HEROLD ENGINEERING LIMITED
Consulting Structural Engineers

202 - 572 Stewart Ave., Nanaimo, B.C. V9S 5T5
Tel: (250) 741-8551 Fax: (250) 741-8553

P98-320

May 28, 1998

Drillwell Enterprises
4994 Polkey Rd
Duncan, BC V9L 4T8

Dear Mr. Slade

Re: Cowichan Bay Fire Improvement District
Fire Hall Seismic Assessment

Further to our recent telephone conversation, Herold Engineering Limited is pleased to provide the following fee quotation for siesmic reiview of the above mentioned structure.

It is our understanding that the building is of concrete block masonry and wood frame construction. The masonry portion of the building surrounds the truck bays with the remainder being two storey wood frame. The building was constructed 20-25 years ago.

Herold Engineering Limited will complete an on site inspection of the structure to ascertain an approximate siesmic capacity. Herold Engineering will identify areas of probable weakness and to make recommendations with respect to possible upgrade options.

We propose to complete our services on an hourly rate basis up to a maximum upset limit of $500.00 for the inspection and preparation of the report. Original structural drawings for the building if available would be of great use in generating our conclusions.

We trust the above to be in order and look forward to assisting you in this matter. Please note if original structural drawings are available, an in-office review of the drawings could be made. This option would be more economical as inspection and travel time would not be required. Please contact the undersigned if you have any questions on this proposal.

Yours truly
HEROLD ENGINEERING LIMITED

per Pamela Pilkington

Brian McClure, P. Eng.

BMc/prp

Benjamin Bryce Levinson, **Architect & Planners**
1248 Fort Street, Victoria, B.C., Canada V8V 3L2 Ph. (250) 382-5125 Fax (250) 380-3999
email: levinson@vanisle.net website: www.tcel.com/~levinson/architect/

September 10, 1999

Cowichan Bay Fire Department
4461 Trans-Canada Highway
Cowichan Bay, BC
V0R 1N0

Attention: Chief Robert Claus

Dear Sirs:

Re: Inspection and preliminary report for Post-Disaster Upgrade Cowichan Bay Fire Hall 4461 Trans-Canada Highway

Further to our telephone conversation of September 7, 1999, we herewith enclose our proposal for the above-noted project.

Our work will include:

1. Inspection of premises by registered Architect.

2. Inspection of premises by Structural Engineer.

3. Interviews with:
   - Fire chief
   - Police Chief
   - Building Department representative

4. Review of B.C. Building Code in relation to Fire Hall.

5. Review of existing drawings and equipment files.

6. Inspection Report by Architect, including:
   - Mechanical proposal depending on directions
   - Electrical proposal, depending on directions

7. Inspection Report by Structural Engineer re: structural aspects

8. Business plan for future of Fire Hall with options for various levels of upgrade:
   - 5-year - short term upgrade, collapse prevention with preliminary estimated costs
   - 10-year - major construction renovation proposal with preliminary estimated costs
   - 20-year - direction and proposal for meeting post-disaster criteria with preliminary estimated costs

Our fee:	Architectural	**$2,000.00 + GST**
	Structural Engineering	**$2,000.00 + GST**
		+ Reimbursables
	If review of a business plan is required as per #8 above	**$1,000**

If you have any questions or require clarification on our services, please do not hesitate to contact us.

Yours truly,

Ben Levinson, MAIBC

Enclosures: brochure and outline of experience

SCHEDULE "A"

Our experience for upgrading buildings to meet new code standards include:

- Preliminary Feasibility Study, St. Ann's Academy
- Preliminary Feasibility Study, Lampoon Street School
- Inspection of hundreds of buildings on Vancouver Island and elsewhere in B.C.

- code upgrade reviews for commercial buildings
- Saanich Fire Hall #3, University of Victoria, Saanich
- Saanich Fire Hall #2
- Central Saanich Fire Hall
- Shawnigan Lake Fire Hall
- Humboldt Street Ambulance Building upgrade
- Naval Officer Training Center Design Building Drawings and Specifications

Cowichan Bay Improvement District

Cowichan, BC

Preliminary Seismic Review of Cowichan Bay Volunteer Fire Rescue Centre

HEROLD ENGINEERING

Prepared For:	Prepared by:
Cowichan Bay Improvement District 4461 Trans-Canada Highway Cowichan Bay, BC V0R 1N0 Attn: Dave Ferguson, Administrative Assistant	Herold Engineering Limited 3701 Shenton Road Nanaimo, BC V9T 2H1
Submitted: DRAFT November 21, 2016	Project No. 4032-001

DRAFT

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1. Introduction

Cowichan Bay Improvement District requested that Herold Engineering Limited provide a seismic review of the Cowichan Bay Fire Rescue Centre. The purpose of this review is to establish the expected performance of this building in a code level seismic event and make recommendations for possible upgrading work that may be necessary.

Lee Rowley P.Eng. met with representatives from the Board of Trustees on the 28th of September, 2016 to discuss the expected outcomes of this report. Key items agreed were as follows:

- The review would be done using the most recent code available, which is the 2015 National Building Code (NBC). This has significantly higher seismic values than the present 2012 British Columbia Building Code (BCBC). The BCBC typically adopts the NBC seismic requirements but will not be replaced until next year at the earliest. However to make the report relevant to the possible time of construction, the newer code was chosen as the basis of the report.

- The report will look at several options including:
    - The practicality of upgrading the building to meet the Post Disaster requirements of the NBC.
    - The requirements for upgrading the building to meet the some of the Post Disaster requirements of the NBC.
    - The requirements to upgrade the building to meet the Life Safety Requirements of the NBC.

- The review will look at the opportunities the recent Energy Audit Report by City Green Solutions provides to combine seismic upgrading with energy saving work such as adding a new building envelope.

- Provide capital-planning options for discussion by the board, making recommendations for next steps.

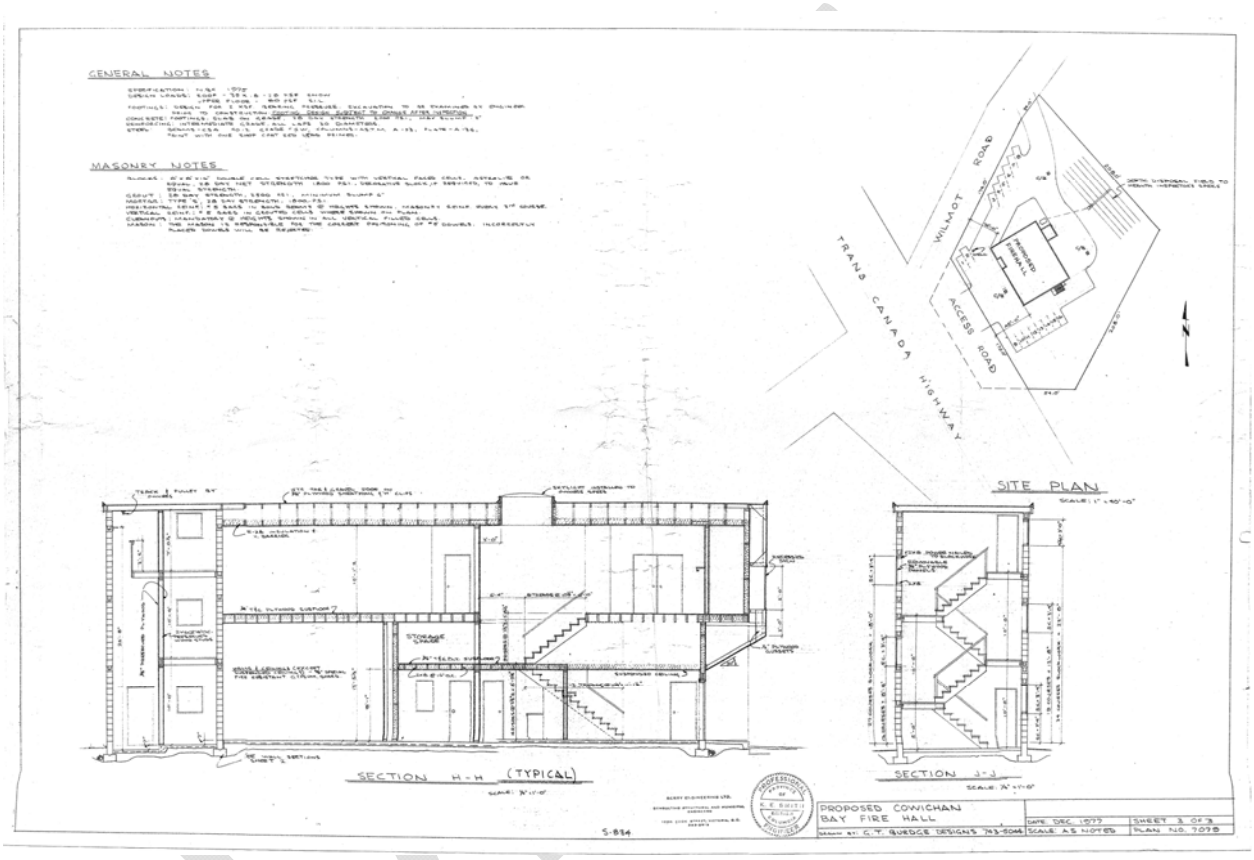
2. Building Description

The building was designed in 1977 and sealed structural drawings were made available for review. The building was designed to the National Building Code of 1975 as a fire hall and appears substantially unchanged since construction.

The building is a two-storey structure of approximately 860m^2 and comprises a three bay apparatus bay, storage and offices at the main level. On the second floor is meeting, kitchen and function space. On the rear elevation is an attached hose tower, which extends up to the same height as the main building.

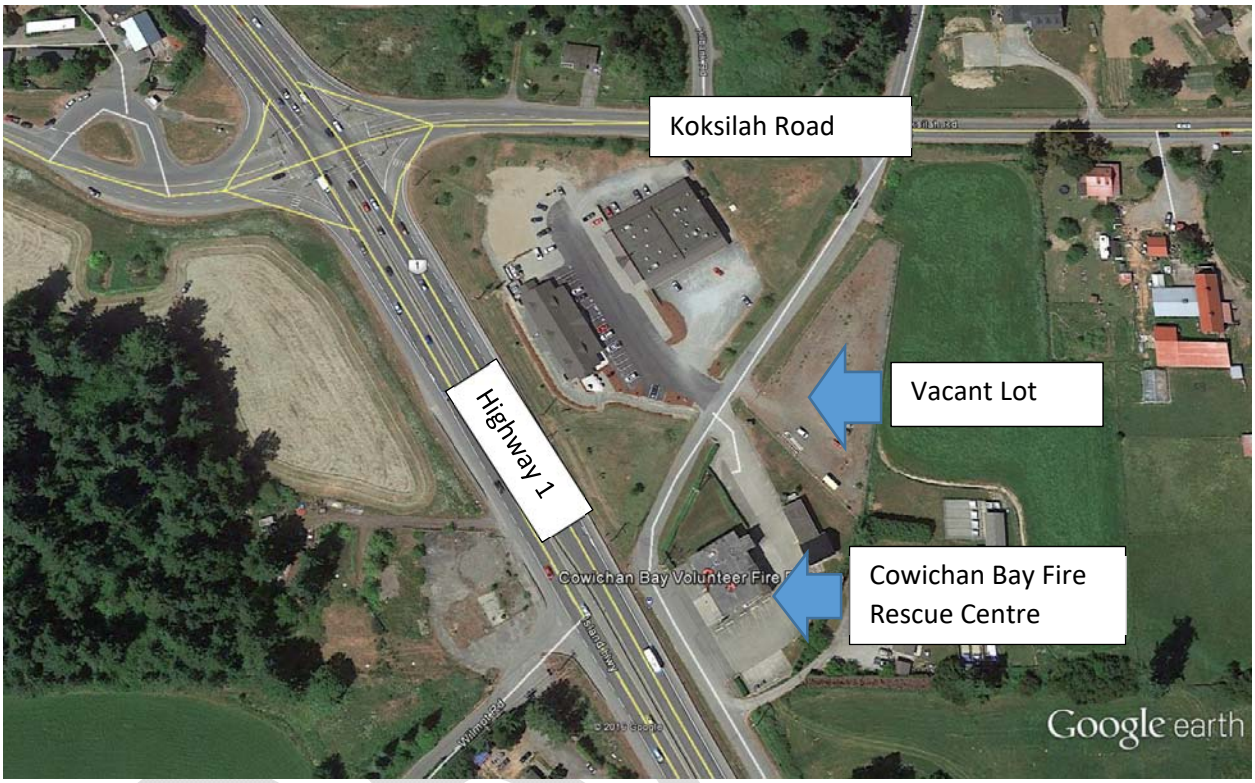
The apparatus bay is constructed in masonry with a post and beam steel structure supporting the wood floor above. The hose tower is constructed in masonry and is built to the rear of the apparatus bay. Adjacent the apparatus bay is the wood frame storage and office areas also supporting a wood floor above.

The second floor comprises 2x12 floor joists spanning over the post and beam frames in the apparatus bay and the 2 x 6 stud walls in the administration and storage areas. Walls at the second floor are 2 x 6 studs, which support parallel-chord timber roof trusses. The exterior walls, floor and roof are sheathed in 3/8" plywood.



3. Building location

The building is located near the intersection of Highway 1 and Koksilah Rd approximately 5 Km south of Duncan. There is a vacant lot to the rear of the site, which could be used for replacement fire hall if so desired.



4. Seismic Performance of Existing Building

We have performed a desk top review based on the original 1977 drawings. In the 1975 NBC some consideration of seismic detailing was required. We have reviewed the performance of various elements of the building relative to the 2015 NBC way of comparison.

Three code related options were considered:

1. Life Safety – Normal Occupancy
2. Post Disaster – Full Code Compliance (Rd = 2.0)
3. Post Disaster – Partial Code Compliance* (Rd = 1.5)

For option 3: the building is designed for the strength needed for post disaster but not the ductility. In this case, although the detailing requirements are much simpler the applied loads are increased.

Our findings are as follows:

Main Floor Masonry Structure

The 197 masonry code required minimum reinforcing for seismic loads. This is shown on the drawings. Using the reinforcing arrangement and material strengths indicated on the drawings we have found the following:

In the north-south direction there is very little seismic resistance provided by the masonry piers separating the apparatus bay doors. Some resistance could be provided by the adjacent wood frame structure however, it is unlikely that the two sections are adequately connected together. We estimate in this direction there is resistance ranging from 5% to 10% of NBC 2015 seismic requirements for life safety and post disaster occupancies.

In the east-west direction, the masonry walls are longer and have greater capacity. The walls meet the life safety requirements of the NBC 2015. However, the walls only meet the 73% of Post Disaster requirements and do not have the required ductility to meet code.

The floor diaphragm comprises wooden floor joists overlaid with plywood sheathing. The sheathing is 68% of the NBC 2015 life safety requirements and 45% of the NBC 2015 post disaster requirements.

Second Floor Wood Frame Structure

We have assumed only the stud walls bearing on the masonry walls are actually carrying seismic loading, as they are the most direct route to the foundations. Based on this the walls running above the apparatus bay doors have resistances ranging from 5% to 10% of NBC 2015 seismic requirements for life safety and post disaster occupancies.

In the east-west direction less windows are present there are higher resistances but the floor diaphragm comprises wooden floor joists overlaid with plywood sheathing. The sheathing is 47% of the NBC 2015 life safety requirements and 31% of the NBC 2015 post disaster requirements.

Foundations

No geotechnical report was provided for this review. An allowable bearing pressure for the soils was given on the drawings as 2000psf or 100kPa. For the analysis and estimated Ultimate Bearing of 200kPa was assumed and a site class D. All assumptions require verification for the purposes of detailed design.

Foundations appear to be shallow strip footings and are likely the governing factor in the reduced seismic resistance of the masonry walls in the north south direction. The mode of failure is rocking of the masonry piers, between the apparatus-bay door openings.

In the east west direction, the masonry walls are longer and so rocking is less likely to be an issue. However, the ultimate bearing pressure capacity of the soil may govern the capacity of the walls. This will need checking as part of a more detailed seismic review.

Connectivity and Load Path

Due to the age of the building, attention to detailing of building connections for seismic loading will not be adequate. For example the attachment of the roof trusses to the stud walls will only be designed for significantly lighter wind forces. The following connections require upgrading:

- Roof diaphragm and trusses to top of stud walls.
- Floor Diaphragm to masonry and stud walls.
- Second floor stud walls to masonry walls.
- Second floor stud walls to first floor stud walls.
- Masonry and stud walls to foundations.

Summary of Building Lateral Resisting System Capacity (north-south direction)

Element	% of NBC 2015		
	% of Life Safety: Rd = 1.5	% of Post Disaster: Rd = 2.0	% of Post Disaster: Rd = 1.5
Roof Diaphragm	47%	42%	31%
2nd Floor Walls	5%	7.5%	10.0%
Floor Diaphragm	68%	60%	45%
1st Floor Walls	5%	7.5%	10.0%
Foundations	5%	7.5%	10.0%

Summary of Building Lateral Resisting System Capacity (east-west direction)

Element	% of NBC 2015		
	% of Life Safety: Rd = 1.5	% of Post Disaster: Rd = 2.0	% of Post Disaster: Rd = 1.5
Roof Diaphragm	32%	28%	21%
2nd Floor Walls	5%	7.5%	10.0%
Floor Diaphragm	46%	40%	30%
1st Floor Walls	136%	97%	90%
Foundations	TBD	TBD	TBD

Note these are based on preliminary calculations only and require verification by more detailed study.

5. Upgrading Options

Based on the findings above it is easy to conclude that the building requires a seismic upgrade. It is particularly weak in the east west direction due to the apparatus bay doors.

We can categorize the options as follows:

- No upgrade
- Upgrade to Life Safety requirements of Code.
- Upgrade to full Post Disaster Compliance of Code
- Upgrade to Strength only requirements for Post Disaster

No Upgrade

There is a high likelihood of a seismic event occurring near or on Vancouver Island in the next 50 years. Therefore, as this is a critical piece of infrastructure needed in such an event some mitigation of the risk to this buildings function should be considered. This could be a new building, a seismic upgrade or a change of location or function.

Life Safety

A life safety upgrade is for normal occupancy suitable for an administrative or general assembly type space. Note that this is lowest level of upgrade recommended.

Percentages of code less that 100 percent are allowed down to 60% in certain jurisdiction however, we recommend that 100 percent should be strived for where possible.

In this case, the scope of a 60 percent upgrade would be similar to a 100 percent upgrade as the same elements would still need to be upgraded.

Full Post Disaster Compliance

To achieve full compliance for the Post Disaster Requirements of the Code not only does the building have to resist higher seismic loading but also the detailing and construction requirements are far more restrictive.

With the masonry portion of the building these detailing requirements will require replacement with or the addition of, lateral resisting elements that fully comply with the today's standards.

With the wood frame elements the shear walls, roof and floors will require extensive blocking requiring removal and replacement of the exterior plywood or the interior drywall surfaces.

This would be a very expensive solution approaching the replacement value of the fire hall. We can investigate this option further if requested to do so, however at this time it is considered the most costly option of the four discussed in this report.

Post Disaster Upgrading for Strength (Rd = 1.5)

This is fundamentally the same as the Life Safety Retrofit however the building is designed for 1.5 more loading.

Due to low ductility of the elements in the building, more damage is likely to occur during a NBC 2015 sized event than the full Post Disaster Upgrade. This is because the detailing is not as good as dissipating the energy of the earthquake. This is a result of the lack of ductility in isolated structural members required to dissipate seismic energy through deformation and yielding.

However, for smaller earthquakes the stronger design will mean the building will resist damage well.

This is considered the second most cost effective upgrade for the building.

6. Combining Seismic Upgrading with a Building Envelope Project

Combining a building envelope upgrade does save costs rather than doing the work separately. However the costs savings are not significant. What it does avoid is doing elements of work twice, especially if the envelope work is after the seismic upgrade.

Ideally, the seismic upgrade is done before the envelope upgrade, if available, funding means only one scope of work can be done at a time. Doing this first avoids redoing elements of the building envelope in order to do the seismic upgrading work later.

We have reviewed the City Green Solutions Energy Audit report dated March 11, 2016 and identified that the biggest overlap of scope which is the recommendation to provide exterior insulation and cladding to the Apparatus Hall. This would allow exterior areas of blockwork to be upgraded and covered for aesthetic reasons.

In addition, recommendations for insulating the wood frame walls and roof were also made. Blown-in insulation was suggested as a solution that did not require the ceiling drywall or roof/floor sheathing to be replaced. As the upgrade would involve installing blocking on the plywood panel edges in the shear wall and diaphragm locations, the framing will need to be exposed. The blocking may also make blown-in insulation difficult to do and so batt insulation or surface applied rigid insulation may be easier to install.

7. Capital Planning Considerations

With the variety options for upgrading and their cost, other options may be worth considering further. Some options are listed below with some advantages and disadvantages for discussion. Note costs are construction only. Project costs are typically upwards of 1.25 x construction costs:

Option 1

Full post disaster upgrade: Fire hall remains in service with minor repairable damage

Advantages

1. Building remains in service and performs well during a major seismic event

Disadvantages

1. Other systems with the possible exception of building envelope remain unchanged.
2. Operational costs remain the same. Unless energy efficiency measures taken.
3. Expensive. Budget construction cost $2500/m^2 (approximately $2,150,000).

Option 2

Post Disaster Equivalent Upgrade: Continue use as a fire hall with minor damage due to poor detailing.

Advantages

1. Building remains in service and performs well during a major seismic event.

Disadvantages

1. Other systems with the possible exception of building envelope remain unchanged.
2. Operational costs remain the same. Unless energy efficiency measures taken.
3. More repairs likely after the earthquake.
4. Expensive. Budget construction cost $2000/m^2 (Approximately $1,720,000).
5. Temporary Fire Hall required during construction.

Option 3

Life Safety Upgrade: Building is safe but likely damaged needing significant repair.

Advantages

1. Building keeps occupants safe.
2. Still can function as a community facility.
3. Lowest cost upgrading option. Budget construction cost $1,500/m^2 (Approximately $1,290,000).

Disadvantages

1. Doesn't function as a fire hall after the event.
2. Operational costs remain the same. Unless energy efficiency measures taken.

3. Possibly cannot get vehicles out of bays.
4. Possible need to demolish building after the earthquake.

Option 4

Demolish Fire hall and Build New purpose built facility to provide same level of services.

Advantages

1. A brand new fully code compliant facility.
2. Energy efficient with low operating costs.

Disadvantages

1. Requires a new site (adjacent lot is available).
2. Costs. Budget construction cost $3,500/m^2. Code will likely require a bigger building. Budget construction cost of $3,600,000.

Option 5

Keep and upgrade old hall to life safety and build new smaller hall nearby.

Advantages

1. New hall that is post disaster compliant.
2. New hall is energy efficient.
3. Keeps community functionality in upgraded structure.

Disadvantages

1. Two facilities to maintain and operate.
2. Costs. Allowing for a simple fire hall of pre-engineered or wood construction of similar area as the ground floor of the existing hall at $2500/m^2. Budget construction cost of $1,290,000 plus $1,075,000 for the new hall is $2,365,000.

8. Conclusion and Recommendation

The new 2015 National Building Code highlights a significant increase in seismic knowledge of the Vancouver Island Region. As such seismic design criteria have been increased significantly.

The current fire hall (although well-built and in good condition) is at significant risk of damage in a seismic event. In a code level seismic event partial collapse is a possibility.

We would therefore recommend some form of seismic mitigation be performed. We have outlined five tentative options for consideration.

To summarize:

The lowest operational cost solution is a new fire hall, however this has the highest capital cost (Option 4).

The lowest capital cost solution is a life safety upgrade, however the operational costs remain high and the fire hall would likely be out of service following an earthquake (Option 3).

The post disaster upgrades (options 1 and 2) have high construction costs and high operational costs.

Option 5 is a compromise solution that provides the fully code compliant fire hall facility at the lowest cost. It also allows phasing of the project for budgeting purposes with the new hall being Phase 1 and the seismic upgrading of the existing hall Phase 2.

9. Closing Comments

We trust the information contained within this report satisfies your current requirements.

Should you have any comments, questions or concerns, please do not hesitate to contact the undersigned.

Please refer to the attached Schedule 1c for liability.

Yours truly,

HEROLD ENGINEERING LIMITED

Prepared By:

Lee Rowley P.Eng.

3701 Shenton Road, Nanaimo BC V9T 2H1
mail@heroldengineering.com
(250) 751-8558

Payment

The Client will pay Herold Engineering the fees as described in the proposal plus all applicable taxes and duties including without limitation the Goods and Services Tax (GST) as applicable. In addition to the Services, the Client will also pay for any and all additional services requested of Herold Engineering even if those services are not listed as Services ("Additional Services").

Herold Engineering will submit invoices to the Client requesting payment for that portion of the Services and Additional Services completed to the date of the invoice. The Client agrees to pay the invoice within 30 days of the date of the invoice (the "Due Date"). Invoices unpaid by the Due Date will be charged interest at a rate of 18% per annum from the date of the invoice until paid.

Herold Engineering may, at its sole discretion, suspend the provision of any and all Services or Additional Services in respect to the Project if one or more invoices remain unpaid for more than 60 days from the Date of Invoice.

General Provisions

The Client shall not assign the whole or any part of this Agreement without the express written consent of Herold Engineering. Herold Engineering may assign to subcontractors and agents such part of the Services or Additional Services as Herold Engineering in its sole discretion shall determine. This proposal, if accepted, shall be governed by and construed in accordance with the laws of the Province of British Columbia.

Herold Engineering shall visit the project site at intervals appropriate to the stage of construction as Herold Engineering, in its sole discretion, considers necessary to ascertain whether the contractor is carrying out the work in general conformity with the contract documents.

Obligations of Client

The Client will assist Herold Engineering by providing all available and necessary information that Herold Engineering reasonably requires to provide the Services (or Additional Services). The Client will examine all requests, reports or other documents presented by Herold Engineering relating to the Services and Additional Services and will promptly provide in writing decisions or general instructions pertaining thereto so as not to delay the provision of the Services or Additional Services.

Termination

Herold Engineering may, without prejudice to any other right or remedy it may have, terminate this agreement if:

(a) the Client is in breach of any of its obligation under this Agreement; or

(b) the Client is insolvent or makes a general assignment for the benefit of creditors or if a receiver is appointed; or

(c) Herold Engineering is prevented from performing the Services (or Additional Services) for a period of thirty days or more as the result of an event which is unavoidable and beyond the control of Herold Engineering that includes without limitation an order of a Court or other public authority, a labour dispute, a communication line failure, power failure or any other natural disaster or Act of God.

If Herold Engineering terminates this Agreement under (a), (b) or (c) above, Herold Engineering shall be entitled to be paid for all Services or Additional Services performed to the date of termination. Further, if Herold Engineering terminates this Agreement under (a) or (b) then Herold Engineering is also entitled to receive from the Client an amount that Herold Engineering, acting reasonably, determines is equivalent to the profit that Herold Engineering has lost as a result of not completing all of its Services or Additional Services, as the case may be, under this Agreement.

If Herold Engineering terminates this Agreement under (a), (b) or (c) above the Client releases and discharges Herold Engineering of and from any and all of its obligations under this Agreement.

Confidentiality

Except as may be required to advance or protect the legal interests of the Client or Herold Engineering or as may be required by law, the parties will keep strictly confidential and will not, without the written consent of the other party, disclose to anyone, either before, during or after termination of this Agreement, the information which comes to the knowledge of a party as a result of this Agreement.

Ownership of Documents and Designs

All right, title and interest in and to any products, technology or other intellectual property developed by Herold Engineering in performing the Services or Additional Services pursuant to the terms of this Agreement including without limitation all drawings, designs, reports, working papers, computations, manuals, documentation and documents of every kind (the "Work Product") shall remain the property of Herold Engineering. Provided the Client has completed all of its obligations under the Agreement, the Client shall be entitled to receive copies of the Work Product at the Client's expense. No part of the Work Product may be reproduced or re-used without the express written consent of Herold Engineering.

Liability

Herold Engineering is only liable to the Client for loss and damage that is directly attributable to its negligent acts or omissions (the "Recoverable Loss and Damage") and in the event of a claim for Recoverable Loss and Damage, the Client agrees that the maximum liability of Herold Engineering to the Client, whether in contract, tort or under any theory of liability, is limited to the lesser of: (a) the amount of fees paid by the Client to Herold Engineering on account of Services (or Additional Services) in relation to the Project as of the date the claim is made or (b) if Herold Engineering has insurance coverage that will respond to the claim for Recoverable Loss and Damage (the "Policy"), then the applicable coverage limit of the Policy.

In no event will Herold Engineering be liable for any indirect, incidental, special, consequential or punitive damages as a consequence of any breach by Herold Engineering or the failure of Herold Engineering to satisfy and/or perform, any term or provision of this Agreement and without limiting the generality of the foregoing, Herold Engineering shall not, under any circumstances, be liable for loss or damage resulting from delays in the completion of the Project, or loss of earnings or loss of profits, howsoever caused.

The Client acknowledges that mould, mildew, or other fungus substances that can present health hazards may develop or exist within the constructed buildings (or existing buildings). The Client agrees that Herold Engineering's Services (or Additional Services) specifically do not include Environmental audits, the identification or treatment of asbestos, moulds, fungus, mildew, radioactive materials or other contaminants (the "Environmental Services") and that if the Client wishes to have these Environmental Services completed, the Client will retain a consultant other than Herold Engineering to perform these Environmental Services.

Dispute Resolution

The purpose of this clause is to establish a process whereby any dispute or difference of opinion under or in connection with this Agreement can be resolved in a fair, efficient and cost-effective manner. Both parties shall use their best efforts to resolve any dispute or difference of opinion under or in connection with this Agreement by good faith amicable negotiations on a "without prejudice" basis, and shall provide frank, candid and timely disclosure of all relevant facts, information and documents to facilitate negotiations. If a dispute or difference of opinion is not resolved to the reasonable mutual satisfaction of the parties within 10 Business Days of the commencement of negotiations, or within such longer period as may be agreed to by the parties, the dispute or difference of opinion shall be submitted to mediation. Both parties agree not to make a request for arbitration or to commence litigation without first seeking agreement through the mediation process.

Mediation shall consist of structured, non-binding negotiations with the assistance of a mediator on a "without prejudice" basis. The mediator shall be appointed by agreement of the parties and shall be impartial and free from any actual or apparent conflict of interest. The costs of mediation shall be shared equally by both parties. If the dispute or difference of opinion is not resolved to the reasonable mutual satisfaction of both parties within 30 calendar days of the appointment of the mediator, or within such longer time as may be mutually agreed to by the parties, the dispute or difference of opinion may, upon the mutual written agreement of the parties, be submitted to binding arbitration in accordance with the laws of the Province of British Columbia.

If the parties are unable to agree on the Arbitrator within 7 days, the Arbitrator shall be appointed under the Commercial Arbitration Act, R.S.B.C. 1996, c.55, as amended and the arbitration shall take place in Nanaimo. The decision of the Arbitrator shall be final and binding on the parties. If the parties do not agree to arbitration, each party shall be free to commence litigation without further notice.