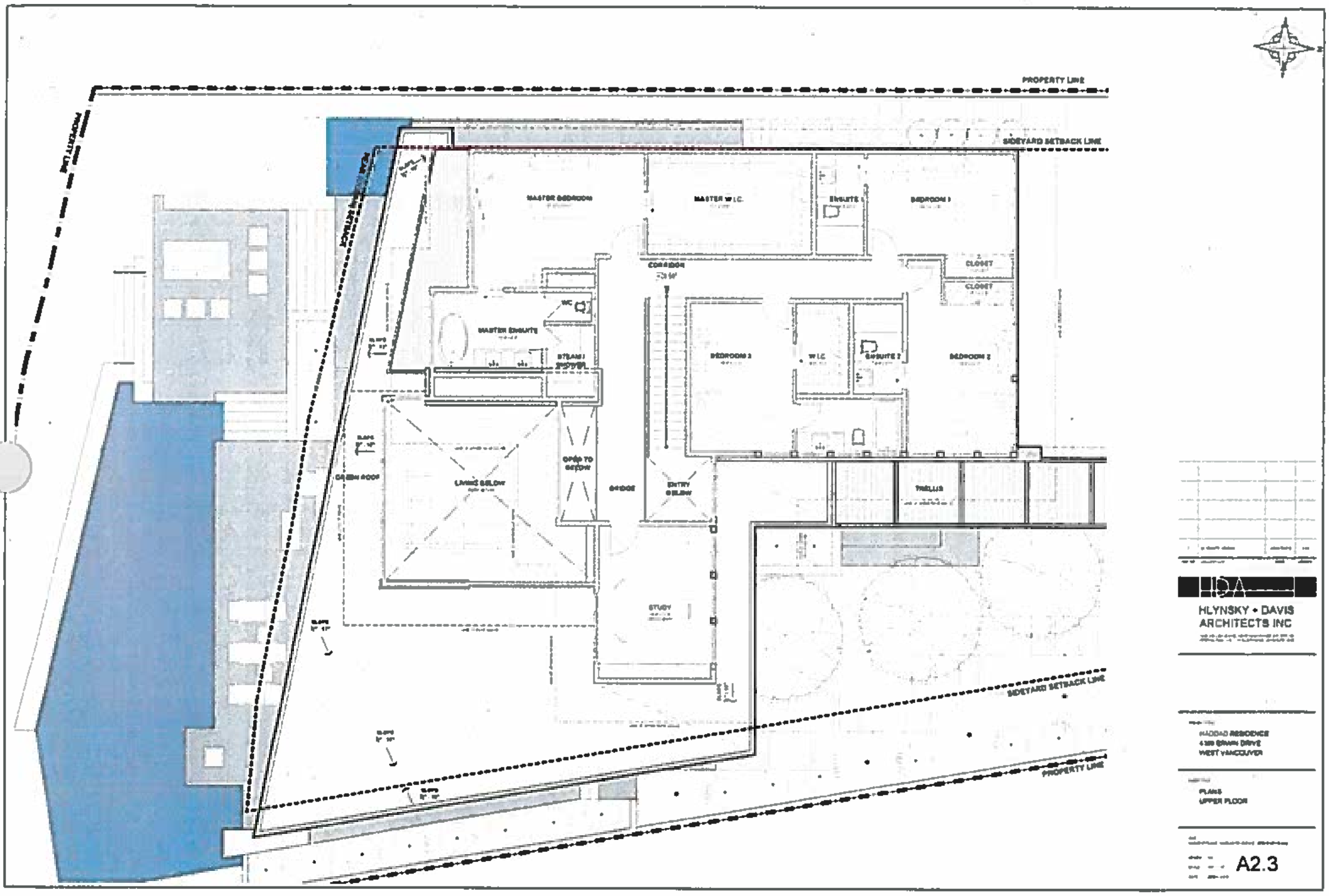
LOT A, BLOCK 7
DISTRICT LOT 582
PLAN 6662
BLOCK
9
13
12
ERWIN DRIVE
BLOCK
7
A
PLAN 6662
C
A
DWELLING
4367 Erwin Drive
Dwelling
4363 Erwin Drive
DL
582
DWELLING
4371 Erwin Drive
INLET
BURRARD


4367 ERWIN DRIVE
PROPERTY LINE
SIDE YARD SETBACK LINE
FRONT YARD SETBACK
DRIVEWAY
PROPOSED RESIDENCE
PROPOSED COACH HOUSE
OCEAN SETBACK
GARDEN
COVERED TERRACE
4371 ERWIN DRIVE
PROJECT STATISTICS
BASED ON F.C.L.
HLYNSKY + DAVIS ARCHITECTS INC
A1.2


PROPERTY LINE
SIDEYARD SETBACK LINE
SPA ABOVE
DECK ABOVE
STEAM
WC
GYM
CHANGE
INFRARED SAUNA
MECHANICAL ROOM
GARAGE ABOVE
RECREATION ROOM
WINE CELLAR
COVERED PATH ABOVE
STORAGE
LAUNDRY
POOL ABOVE
HLYNSKY + DAVIS
ARCHITECTS INC
WEST VANCOUVER
PLANS
LOWER FLOOR
A2.1


PROPERTY LINE
SIDEYARD SETBACK LINE
SPA
POOL EQUIPMENT
CHANGE ROOM
KIDS' COVERED PLAY AREA
GARDEN
GAMES
POWDER
WC
FAMILY
DECK
FIRESIDE LOUNGE
LAWN
MUD ROOM
GARAGE
DRIVEWAY
PLANTER
LIVING
CLOSET
ENTRY
COVERED PATH
PATHWAY
POOL
DINING
COVERED OUTDOOR DINING
OUTDOOR KITCHEN + BBQ
WINE + BUFFET
HLYNSKY + DAVIS ARCHITECTS INC
PLANS
MAIN FLOOR
A2.2



PROPERTY LINE
SIDEYARD SETBACK LINE
MASTER BEDROOM
MASTER W.I.C.
ENSUITE
BEDROOM
CLOSET
CORRIDOR
MASTER ENSUITE
STEAM / SHOWER
BEDROOM 3
W.I.C.
ENSUITE 2
BEDROOM 2
GREEN ROOF
LIVING BELOW
OPEN TO BELOW
BRIDGE
ENTRY BELOW
TRELLIS
STUDY
HLYNSKY • DAVIS
ARCHITECTS INC
PLANS
UPPER FLOOR
A2.3

ATTACHMENT B

Flood Hazard Assessment (Revised) for 4369 Erwin Drive, West Vancouver, BC (issued 22 May 2019)

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nhc
northwest hydraulic consultants ltd

NHC Ref. No. 3004525

22 March 2019

Tara Haddad
[redacted]
West Vancouver, BC, [redacted]

Attention: Tara Haddad
Via email: [redacted]

Re: **Flood Hazard Assessment – Final Report (Revised)**
4369 Erwin Drive, West Vancouver, BC

Dear Ms. Haddad,

A letter report dated 26 February 2019 that summarizes the flood hazard assessment (FHA) study conducted by Northwest Hydraulic Consultants Ltd. (NHC) in support of building permit for the proposed 4369 Erwin Drive development located within the District of West Vancouver (DWV) was previously submitted to you. At the request of your architect, HLYNSKY + DAVIS Architects Inc., we are issuing a revised final report. The purpose of revising this report is to remove the option of reducing the CFL through construction of a wall across the property and to provide specific direction for application of the coastal CFL to the proposed coach house that is to be located at the back of the property fronting on to Erwin Drive.

1 INTRODUCTION

A single-family home is being proposed for 4369 Erwin Drive (Lot A, Block 7, District Lot 582, Group 1, New Westminster District, Plan 6662). The property is located on the north shore of Burrard Inlet within the DWV (**Figure 1**). Cypress Creek flows drains the steep slopes of the coastal North Shore mountains to outlet to Burrard Inlet near the project site. The property is potentially at risk to coastal flood hazards from Burrard Inlet as well as riverine flood hazards from the Cypress creek. NHC has conducted a flood hazard assessment to identify and assess these hazards. This report presents this assessment, the findings, and recommended measures to mitigate the hazard.

The objective of this assessment is to identify and evaluate the flood hazards that may affect the safe development and use of the property with respect to the proposed development and decide if development is possible to an acceptable safety threshold, either without or with mitigation. The currently accepted safety threshold in British Columbia is 0.5% annual exceedance probability (AEP) up to the year 2100. The 0.5% AEP event is often referred to as the 200-year event as such an event is expected, on average, to occur or be exceeded, once every 200 years.

The report has been structured by presenting referenced guidelines, site observations, coastal assessment, and concluding with findings and recommendations. The risk of flooding from the local

Cypress Creek, located 250 m west of the study site, is considered to be of less risk than the coastal flood hazard and therefore the assessment has focused on the coastal derived hazards.

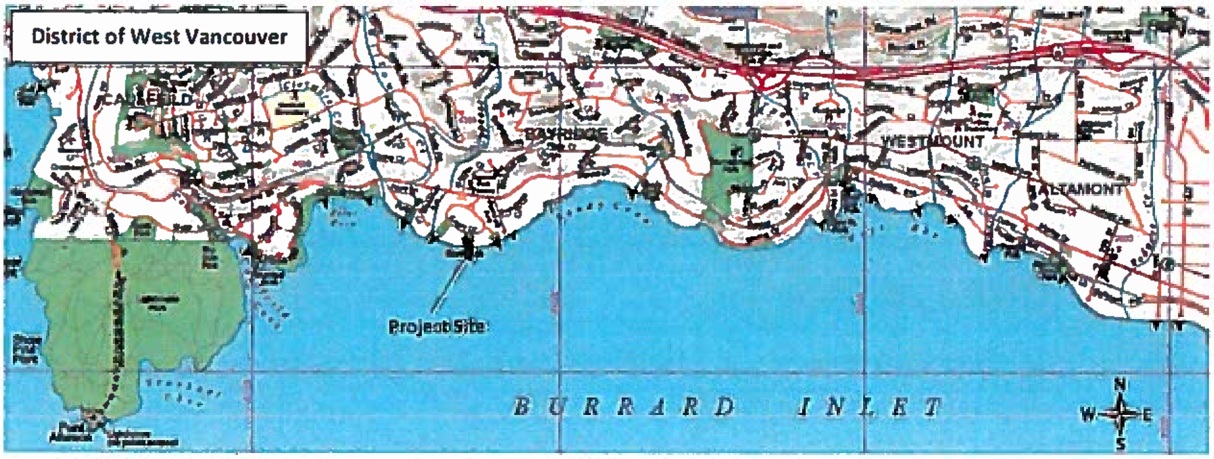


Figure 1. Location map of study site.

1.1 Existing FHA Covenants

DWV requires all applicants applying for a building permit to construct buildings in coastal areas to provide a site specific FHA report, prepared by a qualified professional, that confirms the land may be used safely for the use intended.

The report prepared by a qualified engineer must:

- Be prepared in accordance with the most recent edition of the Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC published by Engineers and Geoscientists of BC (EGBC, 2018);
- Be prepared by a qualified registered engineer;
- Be accompanied by the Flood Hazard and Risk Assurance Statement (Appendix A); and
- Identify all floor areas proposed to be constructed below the 4.5 m Geodetic Survey of Canada Datum (GSCD or GD) and specify use of these areas.

2 REFERENCED GUIDELINES

The following guidelines and regulations were reviewed as part of our investigation of the possible hydrotechnical hazards that could threaten the study property.

- Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC (EGBC, 2018)
- Flood Hazard Area Land Use Management Guidelines (BCMFLNRD, 2018)

- Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Draft Policy Discussion Paper (BC Ministry of Environment, 2011a)
- Coastal Floodplain Mapping – Guidelines and Specifications (BC Ministry of Environment, 2011b)
- Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Guidelines for Management of Coastal Flood Hazard Land Use (BC Ministry of Environment, 2011c)

3 SITE DESCRIPTION

A site investigation was conducted on January 25th, 2019, by a geomorphologist and coastal engineers from NHC to examine the foreshore morphology as well as to identify the condition of existing foreshore structures, and surrounding beach materials. The weather throughout the site inspection was mostly sunny and relatively calm. The tide level at Point Atkinson was about -0.9 m Geodetic Datum (GD) during the site inspection, which permitted a reasonable extent of the inter-tidal foreshore to be visually inspected.

The foreshore of the property is marked by a retaining wall (**Figure 2**) with a crest elevation at El. 3.2 m GD. Large boulders were placed in front of the retaining wall and act as toe protection. The existing foreshore (**Figure 3**) transitions into a gravel and cobble beach sloping at roughly 2.5% slope (40H:1V). The beach faces towards the south-west but is exposed to waves from the west, south, and east.

Figure 2. Existing retaining wall and riprap protection.

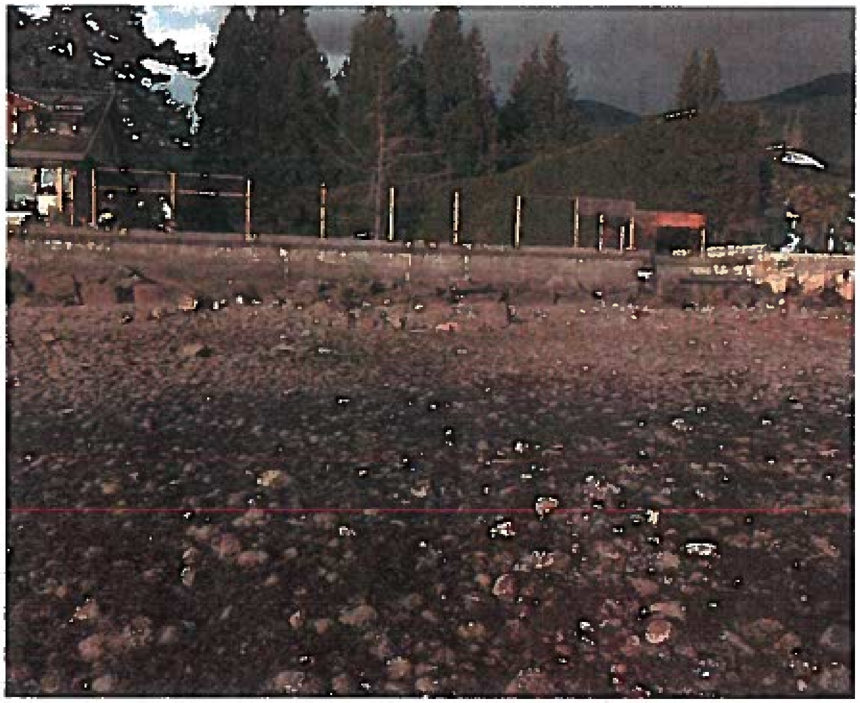


Figure 3. Existing foreshore substrate distribution.

The neighbouring property to the west consists of a similar sized and shaped concrete wall with glass panels installed at the top and similar toe protection features to those at the subject property (**Figure 4**). The neighbouring property to the east also consists of a retaining wall with glass panels installed at the top (**Figure 5**). The site visit occurred roughly one month after a large storm event (December 20th, 2018). Damages to the glass panels at the neighbouring properties were observed. It was also indicated by the project architect, Mr. Gord Hlynsky, at the time of the site visit that the study site and the neighbouring properties were flooded during the event.

Figure 4. Neighbouring property west of the study site.

Figure 5. Neighbouring property east of the study site.

The Cypress Creek channel draining to Burrard Inlet is located about 250 m west of the property. Cypress Creek flow is confined within a channel of relatively high banks; however, the land feature through which the creek drains to the ocean (and upon which the subject property is located) is an alluvial fan and therefore subject to flooding laterally from the creek. The channel transitions from roughly 15% grade upstream of the railway crossing (480 m upstream) to 5% at the Marine Drive crossing (200 m upstream), and roughly 2% as it approaches Burrard Inlet. The closest crossing, Marine Drive, is provided by a clear span bridge. The deep open channel at this crossing reduces the probability of debris blockages, and overland flooding impacting the site from this creek. Therefore, the property is at less risk of flooding from the Cypress Creek compared to the coastal hazard.

4 COASTAL FLOOD HAZARD ANALYSIS

Coastal flood hazards are primarily dictated by flood inundation, but can include overflow and spray, shoreline erosion and scour, beach degradation and aggradation, or physical loading from hydraulic forces or wood debris. Flood inundation is the focus of this coastal assessment. Other coastal hazards are of less concern for this assessment based on initial review, that is:

- Overflow and spray can be assessed and addressed through site drainage design following site design.
- Evidence of limited shoreline aggradation was identified during the site inspection in the proximity of the existing vertical concrete wall. No scour was identified along the toe of the wall. However, the existing toe protection does not appear to be properly designed and constructed. Further wave action could damage the existing toe protection and the toe of the wall. It is recommended that the property owner monitor and inspect the property for erosion and beach degradation twice a year to allow further investigation and mitigation if either become a problem in the future.

Canadian Hydrographic Service Chart 3495 (**Table 1**) presents the local tides at Point Atkinson, which is 1.8 km west of the study site. The existing top of wall at the study site is at 3.2 m GD. Coastal flood levels due to tide, storm surge, wave effects and long-term changes in global and local sea level are expected to be higher than this elevation which could lead to flood inundation.

Table 1. Tidal heights, extremes, and mean water level at Point Atkinson.

Sea State	Tide Elevation (m Geodetic Datum)
Higher High Water, Large Tide (HHWLT)	2.0
Higher High Water, Mean Tide (HHWMT)	1.3
Mean Water Level (MWL)	0.0
Lower Low Water, Mean Tide (LLWMT)	-2.0
Lower Low Water, Large Tide (LLWLT)	-3.1

4.1 Coastal Flood Level

To reduce the likelihood of damage from coastal flood inundation, the coastal flood level was assessed and used to derive a minimum construction level – the flood construction level (FCL). The FCL provides a level of mitigation to limit the likelihood of flooding for homes located along the coast or rivers and creeks. The FCL is generally based on an event with an AEP of 0.5%, often referred to as the 200-year event; since on average it would be expected to occur or be exceeded once every 200-years. In addition, due to changing conditions (primarily human induced global climate change) future conditions are considered up to the expected life of the project; often considered as the year-2100 (roughly 80 years from present).

The BC Ministry of Environment's published Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use (BC Ministry of Environment, 2011b) and the BC Ministry of Forests, Natural Resource Operations and Rural Development's amendment (BCMFLNRD, 2018) present two approaches for determining the 200-year FCL: 1) combined method and 2) probabilistic method. Parameters that sum up FCL for each method are illustrated in **Figure 6** and **Figure 7**.

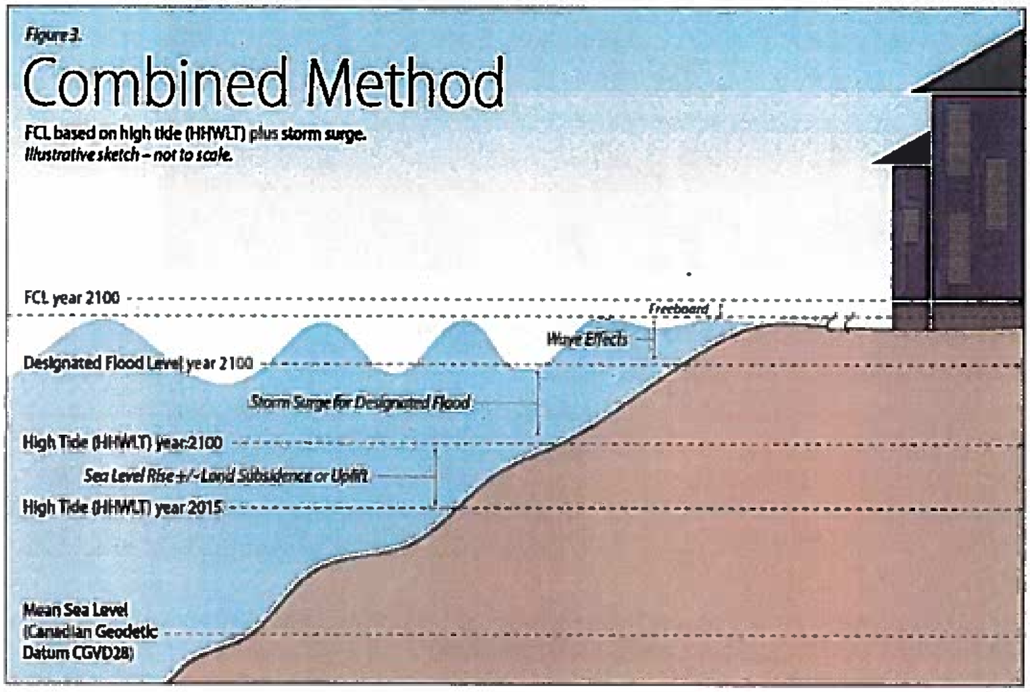


Figure 6. FCL based on combined method (BCMFLNRD, 2018).

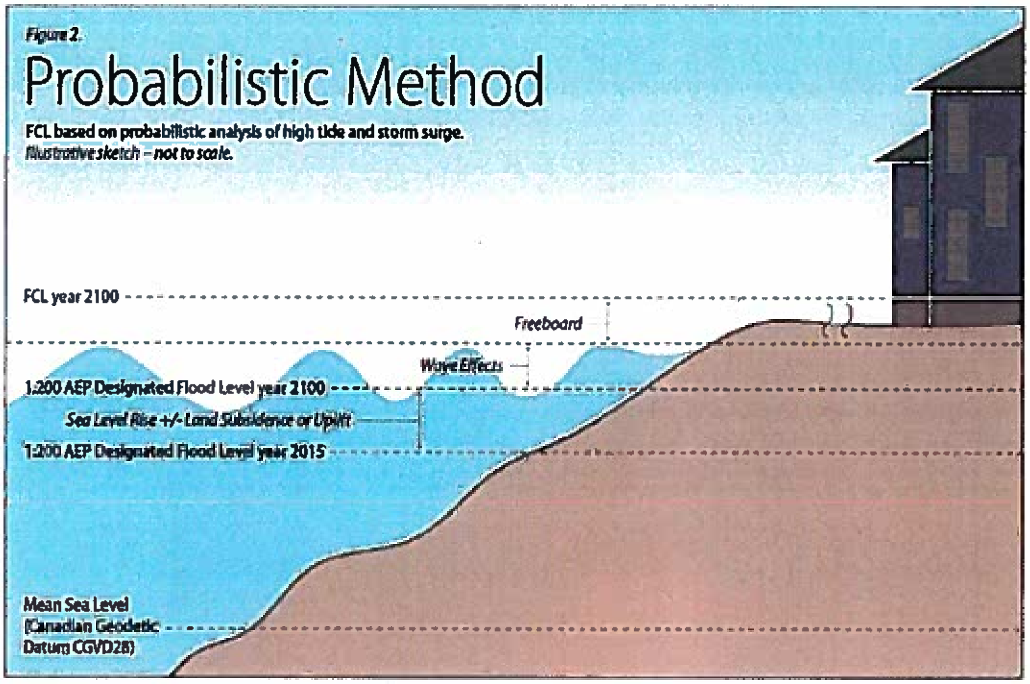


Figure 7. FCL based on probabilistic analysis (BCMFLNRD, 2018).

The combined method is based on the combined effects of HHWLT tide, storm surge, wave run-up, and sea level rise (SLR). This approach generally results in a conservative calculation of a design flood level, as it is often applied ignoring the probability of the various design events cooccurring (the probability that a 200-year storm surge co-occurs during HHWLT and 200-year wave event is closer to a 4,000-year event, AEP of 0.025%, instead of 200-year event, AEP of 0.5%). For this assessment the joint probability approach has been applied.

4.2 Coastal Flood Construction Level Assessment

The coastal flood construction level (FCL) using the probabilistic approach is the sum of:

- 1-in-200 AEP total water level as determined by probabilistic analyses of tides and storm surge;
- Allowances for future SLR to the year 2100
- Allowance for regional uplift or subsidence to the year 2100
- Estimated wave effects associated with the designated storm with an 1-in-200 AEP
- Freeboard

Each of these components are described in the following sections.

Predicted changes in storm intensity and frequency over the next 81 years, which could influence storm surge and wave effects, are highly variable and inconclusive. Such influence has not been incorporated in this analysis.

4.2.1 Joint Occurrence of Storm Surge and Tides

Coastal flood levels for the 1-in-200 AEP was developed by applying the Empirical Simulation Technique (EST) on the long term observed data (66 years) at Point Atkinson (NHC, 2008). The EST method is recommended by the Coastal Hydraulics Laboratory (of the US Army Corps of Engineers) and FEMA for frequency related studies. The analysis determined that the 1-in-200 AEP water level is 2.89 m GD.

4.2.2 Sea Level Rise

Global climate change is expected to result in increased sea levels resulting from melting of global ice and increased ocean volume due to rising water temperature. Typically, projects are considered to have a service life of roughly 80-years, resulting in designs often considering projections to the year-2100. The BC Provincial Sea Dike Guidelines (BC Ministry of Environment, 2011c) recommends that SLR associated with global climate change will result in a base water level 1 m above that seen in the year 2000 by the year-2100. The rate of SLR is projected to increase as the climate warms (**Figure 8**). Therefore, any increase incorporated in the past 18 years is expected to be minimal and hence ignored.

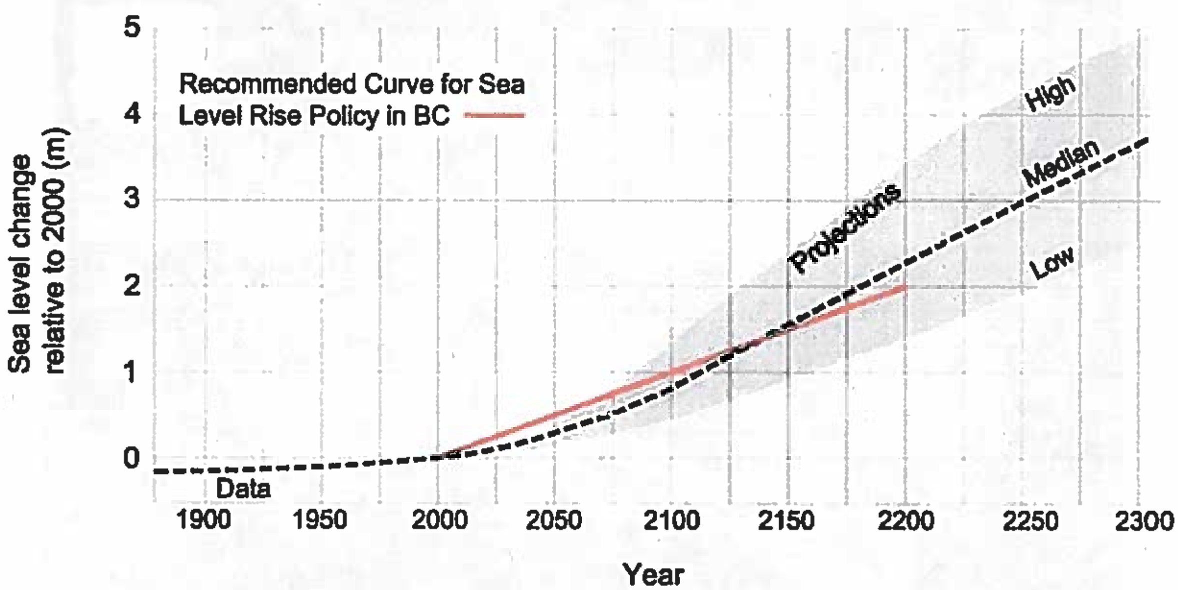


Figure 8. Projected climate change (BC Ministry of Environment, 2011c).

Note that the recommended SLR for planning and design in BC was based on a 2008 study by Fisheries and Oceans Canada (Thomson et al., 2008) and MOE (Bornhold, 2008). The authors of those works acknowledge the design SLR for BC is greater than the global mean SLR projected by the IPCC AR4 (2007) for the year 2100 (roughly 40 cm greater). However, more recent studies, such as IPCC AR5 (2014), suggests global mean SLR of up to 1 m or more by the year 2100. These values were based on the Paris Accord being adopted and adhered to, which appears not to be the case.

Other studies have investigated the potential effect of a collapse of the Antarctic ice sheet and have shown that such an event would result in far greater SLR, with estimates that are orders of magnitude larger than the 1 m to 2 m projected over then next 80-180 years. Recent changes in estimates of global mean SLR to the year 2100 or 2200 have not yet been addressed in the context of coastal BC, but based on recent conversations with FLNRORD, the province is amidst a study of SLR to update the 2011 design values. This study is not expected to be complete until April 2019.Despite the 1 m adopted by this flood hazard assessment, residents along the coast should therefore be aware that SLR could be substantially greater over the next 80-years, which may require raising, reconstruction, or relocation.

4.2.3 Local Subsidence

In addition to a rising sea, downward movement of the ground (subsidence) or upward movement (uplift) will influence the local relative sea level. Provincial guidelines (BC Ministry of Environment, 2011c) for local uplift are based on regional estimates and are less applicable than a more site-specific data source (Mazzotti et al., 2009), which suggests that subsidence for this location is on the order of -1 ± 0.5 mm/yr (**Figure 9**). To the year 2100, this translates to a lowering of 0.12 m.

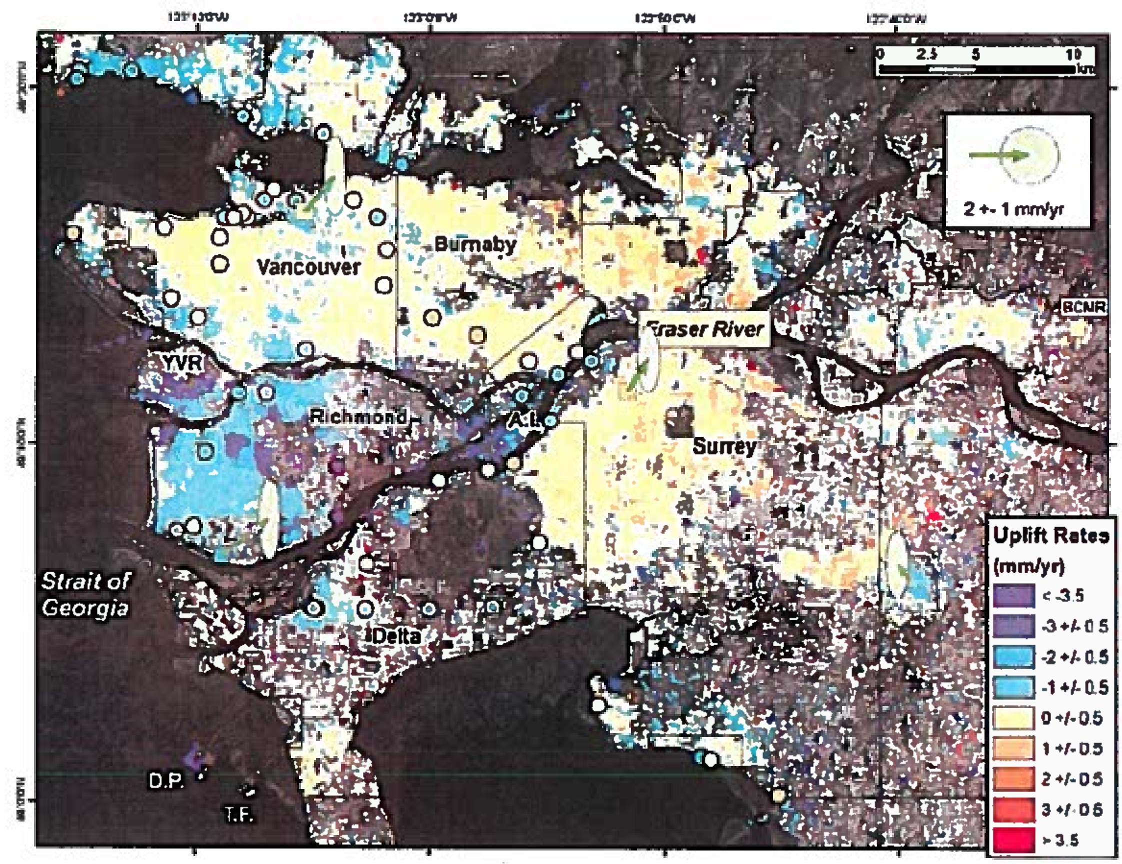


Figure 9. Local subsidence, shown as rate of uplift (Mazzotti et al., 2009).

4.2.4 Wind Analysis

There is one Meteorological Service of Canada (MSC) station in the vicinity of the study area that has a long-term record suitable for wind analysis: Point Atkinson. Twenty years of hourly wind data was used for the study, as summarized in **Table 2**.

Table 2. Point Atkinson station information.

Station	Station ID	Station Location	Period
Point Atkinson	1106200	480768 E 5464953 N	1997–2018

*No data is available for the period between 1959 and 1961.

The local wind climate can be visualized using a wind rose plot, utilizing arrows at the cardinal and inter-cardinal compass points to show the direction from which the winds blow and the magnitude and frequency for a given period. A wind rose showing the direction and magnitude of the winds at Point Atkinson is shown in **Figure 10.**

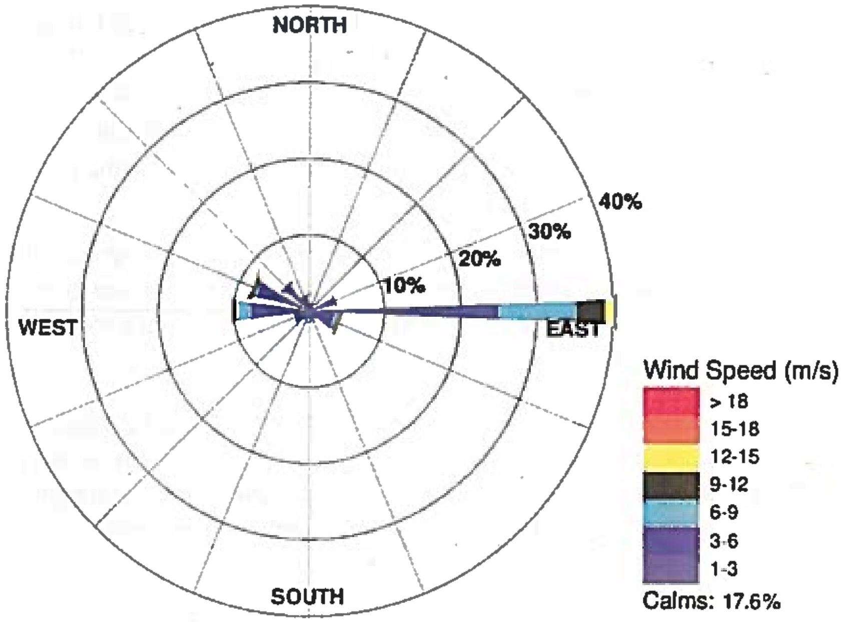


Figure 10. Wind rose based on data from Point Atkinson.

The wind rose shows that wind experienced at Point Atkinson is most frequently from the east and secondly from the west. Frequency analysis was conducted on the Point Atkinson data to obtain the wind speed for the design easterly and westerly storm events. The results are summarized in **Table 3** with the westerly winds being slightly stronger than from the east for the same return frequency.

Table 3. Design wind speeds – Point Atkinson.

Event	Easterly		Westerly	
	Speed (m/s)	Speed (km/hr)	Speed (m/s)	Speed (km/hr)
1-in-5 year	20.4	73	21.0	76
1-in-10 year	20.9	75	22.3	80
1-in-50 year	22.2	80	25.2	91

The guideline suggests that the wave effect is to be based on the 0.5% AEP storm event. However, NHC considers that establishing the FCL based 0.5% AEP storm event occurring with 0.5% AEP water level (tide and surge) to be overly conservative. For this study, the 50-year (2% AEP) storm events were used to for the flood hazard assessment instead of the 200-year (0.5% AEP) storms.

4.2.5 Nearshore Wave Modelling Analysis

A nearshore wave model (Simulating Waves Nearshore or SWAN) of the Strait of Georgia and Burrard Inlet was developed to model wave generation and propagation from deep water into coastal areas and shorelines. SWAN incorporates physical processes such as wave propagation, wave generation by wind, white-capping, shoaling, wave breaking, bottom friction, sub-sea obstacles, wave setup and wave-wave interactions in its computations (Booij, N. et al., 2004). SWAN version 41.20 was used for this study.

Two model grid resolutions were used for the analysis: a fine grid model of the approaches at Burrard Inlet was nested in a coarse grid model of the Strait of Georgia. The coarse grid measures about 113 km southwest to northeast, and 253 km northwest to southeast, with each grid cell measuring 500 m by 500 m. The fine grid measures about 9 km east to west, and 8 km north to south, with each grid cell measuring 50 m by 50 m. The model's bathymetric grids were generated from digitized Canadian Hydrographic Charts and NOAA 3 arc-second resolution data.

The 50-year event (2% AEP) for each design wind directions (westerly and easterly) were used to drive the SWAN model. For each event, a spatially varying Strait of Georgia wind field was developed and applied to both the coarse and fine grid models. The regional wind stations used to generate the spatially varying wind field are presented in **Table 4**.

Model results showing the 50-year waves from the west and east are presented in **Figure 11**, **Figure 12** and **Table 5**. Wave height is shown by colour shading, wave direction and relative heights are shown by vectors. The largest waves to reach the project site are from the east. The design significant wave height and mean wave period at the study area are from the east at 1.75 m and 4.64 seconds respectively.

Table 4. Regional wind data sources.

Station	Station ID	Period	Location
Entrance Island	EC ID 1022689	1994 – 2018 (Present)	49°12'31.195" N 123°48'38.001" W
Ballenas Island	EC ID 1020590	1994 – 2018 (Present)	49°21'01.000" N 124°09'37.000" W
Nanaimo Airport	EC ID 1025370	1954 – 2013	49°03'16.000" N 123°52'12.000" W
Nanaimo Airport	EC ID 1025365	2014 – 2018 (Present)	49°03'16.000" N 123°52'12.000" W
Sandheads CS	EC ID 1107010	1994 – 2018 (Present)	49°06'21.225" N 123°18'12.123" W
Saturna Island CS	EC ID 1017101	1994 – 2018 (Present)	48°47'02.067" N 123°02'41.082" W
Sisters Island	EC ID 2027403	1995 – 2018 (Present)	49°29'11.800" N 124°26'05.800" W
Victoria Int'l Airport	EC ID 1018620	1953 – 2013	48°38'50.010" N 123°25'33.000" W
Victoria Int'l Airport	EC ID 1018621	2013 – 2018 (Present)	48°38'50.000" N 123°25'33.000" W
Kelp Reefs	EC ID 1013998	1997 – 2018 (Present)	48°32'51.700" N 123°14'13.320" W
Halibut Bank	C46146	1992 – 2018 (Present)	49°20'24.000" N 123°43'48.000" W
Sentry Shoal	C46131	1992 – 2018 (Present)	49°54'36.000" N 124°59'24.000" W
Pat Bay	C46134	2001 – 2016	48°38'60.000" N 123°30'00.000" W

Table 5. Simulation results of design waves near project site

Event	Easterly Event		Westerly Event	
	Hs (m)	T (s)	Hs (m)	T (s)
1-in-50 year	1.75	4.64	1.61	6.22

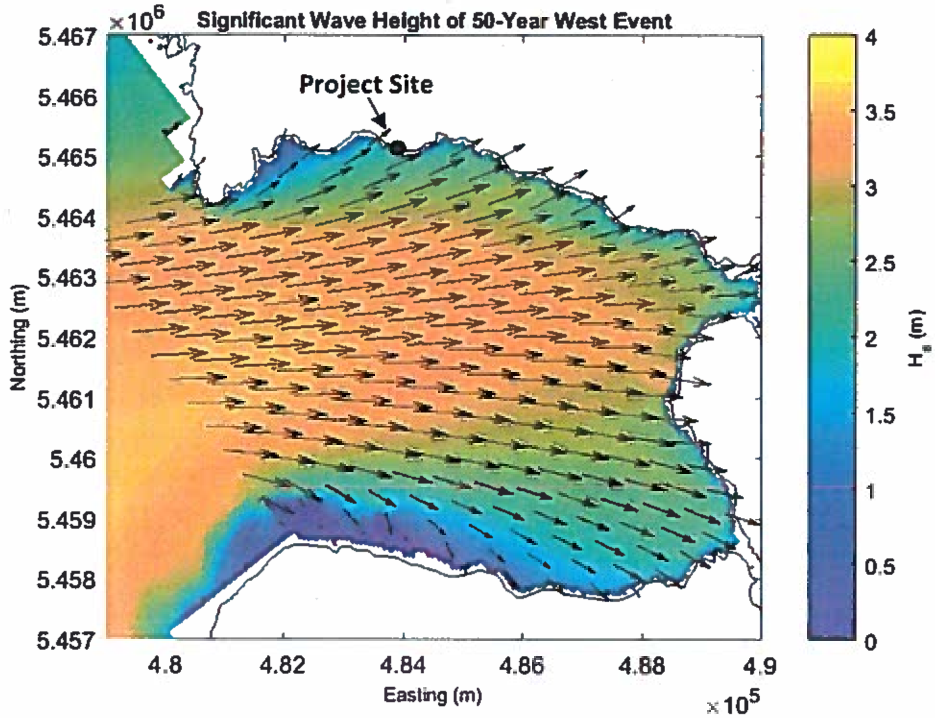


Figure 11. Significant wave height (Hs) and direction for simulated 50-year westerly event.

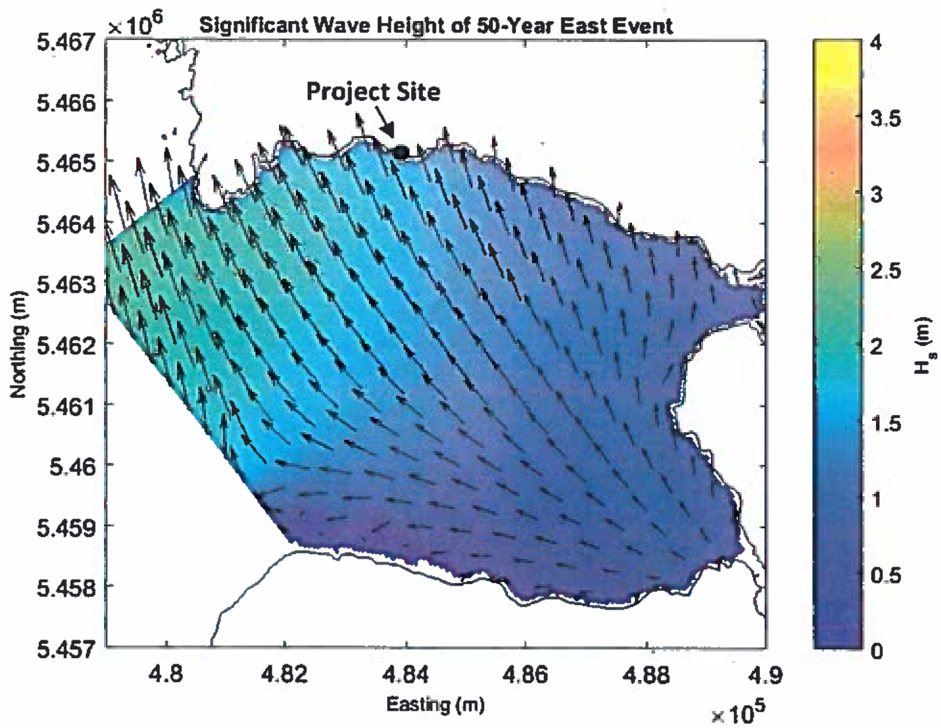


Figure 12. Significant wave height (Hs) and direction for simulated 50-year easterly event.

4.2.6 Wave runup and Wave Effect Assessment

Wave runup at the shoreline determines the extent over which waves act. Wave runup is therefore an important parameter to determine flood inundation extents from coastal storms. To determine the maximum wave runup, a Simulating Waves till Shore (SWASH) numerical model was developed to simulate the wave transformation, breaking and overflow on the shoreline (The SWASH team, 2018). For this study, SWASH version 5.01 was used.

To illustrate the effectiveness of the model to this type of application, **Figure 13** shows an example of the SWASH model results against the observed nearshore process during the December 20th, 2018 storm event in West Vancouver. A 20-second long model simulation video can be viewed at https://www.youtube.com/watch?v=qXIFPvBgeII.

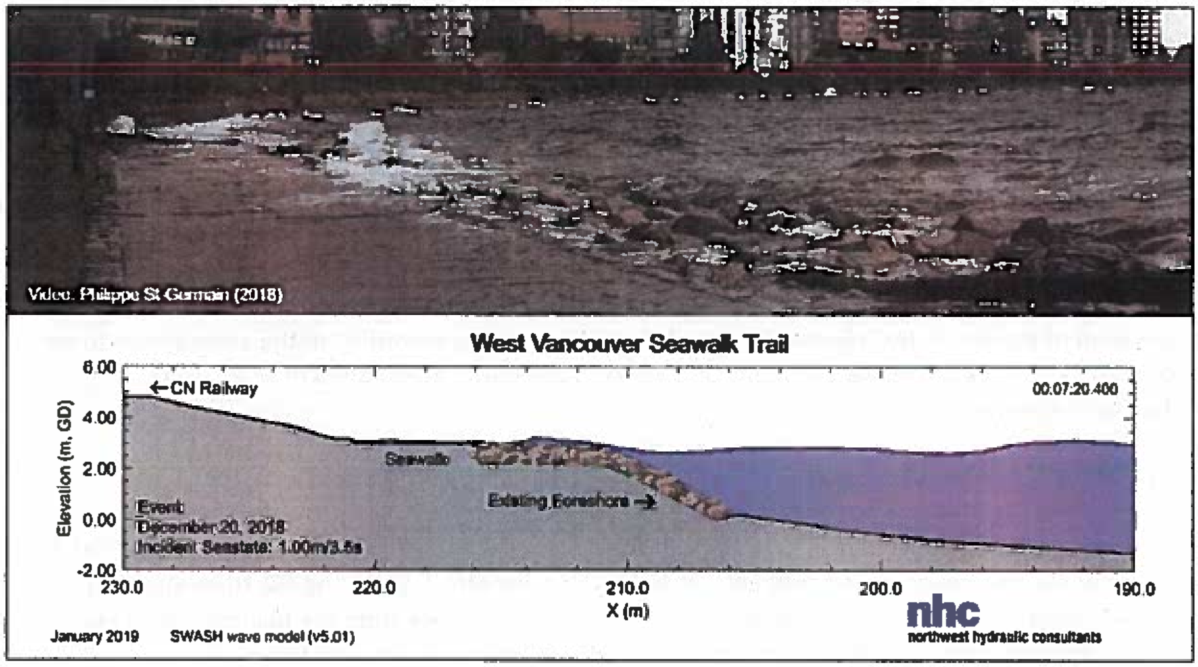


Figure 13. Numerical simulations of wave propagation and overtopping - December 20, 2018 storm event in West Vancouver.

Several simulations were performed as part of the wave runup analysis. A general profile of the study site was created using the architectural drawings provided by the client (**Appendix B**), the foreshore survey data collected during the site visit, and bathymetry data used in the SWAN model. Limited information with respect to the length of certain structural components was provided and therefore some assumptions have had to be made. The proposed upland profile consists of the lawn area extending from the existing concrete wall (3.85 m GD) followed by a fireside lounge (4.63 m GD) and deck area (5.55 m GD).

Figure 14 shows a snapshot of the SWASH model output for the proposed design under the future design water level conditions. The result shows that the wave runups were calculated to be 1.4 m and

1.2 m under the current and future design water levels, respectively. The different wave runup values correspond to different DWL and foreshore geometry.

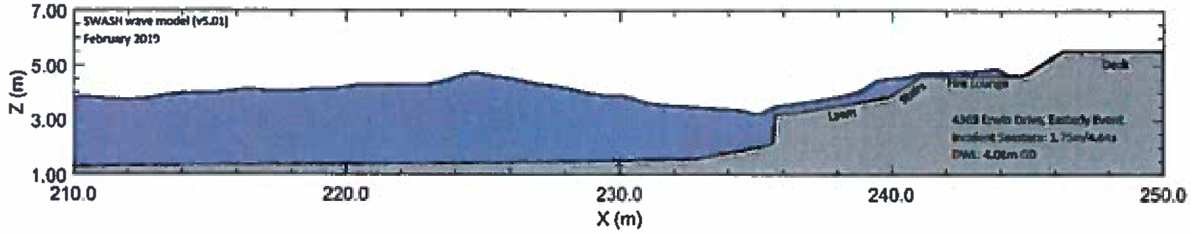


Figure 14. SWASH wave overtopping sample results - proposed property conditions.

Various options for reducing the wave runup component were assessed, including soft engineering solutions and construction of 'hard' elements, such as a concrete wall. Given the low elevation of the lawn and beach garden proposed, a soft engineering solution is expected to have a limited effect on wave runup. The option of reducing wave runup with a secondary concrete wall has been determined to be non-practical.

4.2.7 Freeboard

The freeboard is applied to account for temporal and spatial variances in wave climate and surge, as well as precision of the calculation overall. Freeboard for infrastructure according to the amendment to the Flood Hazard Area Land Use Management Guidelines (BCMFLNRD, 2018) is 0.6 m when using the probabilistic approach.

4.2.8 Flood Construction Level

Table 6 summarizes the resulting FCL for the current condition and that predicted for the year 2100. The FCL to be applied to the proposed residence includes the wave effect, while the FCL to be applied to the proposed coach house, by virtue of being set back a sufficient distance from the boundary with Burrard Inlet and receiving protection from the proposed residence, does not and so is lower.

Table 6. Flood construction levels.

FCL Input	Year 2019 Elevation (m)	Year 2100 Elevation (m) Proposed Residence	Year 2100 Elevation (m) Coach House
Tide + storm surge (joint probability)	2.89	2.89	2.89
+ wave effect	1.38	1.22	0
+ Design sea level rise (to year 2100)	0	1.0	1.0
+ Subsidence (to year 2100)	0	0.12	0.12
Coastal flood level	4.27	5.23	4.01
+ Freeboard (m)	0.6	0.6	0.6
Flood construction level	**4.87**	**5.83**	**4.61**

Notes:
[1]CFL based on the ground elevation behind the wall.

4.3 Tsunami Hazard

In addition to wave and storm events, high water and coastal property inundation could potentially occur from a tsunami event. Previously denoted as tidal waves, the Japanese term tsunami, is now used to denote long period waves (5 to 60 minutes) that radiate out from the rapid displacement of a large volume of water. The initial displacement can result from an earthquake, landslide, volcanic eruption, glacier calving, or impact from a meteorite. However, major tsunami events generally are a result of earthquakes that produce substantial vertical movement of the sea floor in sufficiently shallow water.

Assessment of tsunami hazards are beyond the scope of this project; however, previous studies suggest that the tsunami wave height reaching Vancouver Harbour would be roughly 10% of the tsunami wave height observed at Tofino on the west coast of Vancouver Island (Spaeth and Berkman, 1967) and that run up from a tsunami is expected to be less than 2 m on the North Shore from a tsunamis originating from the Pacific Ocean (Clague et al., 2005). Such an event would be extremely large on the west coast of Vancouver Island assuming the attenuation through the strait is roughly 10%.

The expected maximum tsunami run-up of less than 2 m would be for events far less frequent than the 200-year event, and when added to mean water high high tide (MWHHT), sea level rise, and subsidence, is still below the coastal derived FCL minus freeboard (El. 4.42 m versus El. 5.23 m).

5 SUMMARY AND RECOMMENDATIONS

A hydrotechnical flood hazard assessment was conducted for the subject property at 4369 Erwin Drive. It has been found that flooding originating from Burrard Inlet is the governing hazard. From this study, the following recommendations are made for safe use of the property:

1) The 2100-year design FCL for the project site was found to be 5.83 m GD for the proposed residence and 4.61 m for the proposed coach house.

2) Building entrances and windows to habitable space should be at or above the applicable FCL.
3) The underside of any wooden floor system, or the top of any concrete floor system used for habitation should be above the applicable FCL. An exception to this recommendation for wooden floor systems can be made if the underside of the wooden floor system is inset inside and below the top of concrete foundation, in which case the top of concrete foundation should be above the FCL.
4) No enclosed space to be used for habitation or storage of goods that can be damaged by floodwaters should be below the applicable FCL. An exception to this recommendation can be made if suitable provisions are made to design the space below the FCL such that flood waters cannot enter the space; for instance, a 'floodproof' basement is designed and certified by a qualified engineer.
5) All main electrical and mechanical infrastructure are to be above the applicable FCL. Any electrical supply below the FCL (i.e. outlets or lighting) should be protected by GFCI (ground fault circuit interruption) located above the FCL. Mechanical infrastructure may be located within a floodproof enclosed space below the FCL if the provisions of Recommendation #4 (above) are met.
6) The residence is set back from the edge of water a minimum of 15 m. Additional set back improves options to address further increases in SLR that may occur as well as shoreline erosion if it becomes a problem in the future.
7) If the site is landscaped with isolated low lying ground between the property's boundary with Burrard Inlet and the proposed residence, than stormwater drainage is designed to accommodate potential spray and overtopping.
8) Any ingress or egress routes existing above the applicable FCL are adequate for evacuation during a flood with loss of electrical power.
9) From all areas below the applicable FCL (i.e. underground parking) an unobstructed means of pedestrian ingress and egress is provided above the FCL, suitable for use under loss of electrical power.
10) Final building plans should be reviewed by qualified registered engineer to ensure they meet the recommendations presented within this FHA.

In addition, it is recommended that the property owner monitor and inspect the property for erosion and beach degradation twice a year to allow further investigation and mitigation if either become a problem in the future.

This flood hazard assessment was conducted following EGBC 2018 Class 1 flood hazard assessment guidelines. A summary of the EGBC criteria for such an assessment is presented in **Table 7**.
Hazards other than flood hazards from Burrard Inlet and the adjacent creeks, such as geotechnical, fire, and wildlife hazards have not been assessed as part of this assessment. Stormwater and sediment management has not been designed or assessed through this study and may also impose hazards if not adequately addressed.

Table 7. Summary of EGBC typical Class 1 flood hazard assessment methods and deliverables

EGBC Flood Hazard Assessment Component	Notes
Typical hazard assessment methods and climate/environmental change considerations	
Site inspection and qualitative assessment of flood hazard	Completed by NHC 2019
Identify any very low hazard surfaces in the consultation area (i.e., river terraces)	Completed by NHC 2019
Estimate erosion rates along river banks	River erosion not applicable to site. Coastal erosion not evident.
1-D or possibly 2-D modelling, modelling of fluvial regime and future trends in river bed changes, erosion hazard maps, possibly paleoflood analysis	2-D coastal modelling completed by NHC 2019
Identify upstream or downstream mass movement processes that could change flood levels (e.g., landslides leading to partial channel blockages, diverting water into opposite banks)	N/A – erosion risk deemed low
Conduct simple time series analysis of runoff data, review climate change predictions for study region, include in assessment if considered appropriate	N/A – erosion risk deemed low
Quantify erosion rates by comparative air photograph analysis	N/A – erosion risk deemed low
Typical deliverables	
Letter report or memorandum with at least water levels and consideration of scour and bank erosion	Completed
Cross-sections with water levels, flow velocity and qualitative description of recorded historic events, estimation of scour and erosion rates where appropriate with maps showing erosion over time	N/A – erosion risk deemed low
Maps with area inundated at different return period, flow velocity, flow depth, delineation of areas prone to erosion and river bed elevation changes, estimates of erosion rates	Areas and elevations inundated during the 200-year return period design event described

6 CLOSURE

We hope this work and report meets your current needs. If you have any questions don't hesitate to contact Derek Ray or Edwin Wang by phone 604-980-6011 or email (dray@nhcweb.com | ewang@nhcweb.com).

Sincerely,

Northwest Hydraulic Consultants Ltd.

Prepared by:

22 March, 2019

Adrian Simpalean, MASc.
Hydrotechnical Analyst

Reviewed by:

PROFESSIONAL PROVINCE OF D.A. RAY #25269 BRITISH COLUMBIA GEOSCIENTIST

22 Mar, 2019

Derek Ray, P.Geo.,
Principal Coastal Geomorphologist

PROFESSIONAL PROVINCE OF E. C. WANG # 29366 BRITISH COLUMBIA ENGINEER

Mar 22, 2019

Edwin Wang, P.Eng.,
Hydrotechnical Engineer

DISCLAIMER

This document has been prepared by **Northwest Hydraulic Consultants Ltd.** for the benefit of **Tara Haddad** for specific application to the **Flood Hazard Assessment at 4369 Erwin Drive, West Vancouver.** The information and data contained herein represent **Northwest Hydraulic Consultants Ltd.** best professional judgment in light of the knowledge and information available to **Northwest Hydraulic Consultants Ltd.** at the time of preparation, and was prepared in accordance with generally accepted engineering practices.

Except as required by law, this report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by **Tara Haddad**, its officers and employees. **Northwest Hydraulic Consultants Ltd.** denies any liability whatsoever to other parties who may obtain access to this report for any injury, loss or damage suffered by such parties arising from their use of, or reliance upon, this report or any of its contents.

REFERENCES

BC Ministry of Environment (2011a). *Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Draft Policy Discussion Paper.*

BC Ministry of Environment (2011b). *Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Guidelines for Management of Coastal Flood Hazard Land Use.*

BC Ministry of Environment (2011c). *Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use – Sea Dike Guidelines.*

BCMFLNRD (2018). *Flood Hazard Area Land Use Management Guidelines Sea Level Rise Amendment.*

Booij, N., Haagsma, Ij.G., Holthuijsen, L.H., Kieftenburg, A.T.M.M., Ris, R.C., van der Westhuysen, A.J., and Zijlema, M. (2004). *SWAN User Manual SWAN Cycle III Version 40.41.* Delft University of Technology, The Netherlands.

Bornhold, B. D. (2008). *Projected sea level changes for British Columbia in the 21st Century.* Province of British Columbia, Victoria, BC. 10 pp.

Clague et al. (2005). *Tsunami Hazard to North and West Vancouver, British Columbia.* Centre for Natural Hazard Research, Simon Fraser University. 25 pp.

EGBC (2018). *Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC.*

IPCC (2007). *Contribution of Working Groups I, II and III to the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change. Core Writing Team, Pachauri, R.K. and Reisinger, A. (Eds.). Geneva, Switzerland.* 104 pp.

IPCC (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland.* 151 pp.

Lambert, A., Mazzotti, S., Van der Kooij, S., and Mainville, A. (2008). *Subsidence and relative sea level rise in the Fraser River delta, Greater Vancouver, British Columbia, from combined geodetic data* (Open File 5698). Geological Survey of Canada. 44 pp.

The SWASH team (2018). *SWASH (Simulating WAves till SHore) User Manual version 5.01A.*

Thomson, R. E., Bornhold, B. D., and Mazzotti, S. (2008). *An examination of the factors affecting relative and absolute sea level in Coastal British Columbia.* Canadian Technical Report of Hydrography and Ocean Sciences. 49 pp.

Appendix A

Flood Hazard and Risk Assurance Statement

APPENDIX J: *FLOOD HAZARD* AND *RISK* ASSURANCE STATEMENT

Note: This Statement is to be read and completed in conjunction with the "*APEGBC Professional Practice Guidelines - Legislated Flood Assessments in a Changing Climate*, March 2012 ("*APEGBC* Guidelines") and is to be provided for *flood assessments* for the purposes of the *Land Title Act*, Community Charter or the *Local Government Act*. Italicized words are defined in the *APEGBC* Guidelines.

To: The *Approving Authority* Date: 2019-02-26

Planning, Permit, and Properties, District of North Vancouver

4369 Erwin Drive, West Vancouver, BC V7V 3A7

Jurisdiction and address

With reference to (check one):

- ☐ Land Title Act (Section 86) – Subdivision Approval
- ☐ Local Government Act (Sections 919.1 and 920) – Development Permit
- ☑ Community Charter (Section 56) – Building Permit
- ☐ Local Government Act (Section 910) – Flood Plain Bylaw Variance
- ☐ Local Government Act (Section 910) – Flood Plain Bylaw Exemption

For the Property:

Lot A, Block 7, District Lot 582, Group 1, New Westminster District, Plan 6662

Legal description and civic address of the Property

The undersigned hereby gives assurance that he/she is a *Qualified Professional* and is a *Professional Engineer* or *Professional Geoscientist*.

I have signed, sealed and dated, and thereby certified, the attached flood assessment report on the Property in accordance with the APEGBC Guidelines. That report must be read in conjunction with this Statement. In preparing that report I have:

Check to the left of applicable items

✓ 1. Collected and reviewed appropriate background information

✓ 2. Reviewed the proposed *residential development* on the Property

✓ 3. Conducted field work on and, if required, beyond the Property

✓ 4. Reported on the results of the field work on and, if required, beyond the Property

✓ 5. Considered any changed conditions on and, if required, beyond the Property

6. For a *flood hazard* analysis or *flood risk* analysis I have:
   - ✓ 6.1 reviewed and characterized, if appropriate, floods that may affect the Property
   - ✓ 6.2 estimated the *flood hazard* or *flood risk* on the property
   - ✓ 6.3 included (if appropriate) the effects of climate change and land use change
   - ✓ 6.4 identified existing and anticipated future *elements at risk* on and, if required, beyond the Property
   - ✓ 6.5 estimated the potential *consequences* to those *elements at risk*

7. Where the *Approving Authority* has adopted a specific level of *flood hazard* or *flood risk* tolerance or return period that is different from the standard 200-year return period design criteria[1], I have
   - ✓ 7.1 compared the level of *flood hazard* or *flood risk* tolerance adopted by the *Approving Authority* with the findings of my investigation
   - ✓ 7.2 made a finding on the level of *flood hazard* or *flood risk* tolerance on the Property based on the comparison
   - ✓ 7.3 made recommendations to reduce the *flood hazard* or *flood risk* on the Property

[1] *Flood Hazard Area Land Use Management Guidelines* published by the BC Ministry of Forests, Lands , and Natural Resource Operations and the 2009 publication *Subdivision Preliminary Layout Review – Natural Hazard Risk* published by the Ministry of Transportation and Public Infrastructure. It should be noted that the 200-year return period is a standard used typically for rivers and purely fluvial processes. For small creeks subject to debris floods and debris flows return periods are commonly applied that exceed 200 years. For life-threatening events including debris flows, the Ministry of Transportation and Public Infrastructure stipulates in their 2009 publication *Subdivision Preliminary Layout Review – Natural Hazard Risk* that a 10,000-year return period needs to be considered.

8. Where the *Approving Authority* has **not** adopted a level of *flood risk* or *flood hazard* tolerance I have:

NA 8.1 described the method of *flood hazard* analysis or *flood risk analysis* used

NA 8.2 referred to an appropriate and identified provincial or national guideline for level of *flood hazard* or *flood risk*

NA 8.3 compared this guideline with the findings of my investigation

NA 8.4 made a finding on the level of *flood hazard* of *flood risk* tolerance on the Property based on the comparison

NA 8.5 made recommendations to reduce *flood risks*

N/A 9. Reported on the requirements for future inspections of the Property and recommended who should conduct those inspections.

Based on my comparison between

Check one

- ☐ the findings from the investigation and the adopted level of *flood hazard* or *flood risk* tolerance (item 7.2 above)
- ☑ the appropriate and identified provincial or national guideline for level of *flood hazard* or *flood risk* tolerance (item 8.4 above)

I hereby give my assurance that, based on the conditions contained in the attached flood assessment report,

Check one

- ☐ for subdivision approval, as required by the *Land Title Act* (Section 86), "that the land may be used safely for the use intended".

  Check one
  - ☐ with one or more recommended registered *covenants*.
  - ☐ without any registered *covenant*.
- ☑ for a development permit, as required by the *Local Government Act* (Sections 919.1 and 920), my report will "assist the local government in determining what conditions or requirements under [Section 920] subsection (7.1) it will impose in the permit".
- ☐ for a building permit, as required by the Community Charter (Section 56), "the land may be used safely for the use intended".

  Check one
  - ☑ with one or more recommended registered *covenants*.
  - ☐ without any registered *covenant*.
- ☐ for flood plain bylaw variance, as required by the *Flood Hazard Area Land Use Management Guidelines* associated with the *Local Government Act* (Section 910), "the development may occur safely".
- ☐ for flood plain bylaw exemption, as required by the *Local Government Act* (Section 910), "the land may be used safely for the use intended".

Derek Ray
Name (print)

2019-02-26
Date

[signature]
Signature

Address
30 Gostick Place, North Vancouver, BC V7M 3G3

604-980-6011
Telephone

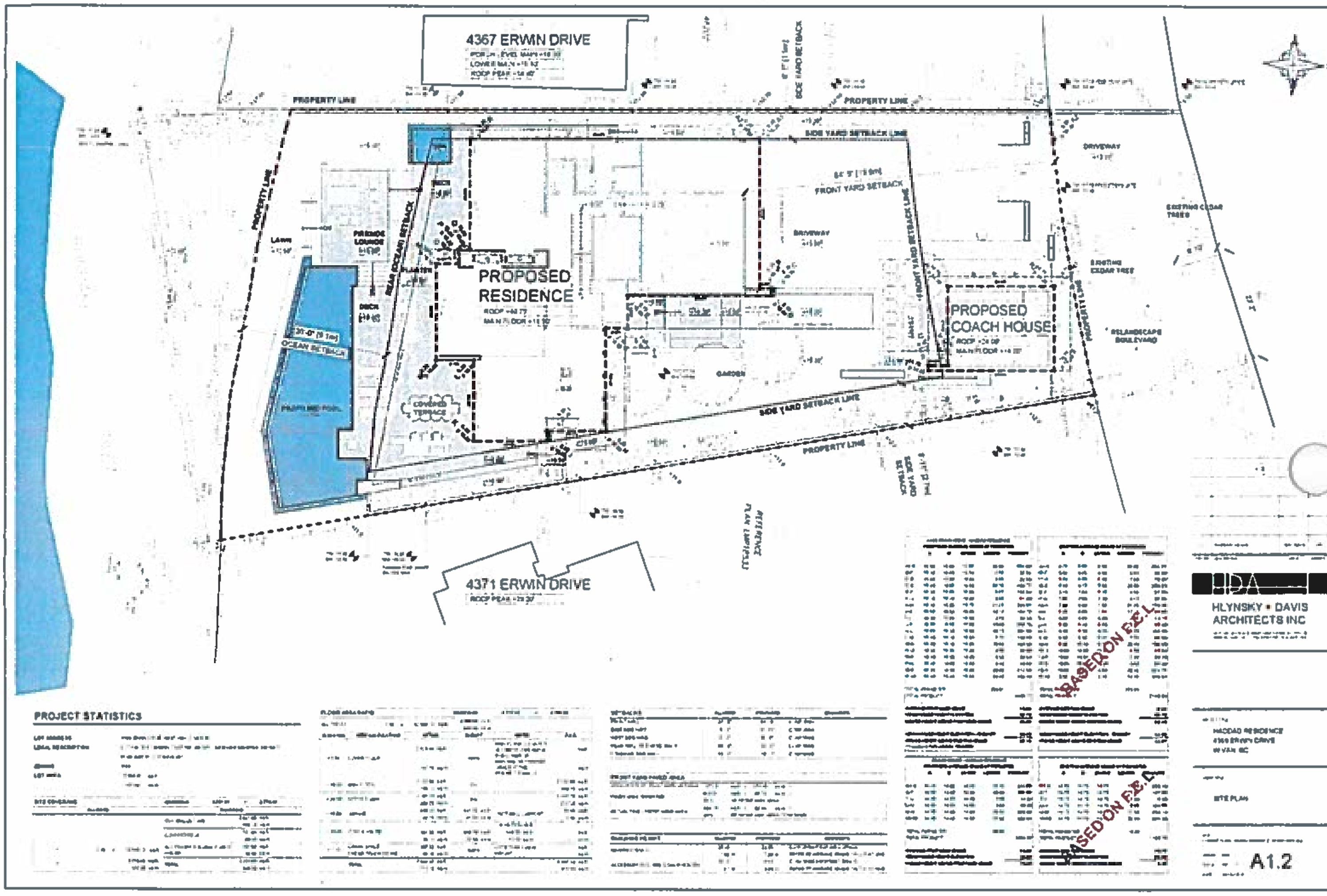
(Affix Professional seal here)

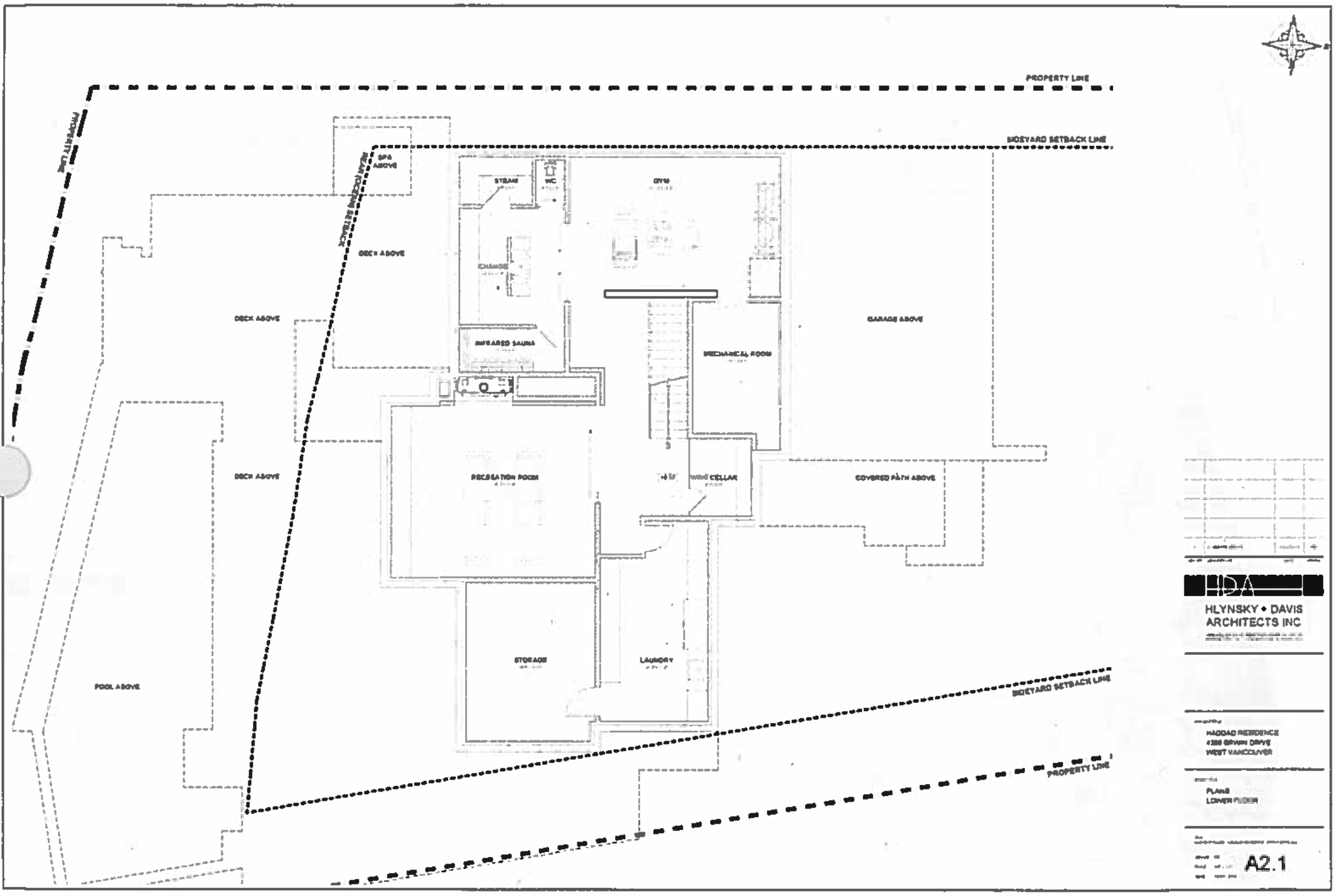
If the *Qualified Professional* is a member of a firm, complete the following.

I am a member of the firm Northwest Hydraulic Consultants Ltd. (NHC) (Print name of firm)
and I sign this letter on behalf of the firm.

Appendix B

Received Design Drawings


4367 ERWIN DRIVE
PROPERTY LINE
SIDE YARD SETBACK LINE
FRONT YARD SETBACK
DRIVEWAY
PROPOSED RESIDENCE
PROPOSED COACH HOUSE
OCEAN SETBACK
COVERED TERRACE
GARDEN
4371 ERWIN DRIVE
PROJECT STATISTICS
BASED ON F.E.L
HLYNSKY • DAVIS
ARCHITECTS INC
A1.2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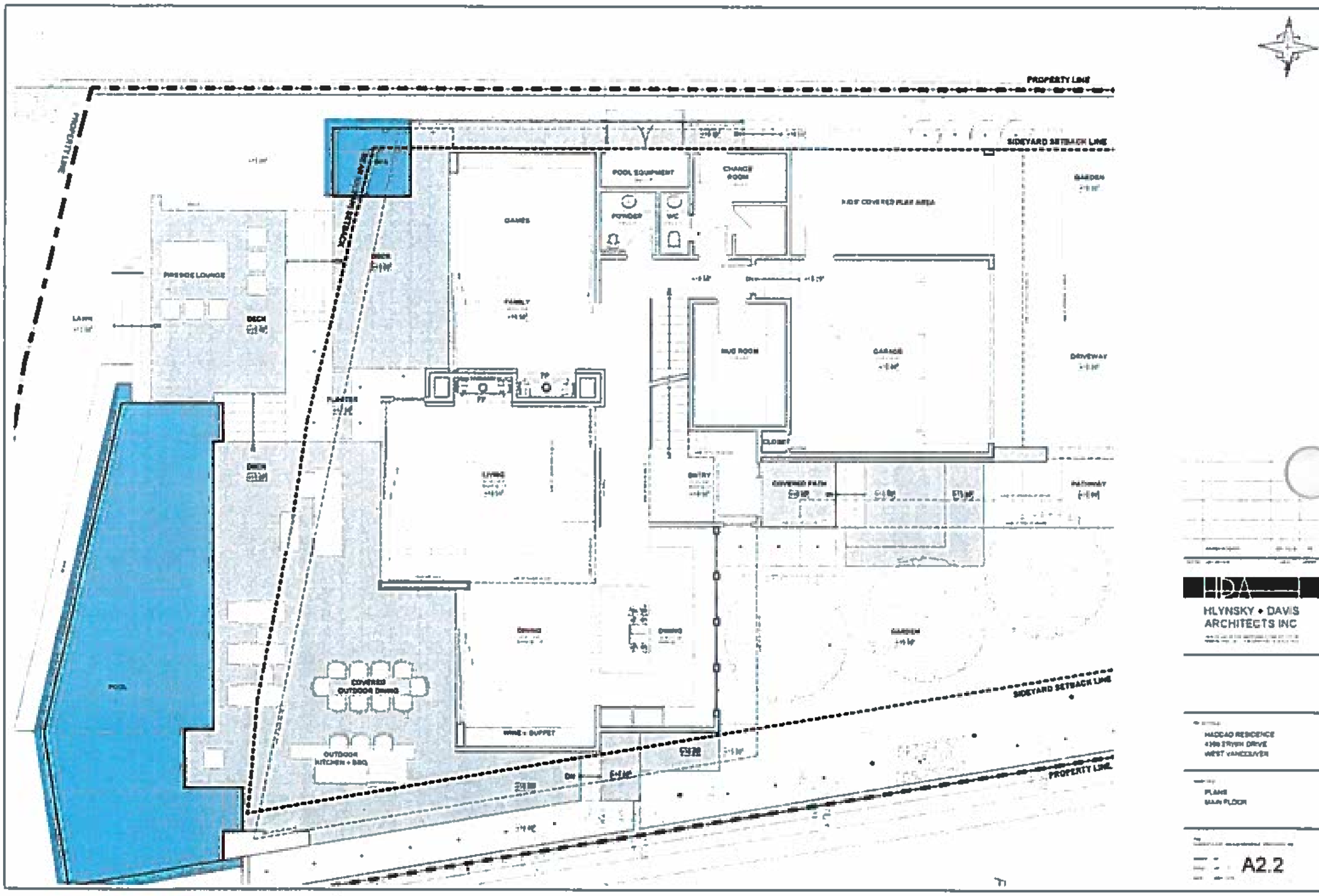
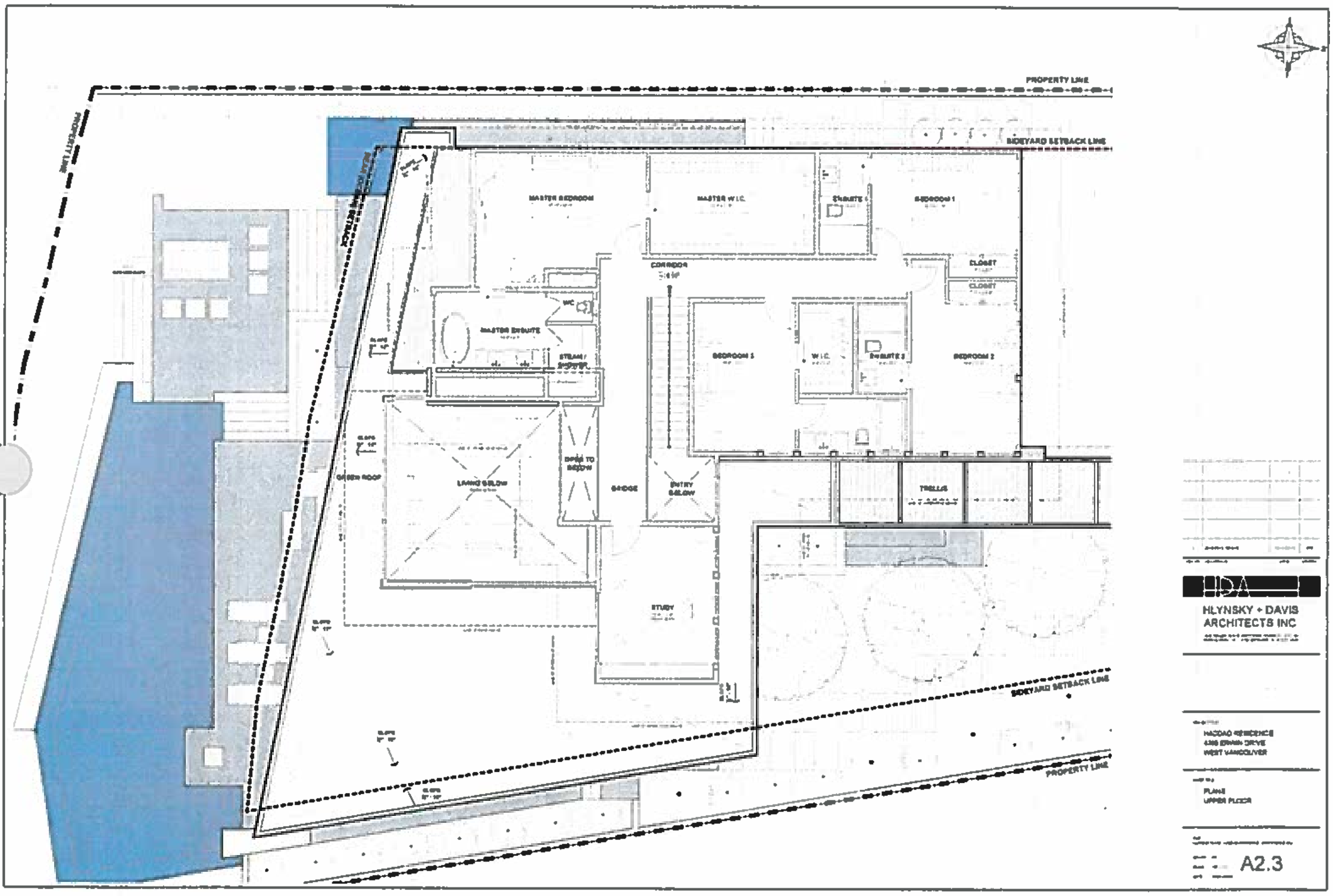
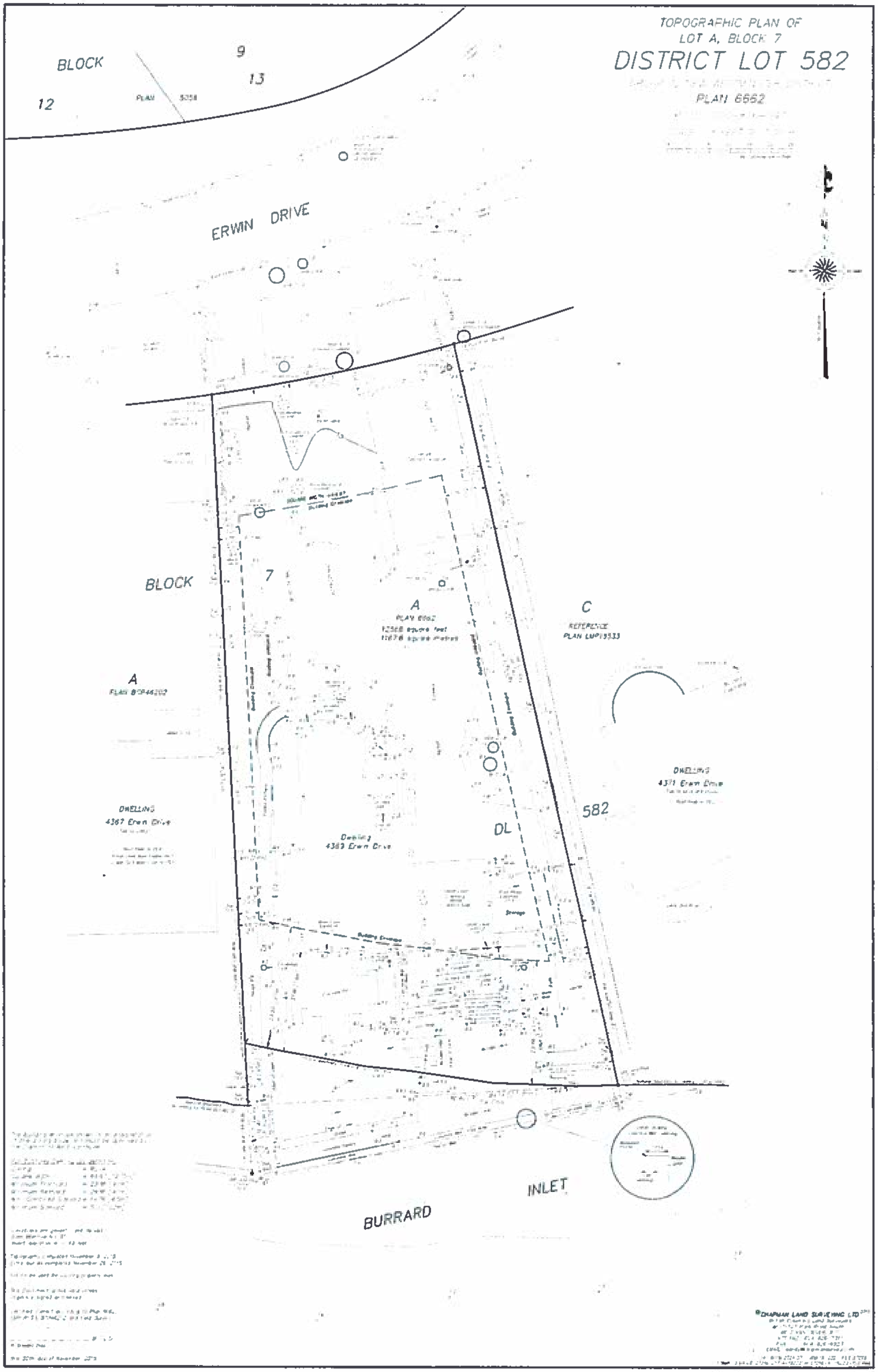
SIDEYARD SETBACK LINE
SPA ABOVE
STEAM
WC
GYM
CHANGE
DECK ABOVE
DECK ABOVE
REAR YARD SETBACK
INFRARED SAUNA
MECHANICAL ROOM
GARAGE ABOVE
DECK ABOVE
RECREATION ROOM
WINE CELLAR
COVERED PATH ABOVE
POOL ABOVE
STORAGE
LAUNDRY
SIDEYARD SETBACK LINE
PROPERTY LINE
HLYNSKY ◆ DAVIS
ARCHITECTS INC
HADDAD RESIDENCE
WEST VANCOUVER
PLANS
LOWER FLOOR
A2.1


PROPERTY LINE
SIDEYARD SETBACK LINE
POOL EQUIPMENT
GAMES
FAMILY
POWDER
WC
GARAGE
DRIVEWAY
GARDEN
MUD ROOM
CLOSET
ENTRY
COVERED PATH
PATHWAY
LIVING
DINING
WINE + BUFFET
COVERED OUTDOOR DINING
OUTDOOR KITCHEN + BBQ
DECK
LAWN
POOL
HLYNSKY + DAVIS
ARCHITECTS INC
A2.2


PROPERTY LINE
SIDEYARD SETBACK LINE
MASTER BEDROOM
MASTER W.I.C.
ENSUITE 1
BEDROOM 1
CORRIDOR
CLOSET
CLOSET
MASTER ENSUITE
STEAM / SHOWER
BEDROOM 3
W.I.C.
ENSUITE 2
BEDROOM 2
GREEN ROOF
LIVING BELOW
OPEN TO BELOW
BRIDGE
ENTRY BELOW
TRELLIS
STUDY
SIDEYARD SETBACK LINE
PROPERTY LINE
HLYNSKY + DAVIS ARCHITECTS INC
HADDAD RESIDENCE
WEST VANCOUVER
PLANS
UPPER FLOOR
A2.3


TOPOGRAPHIC PLAN OF
LOT A, BLOCK 7
DISTRICT LOT 582
PLAN 6662
BLOCK
9
13
12
ERWIN DRIVE
BLOCK
7
A
C
A
DWELLING
Dwelling
DL
582
DWELLING
BURRARD
INLET

ATTACHMENT C

Hlynsky+Davis Architects Inc. Drawing Set for Haddad Residence at 4369 Erwin Drive, West Vancouver (Revision 3, issued as DVP Application on 13 August 2019)

DRAWING LIST

A1.1	RENDERS
A1.2	CONTEXT PHOTOS
A1.3	SITE PLAN
A1.4	AVERAGE GRADE
A2.1	LOWER FLOOR PLAN
A2.2	MAIN FLOOR PLAN
A2.3	UPPER FLOOR PLAN
A2.4	ROOF PLAN
A4.1	NORTH ELEVATION COACH HOUSE
A4.2	NORTH ELEVATION
A4.3	EAST ELEVATION
A4.4	SOUTH ELEVATION
A4.5	WEST ELEVATION
A5.1	SECTION ENTRY
LDP 1.01	LANDSCAPE MASTER PLAN
LDP 4.01	PERMIT PLANTING PLAN

HADDAD RESIDENCE 4369 ERWIN DRIVE

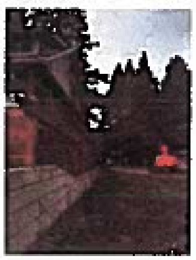
HLYNSKY + DAVIS
ARCHITECTS INC

HADDAD RESIDENCE
4369 ERWIN DRIVE
W VAN BC

RENDERS

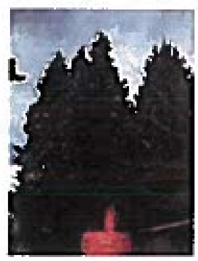
A1.1

CONTEXT VIEW



WEST NEIGHBOUR LOOKING NORTH

EAST NEIGHBOUR LOOKING NORTH



SOUTH EAST FORESHORE ENCROACHMENT

SOUTH EAST FORESHORE ENCROACHMENT

SOUTH EAST FORESHORE ENCROACHMENT

SOUTH EAST FORESHORE ENCROACHMENT

SOUTH EAST FORESHORE ENCROACHMENT

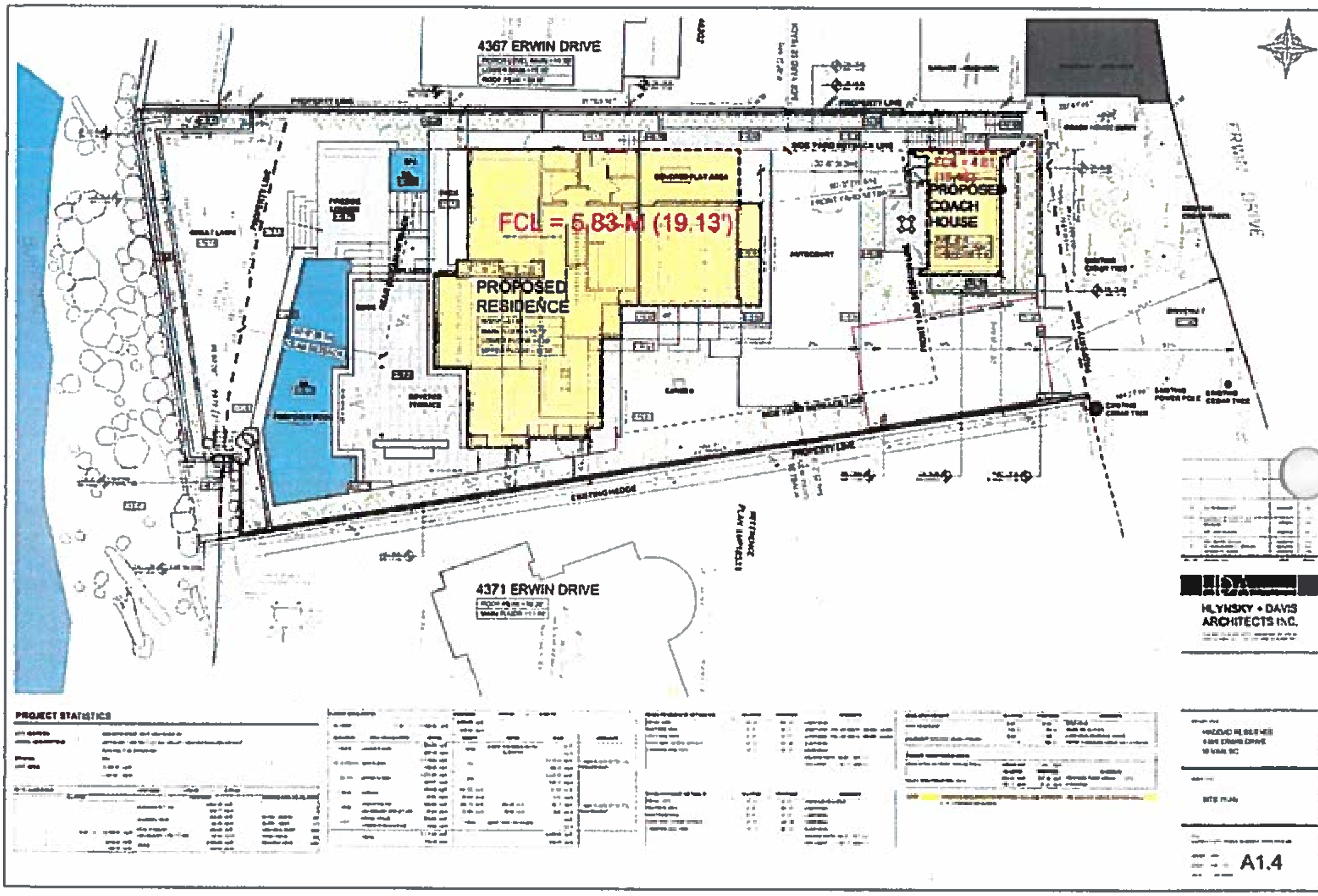
SOUTH EAST FORESHORE ENCROACHMENT

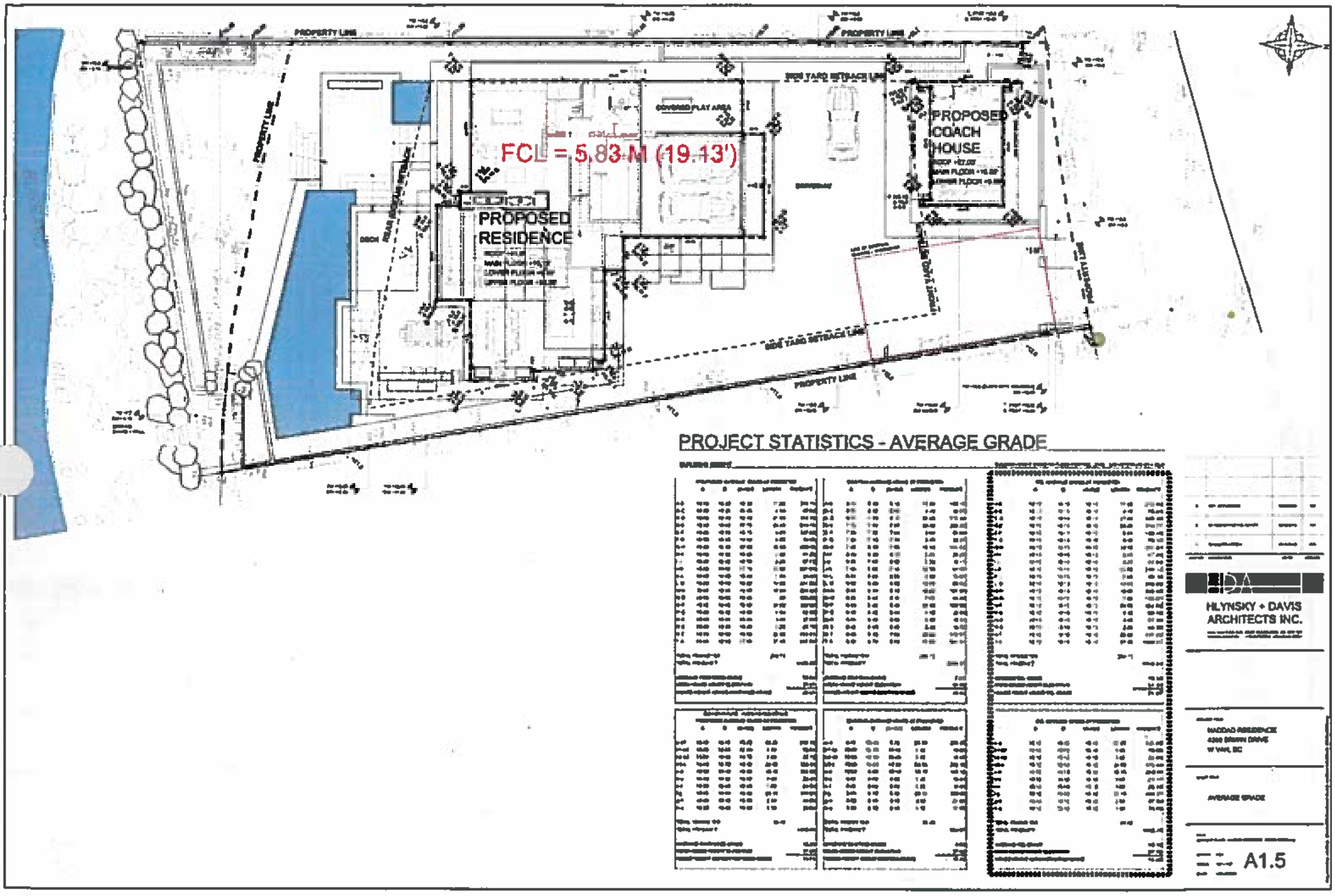
HLYNSKY • DAVIS
ARCHITECTS INC

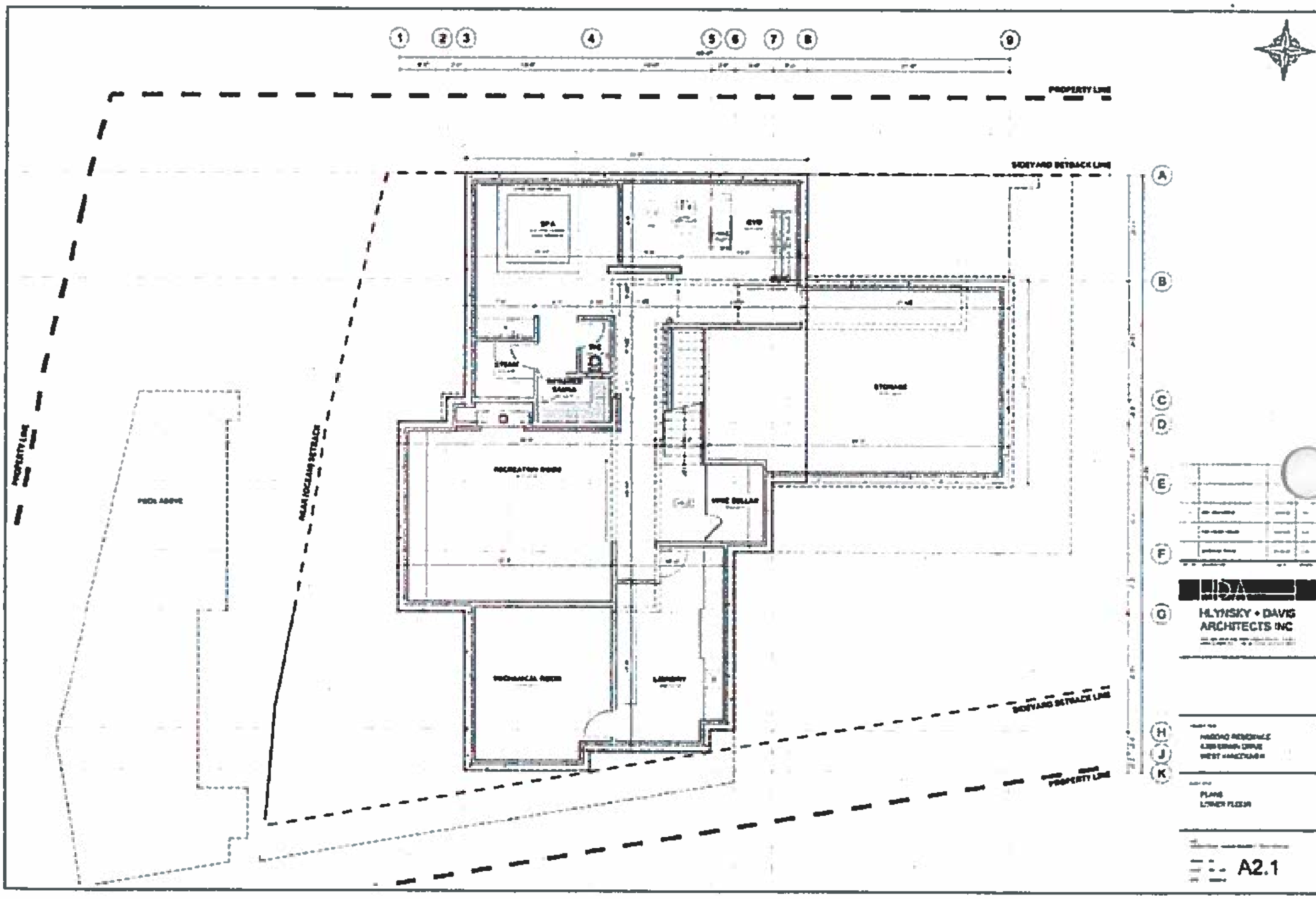
HADDAD RESIDENCE
W VAN BC

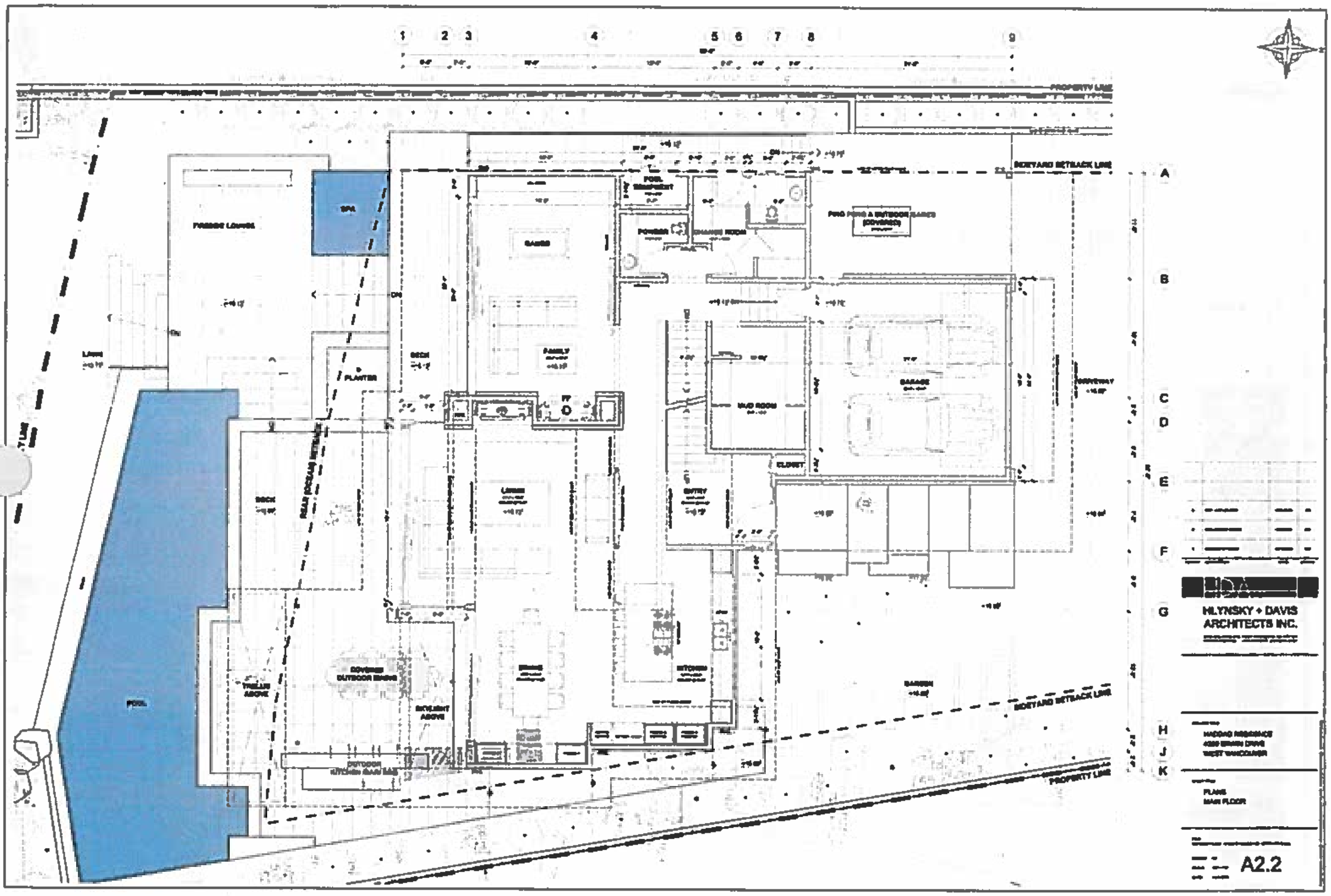
CONTEXT PHOTOS

A1.2


4367 ERWIN DRIVE
FCL = 5.83 M (19.13')
PROPOSED RESIDENCE
PROPOSED COACH HOUSE
4371 ERWIN DRIVE
HLYNSKY + DAVIS ARCHITECTS INC.
PROJECT STATISTICS
A1.4


PROPERTY LINE
PROPOSED RESIDENCE
PROPOSED COACH HOUSE
FCL = 5.83 M (19.13')
PROJECT STATISTICS - AVERAGE GRADE
HLYNSKY + DAVIS
ARCHITECTS INC.
A1.5


PROPERTY LINE
SIDEYARD SETBACK LINE
SPA
GYM
STEAM
STORAGE
RECREATION ROOM
WINE CELLAR
MECHANICAL ROOM
LAUNDRY
POOL ABOVE
HLYNSKY • DAVIS
ARCHITECTS INC
PLANS
LOWER FLOOR
A2.1



1
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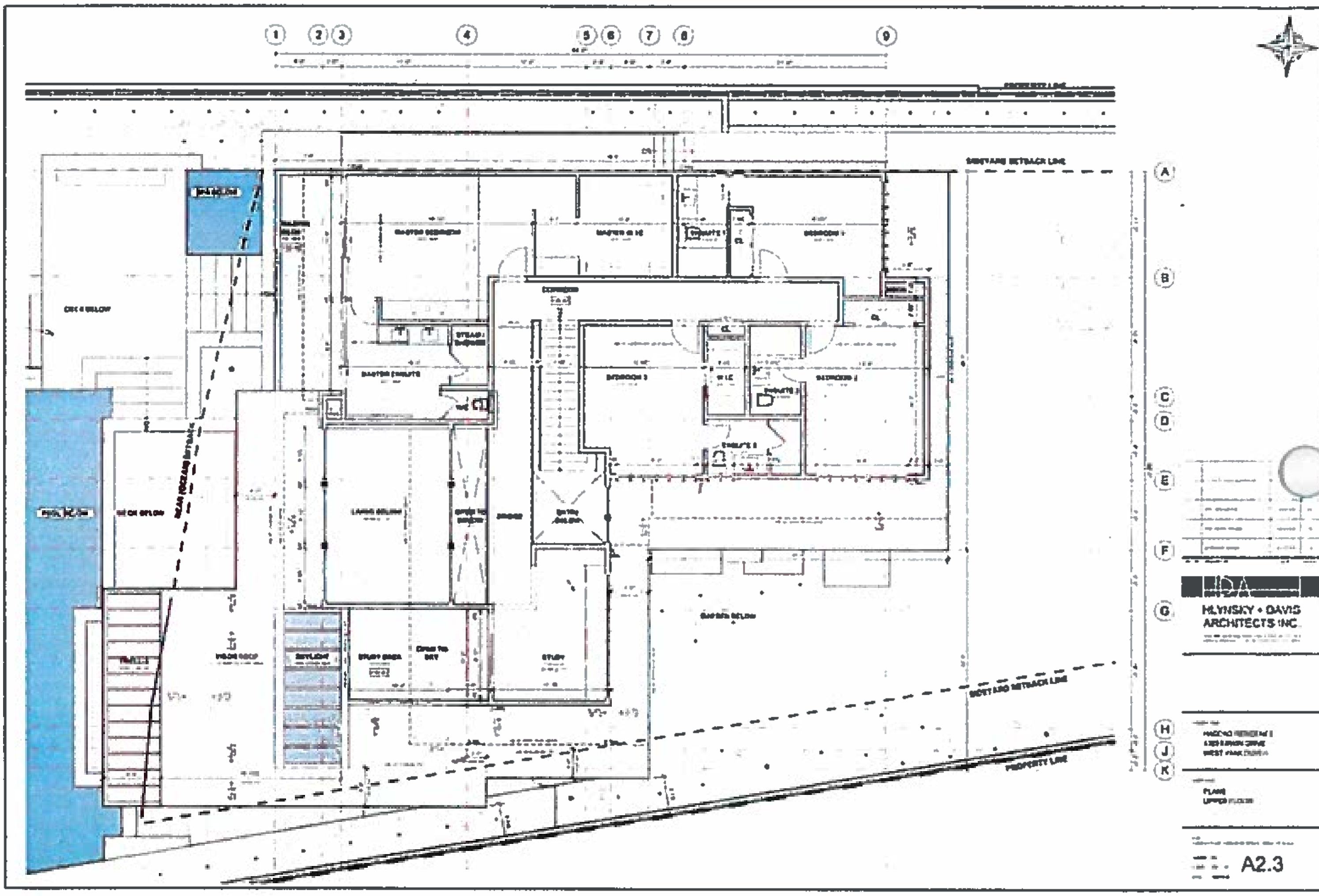
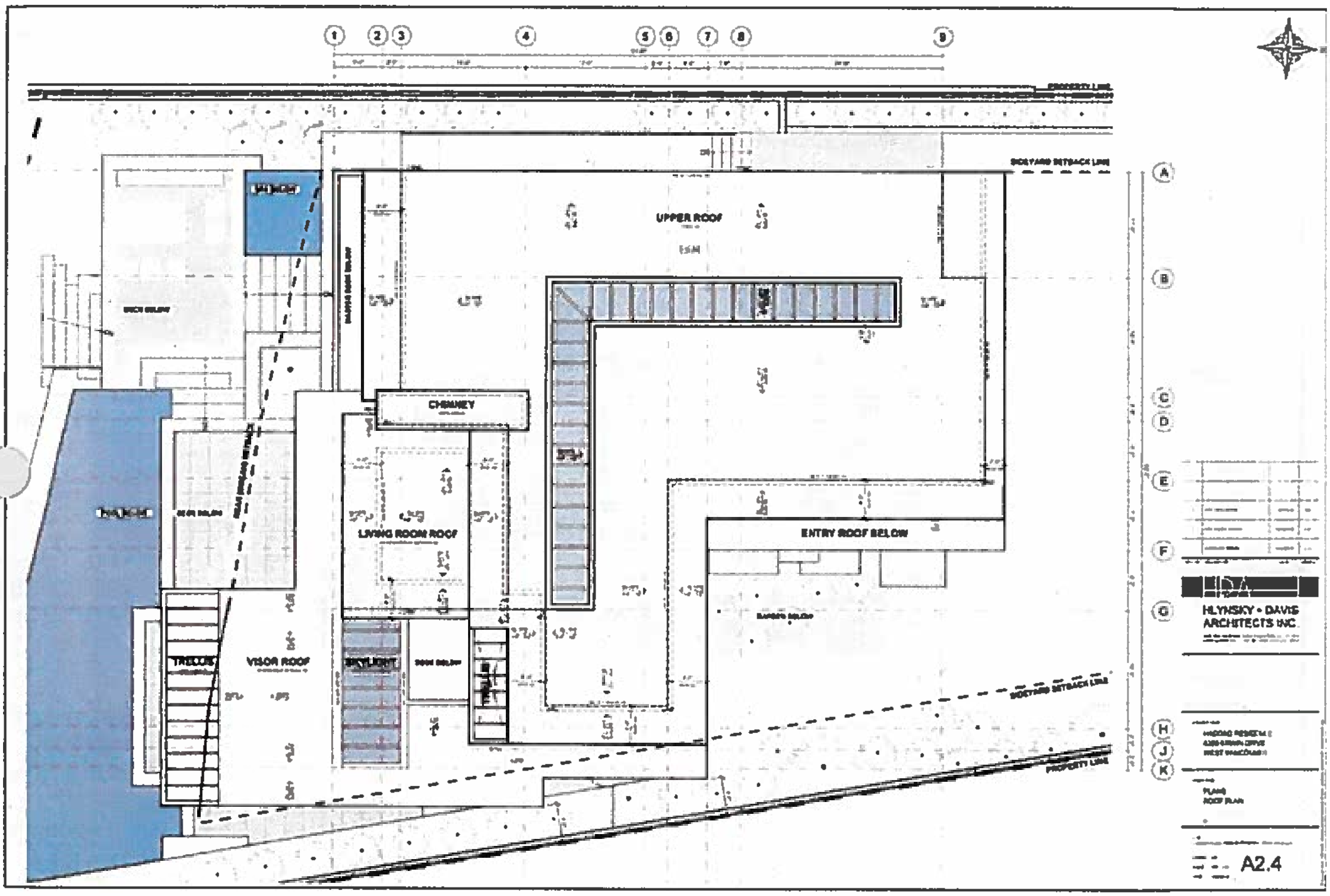
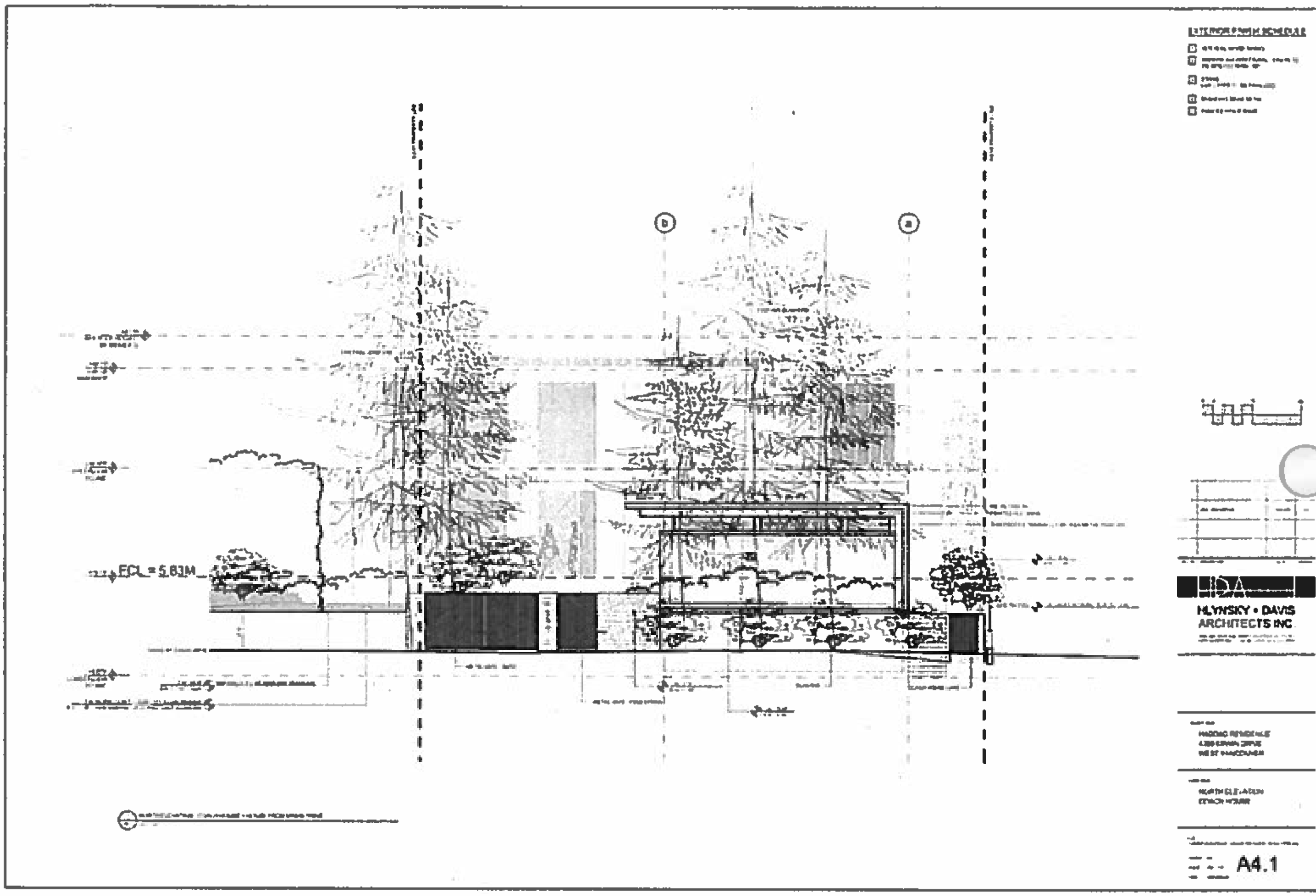
B
C
D
E
F
G
H
J
K
PROPERTY LINE
SIDEYARD SETBACK LINE
SPA
POOL
DECK
GARAGE
MUD ROOM
CLOSET
ENTRY
KITCHEN
DINING
LIVING
FAMILY
GARDEN
DRIVEWAY
HLYNSKY + DAVIS
ARCHITECTS INC.
PLANS
MAIN FLOOR
A2.2


HLYNSKY + DAVIS
ARCHITECTS INC.
PLANS
UPPER FLOOR
A2.3


UPPER ROOF
CHIMNEY
LIVING ROOM ROOF
ENTRY ROOF BELOW
TRELLIS
VISOR ROOF
SKYLIGHT
TRELLIS
SIDEYARD SETBACK LINE
PROPERTY LINE
HLYNSKY • DAVIS
ARCHITECTS INC.
A2.4



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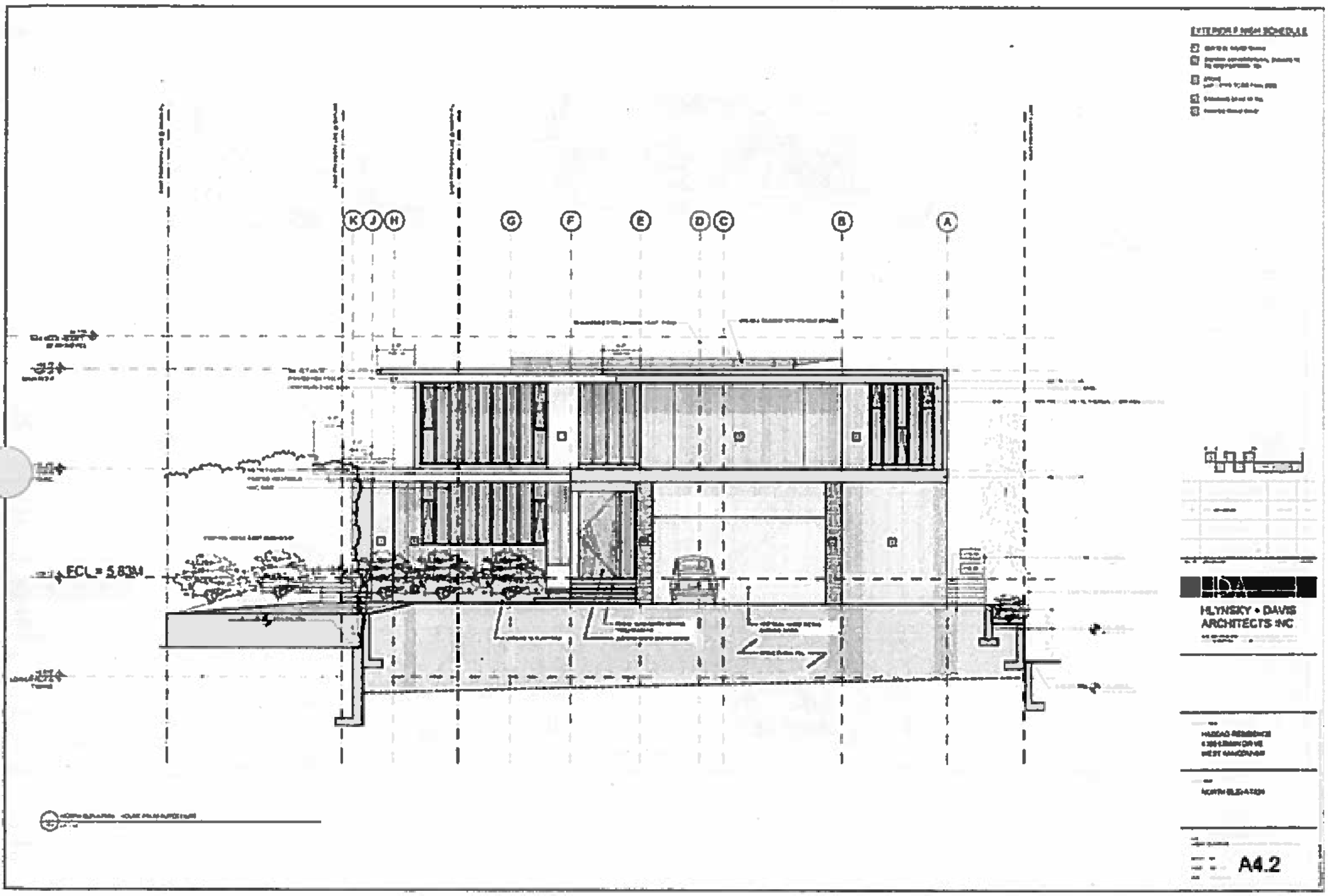
HLYNSKY • DAVIS
ARCHITECTS INC
A4.1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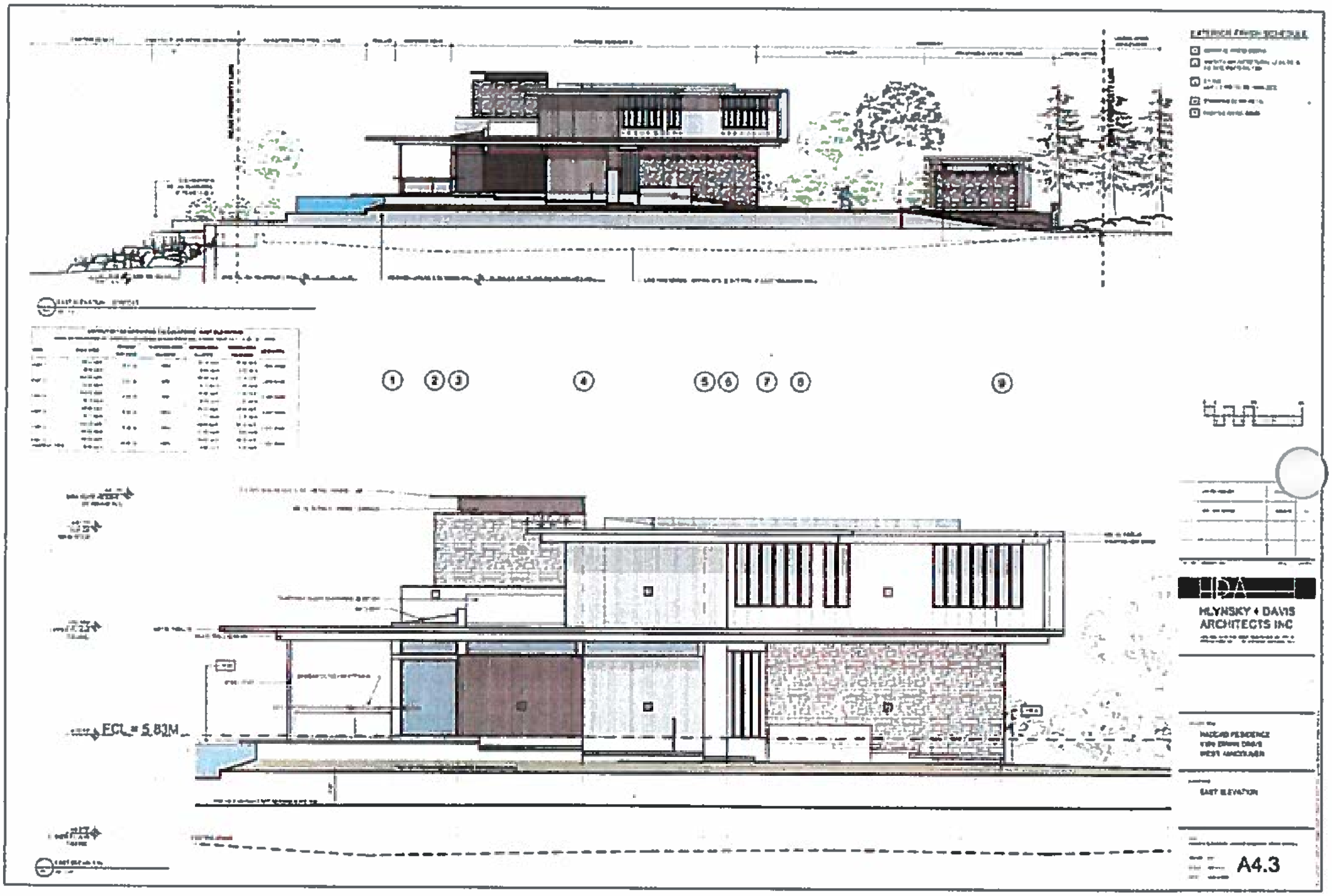
ARCHITECTS INC
A4.2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ARCHITECTS INC
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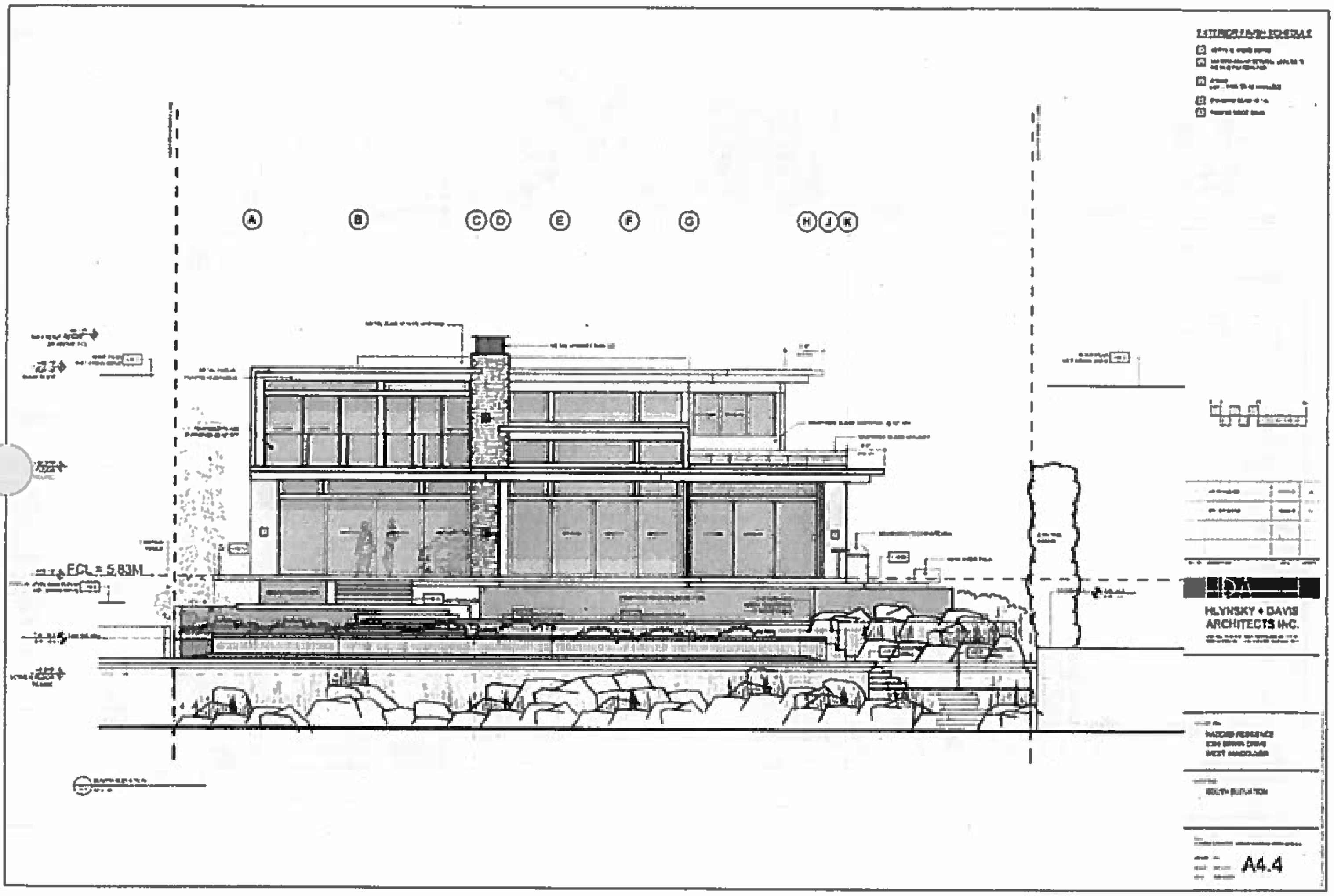
A
B
C
D
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G
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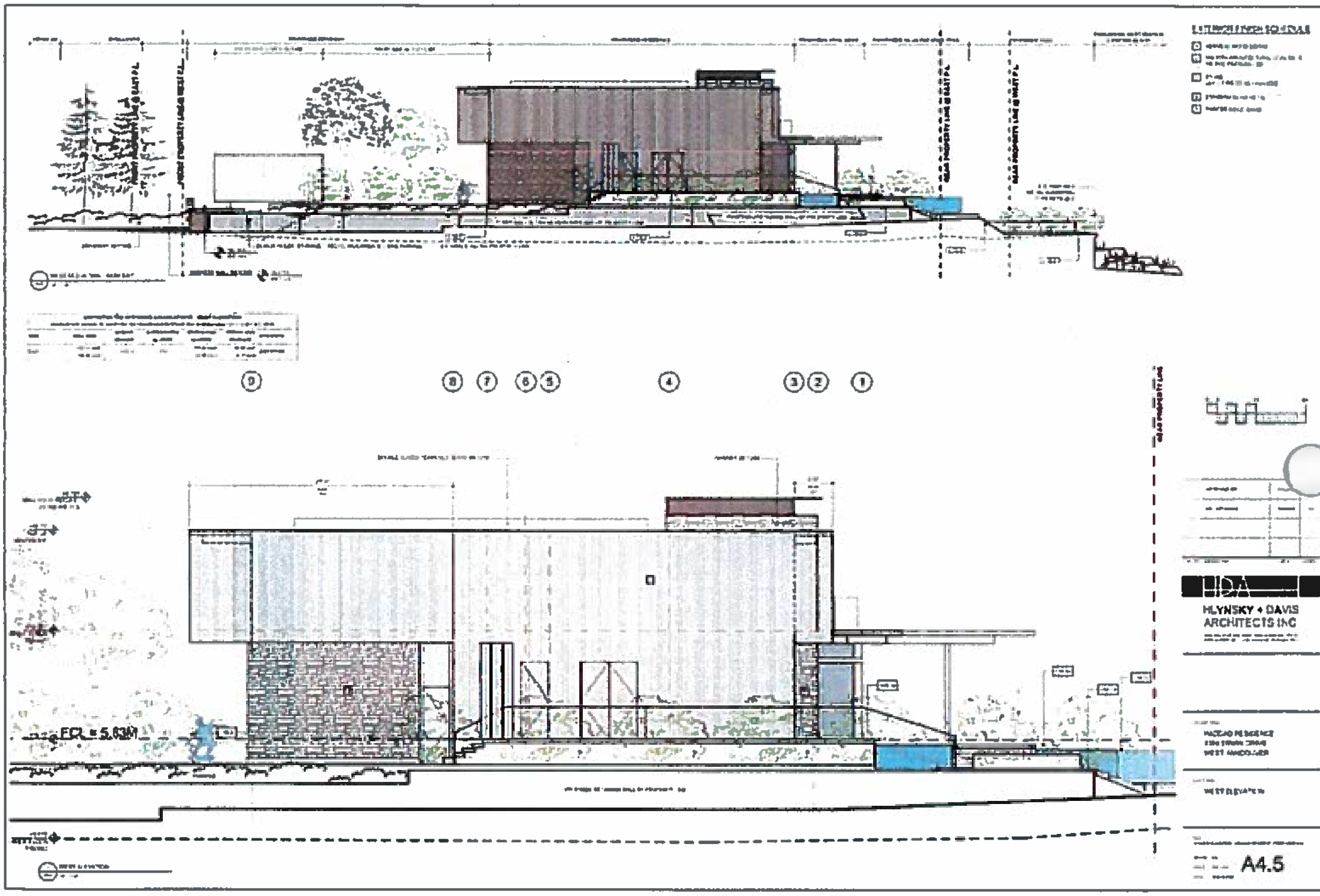
J
K
ECL = 5.83M
HLYNSKY + DAVIS
ARCHITECTS INC.
A4.4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ARCHITECTS INC
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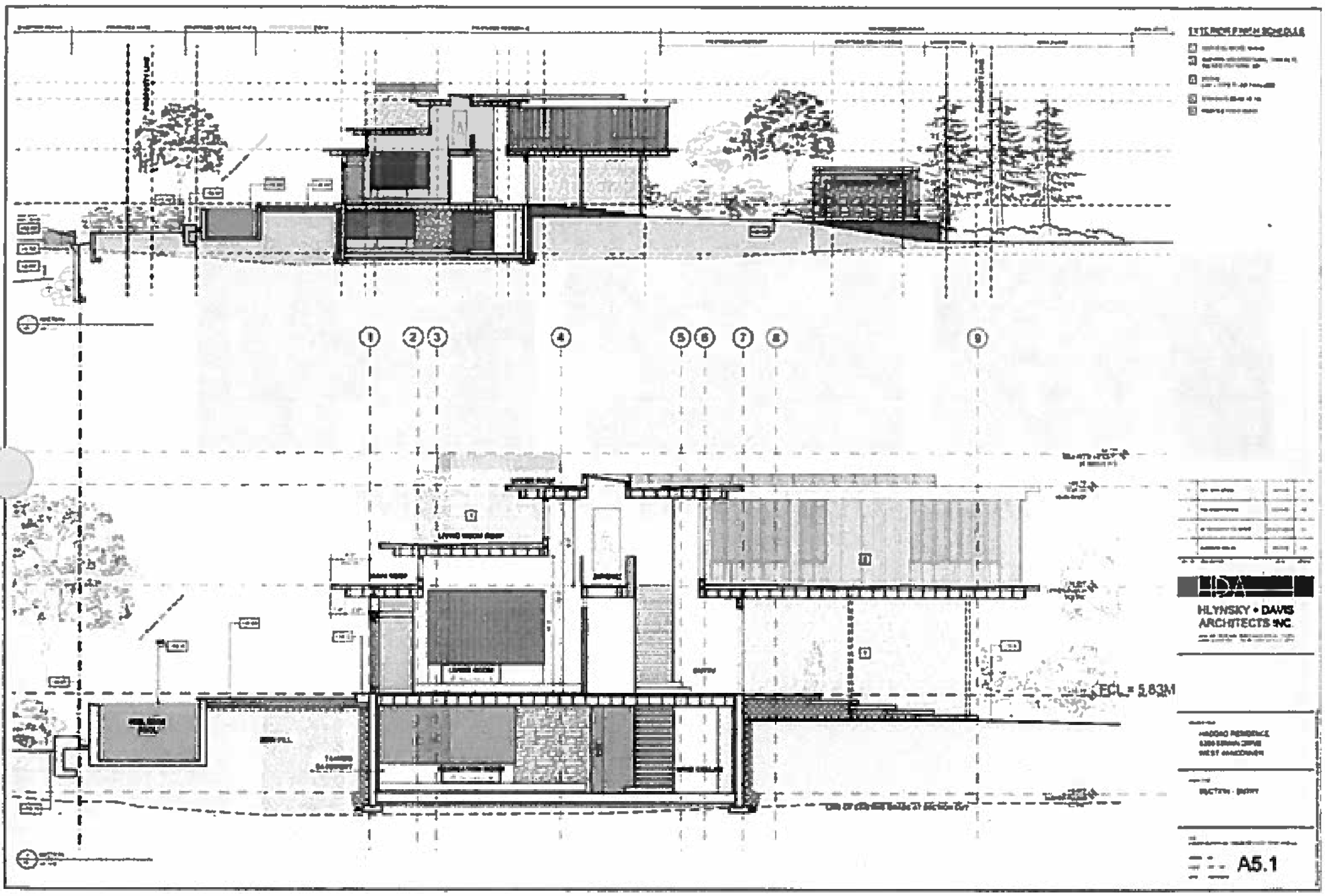


HLYNSKY • DAVIS
ARCHITECTS INC
FCL = 5.83M
A5.1

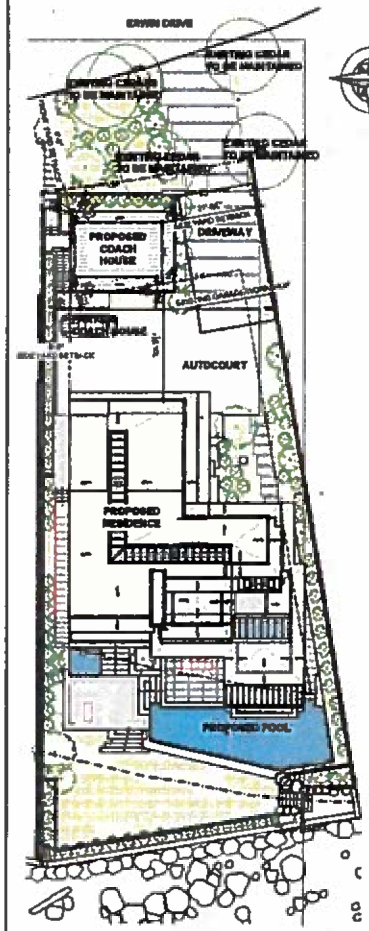
HADDAD COACH HOUSE   4369 ERWIN DRIVE

HLYNSKY + DAVIS
ARCHITECTS INC

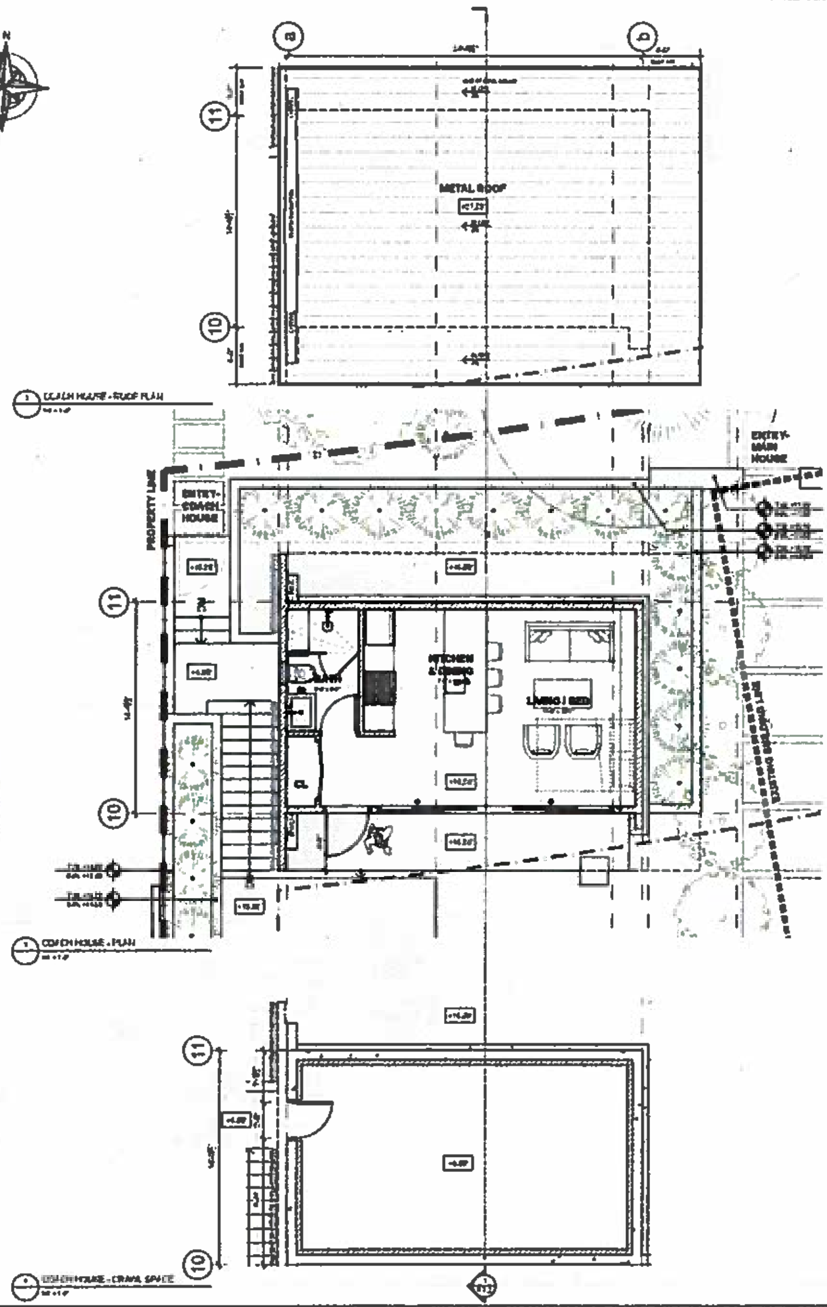
HADDAD RESIDENCE
4369 ERWIN DRIVE
WEST VANCOUVER

COACH HOUSE
RENDERS

A7.0



COACH HOUSE - CONTEXT PLAN



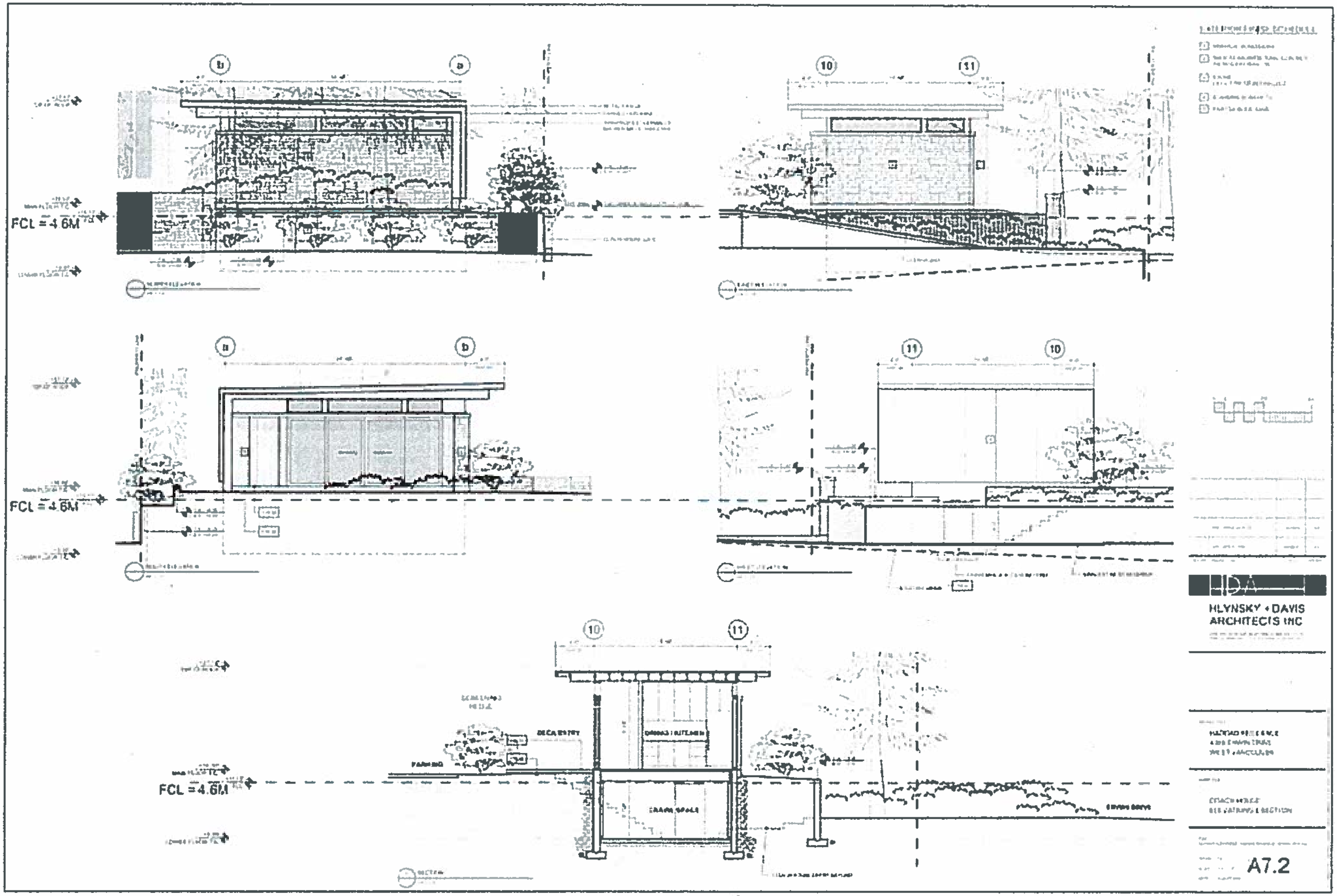
COACH HOUSE STATISTICS

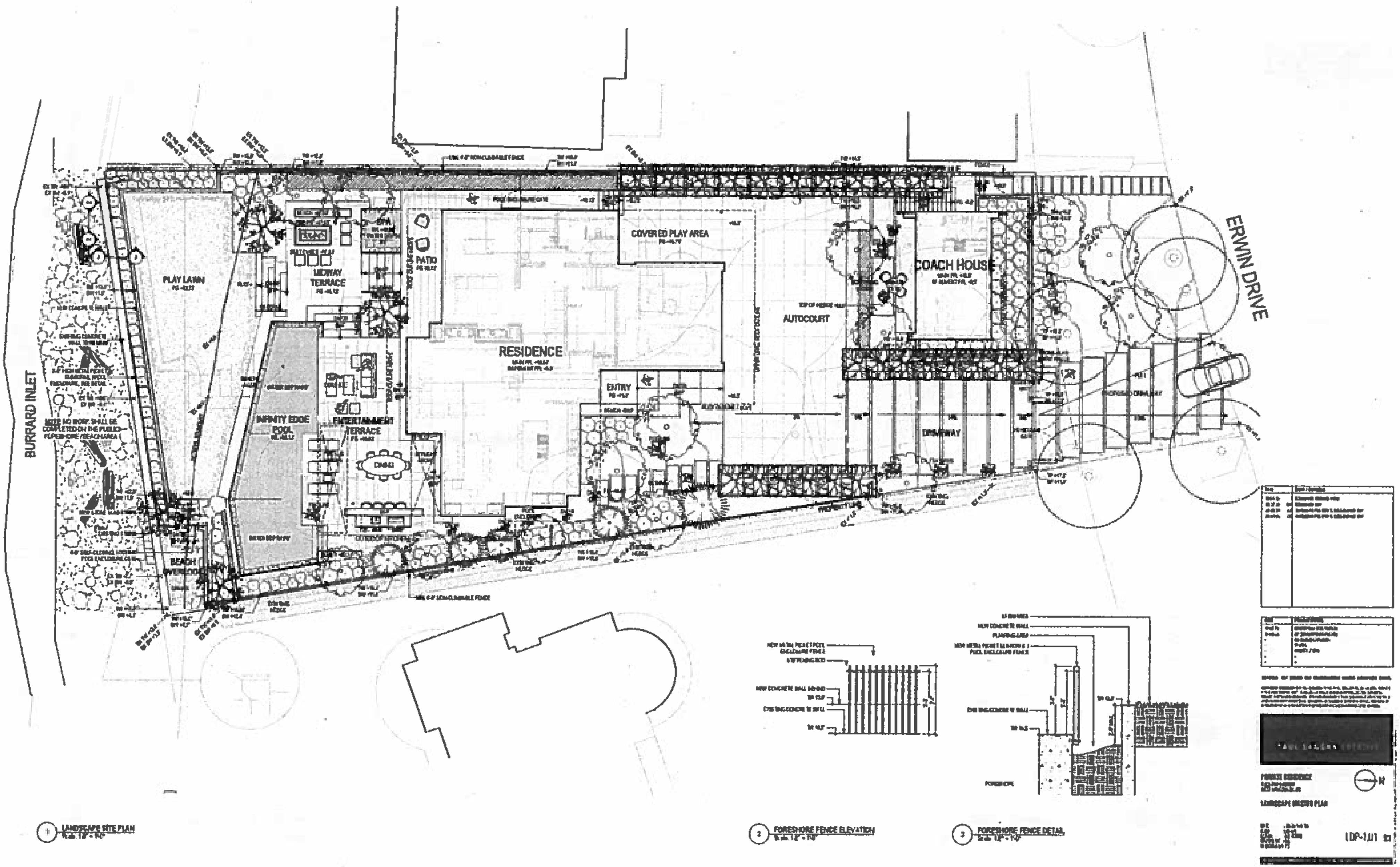
HLYNSKY + DAVIS ARCHITECTS INC.

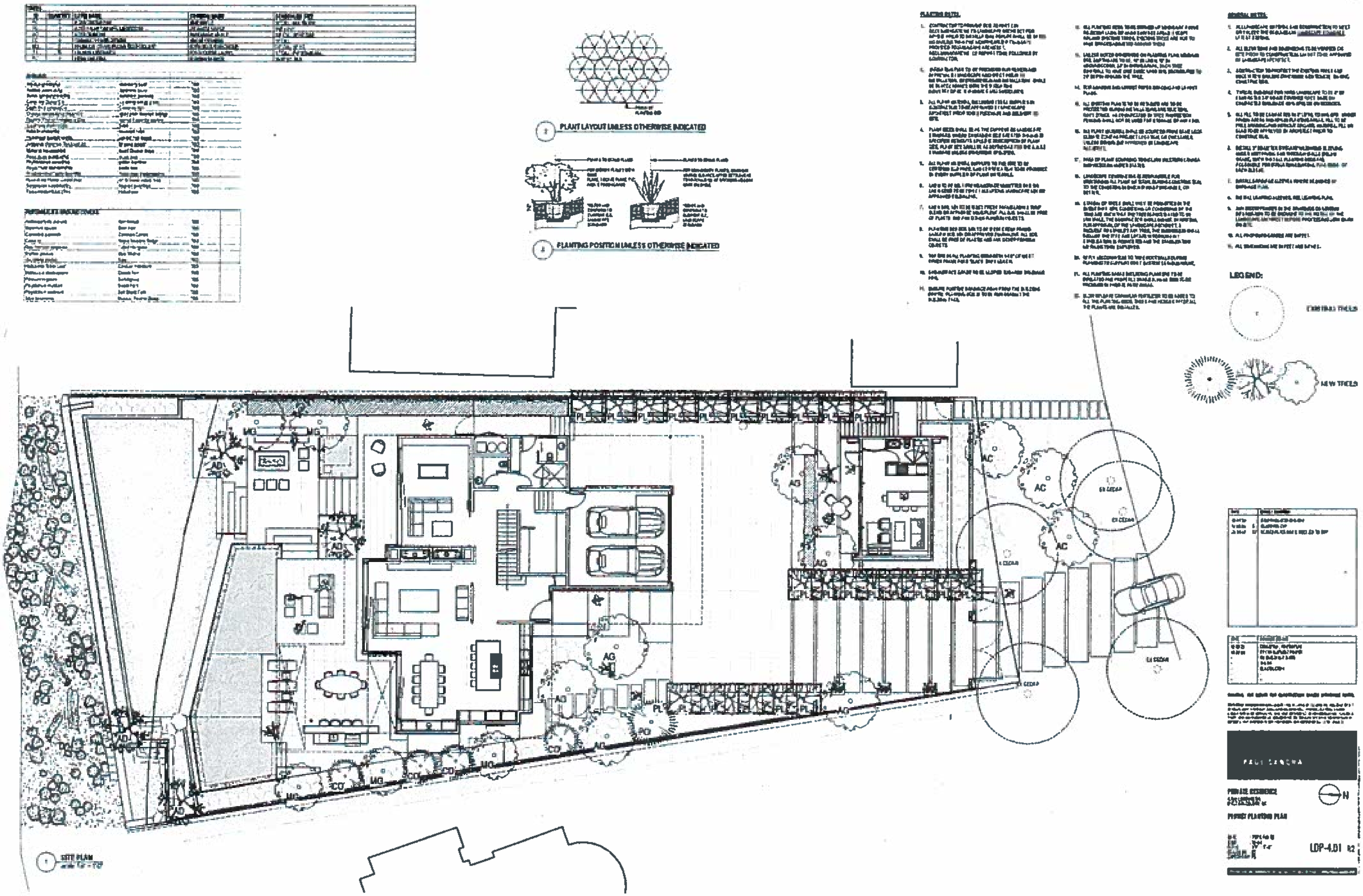
HADDAD RESIDENCE
4388 ERWIN DRIVE
WEST VANCOUVER

COACH HOUSE PLANS

A7.1


FCL = 4.6M
FCL = 4.6M
FCL = 4.6M
HLYNSKY + DAVIS
ARCHITECTS INC
A7.2


BURRARD INLET
ERWIN DRIVE
PLAY LAWN
MIDWAY TERRACE
SPA
PATIO
RESIDENCE
COVERED PLAY AREA
AUTOCOURT
COACH HOUSE
ENTRY
INFINITY EDGE POOL
ENTERTAINMENT TERRACE
BEACH OVERLOOK
DRIVEWAY
LANDSCAPE SITE PLAN
FORESHORE FENCE ELEVATION
FORESHORE FENCE DETAIL
LDP-1.01


PLANTING NOTES:
GENERAL NOTES:
PLANT LAYOUT UNLESS OTHERWISE INDICATED
PLANTING POSITION UNLESS OTHERWISE INDICATED
LEGEND:
EXISTING TREES
NEW TREES
AG
AC
AD
MG
CO
PL
SITE PLAN
N
LDP-4.01 R2