KERR WOOD LEIDAL
consulting engineers

Greater Vancouver
200 - 4185A Still Creek Drive
Burnaby, BC V5C 6G9
T 604 294 2088
F 604 294 2090

Technical Memorandum #1

DATE: April 23, 2021

TO: Robyn Holme, RPP, MCIP
Comox Valley Regional District

FROM: Eric Morris, M.A.Sc., P.Eng.
Craig Sutherland, M.Sc., P.Eng.

RE: **Coastal Flood Mapping Project**
Technical Memorandum #1 – Coastal and River Base Map Development
Our File 2623.014-120

1. Introduction

Kerr Wood Leidal Associates Ltd. (KWL) has been retained by the Comox Valley Regional District (CVRD) to provide consulting engineering services for the preparation of coastal floodplain mapping. The coastal floodplain mapping includes the anticipated effects of sea level rise and will be used by the CVRD for land use planning, emergency planning and risk assessment.

This technical memorandum (#1) documents the coastal and river base map development component of the project. Other technical memoranda will document the remaining project components.

1.1 Project Scope

The main project tasks include:

1. Conducting a mapping workshop to discuss mapping objectives and deliverables.
2. Collection and integration of topographic and bathymetric mapping from a variety of sources including bathymetric data collected in the Oyster River as part of the project scope, bathymetric data in the sea obtained from the Canadian Hydrographic Service and topographic data in upland and intertidal areas obtained from GeoBC and other sources. This project task is the focus of this technical memorandum.
3. Hydrologic and hydraulic modelling of the Oyster River downstream of Highway 19 to its mouth at the Strait of Georgia and the lower reaches of the Courtenay River, Puntledge River (downstream of the BC Hydro Powerhouse) and Tsolum River (downstream of the Piercy Road Bridge/North Courtenay Connector). Modelling was conducted for floods having annual exceedance probabilities (AEP) ranging from 10% to 0.2% and included the anticipated effects of climate change.
4. Hydraulic modelling of coastal water levels (tide plus storm surge) and wave effects in deep and shallow water to determine wave heights in the surf zone and the maximum elevation of wave run-up for storm events with AEPs ranging from 10% to 0.2% and sea levels ranging from current conditions to a projected scenario with two metres of sea level rise (to Year 2200).
5. A desktop geomorphologic assessment of the shoreline and the lower Oyster River and shoreline to identify areas that may be non-erodible or exceptionally vulnerable to erosion.

6. Determination of flood levels for the Oyster River, the lower Courtenay/Puntledge/Tsolum River system and coastal areas.
7. Preparation of 1:4000 scale regulatory floodplain maps which show flood levels and floodplain extents and digital mapping for flood levels, setbacks, inundation depths, wave heights and climate change planning areas.

A series of reports and memoranda are provided to describe data sources, analysis approaches, assumptions, and study findings:

1. Technical Memorandum #1 – Coastal and River Base Map Development
2. Technical Memorandum #2 – Fluvial and Coastal Geomorphology
3. Technical Memorandum #3A – Fluvial Modelling – Oyster River Hydrology and Model Assumptions
4. Technical Memorandum #3B – Fluvial Modelling – Courtenay River Hydrology and Model Assumptions
5. Technical Memorandum #4 – Coastal Modelling
6. Technical Memorandum #5 – Coastal and Fluvial Mapping Products
7. Final Report – Coastal Flood Mapping Project
8. Coastal and Fluvial Models User Guide

This is Technical Memorandum #1, which outlines the development of the base mapping for use in the coastal and river modelling and the preparation of the flood mapping products. Section 2 of this document describes the sources of the base mapping, including surveys and orthophotos. Section 3 describes how the mapping data was integrated to produce the base mapping used in this project.

This memorandum does not describe the mapping used to develop the model of the Courtenay River system because the model was developed under a separate project. Reference should be made to the KWL memorandum *City of Courtenay, Integrated Flood Management Study, Hydrodynamic Model Development and Flood Management Options Evaluation, November 29, 2013* prepared for McElhanney Engineering for further details on the base mapping used for model development (KWL, 2013).

1.2 Glossary and Abbreviations

AEP	=	Annual Exceedance Probability. Probability of an event (e.g., flood event) of equal or greater magnitude occurring in a given year. The AEP is the inverse of the Return Period.
Bathymetric Survey	=	Survey to establish elevations of underwater river channel bed or ocean bed surfaces.
CGVD28	=	Canadian Geodetic Vertical Datum, original vertical datum used in Canada, roughly equal to mean sea level.
CGVD2013	=	Canadian Geodetic Vertical Datum 2013, updated vertical datum used for mapping in this study.
CD	=	Chart Datum. Datum typically used in marine charts which is roughly equivalent to the lowest astronomical tide in the area depicted in the chart.

DEM	=	Digital Elevation Model. A generic term for a map that represents the topographic elevation of the earth's surface. A DEM can be represented as a raster (a grid of squares, also known as a heightmap when representing elevation) or as a vector-based triangular irregular network (TIN).
Flood Hazard Maps	=	Engineering maps that display the results of hydrologic and hydraulic investigations (including water level, water depth, and velocity) and show areas that could be flooded under different scenarios. These maps are used for planning purposes related to land use planning, emergency management, and flood mitigation. Note that this is the working definition for this project and other projects, or organizations may have a different definition.
GNSS	=	Global Navigation Satellite System. A GNSS is a system that uses satellites to provide geo-spatial positioning. It uses electronic receivers to determine their location (longitude, latitude, and altitude/elevation) to high precision (within a few centimeters to metres) using time signals transmitted along a line of sight by radio from the satellites.
Inundation Maps	=	Topographic maps showing the extent of floodwater in plan, for the specific designated flood.
LAS File Format	=	The LAS (LASer) format is a file format designed for the interchange and archiving of LiDAR point cloud data. It is an open, binary format.
LiDAR	=	Light Detection And Ranging. A remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the Earth. LiDAR collected at a regional scale is usually collected by aircraft.
MKP File Format	=	Model Key Point file format. A "thinned out", generalised subset of the original x,y,z data points used to represent the minimum number of points required to determine the shape of the ground. MKP files are generated to reduce file sizes and make data handling more manageable.
Regulatory Floodplain Mapping	=	Maps used for regulatory purposes, such as developing floodplain bylaws and informing official community plans. For the Coastal Flood Mapping Project, the regulatory mapping is based on inundation mapping for a 0.5% AEP storm incremented by a freeboard allowance to establish the Flood Level and floodplain limits.
Return Period	=	An estimate of the average interval of time between events of a certain intensity or size. The inverse of the Annual Exceedance Probability.
SRD	=	Strathcona Regional District.
TIN File Format	=	Triangular Irregular Network file format. Vector-based digital geographic data used to represent surface morphology constructed by triangulating a set of points. The points are connected with a series of edges to form a network of triangles. There are different methods of interpolation to form these triangles, the Delaunay triangulation method being the most common.
Topographic	=	The shape and features of a land surface. In the context of this study, topographic features are those above the water level (as opposed to bathymetric which refer to features below the water level).

UTM10	=	Universal Transverse Mercator map projection for Zone 10. Map projections are used to project the spherical surface of the earth on a flat plane and involve some distortion, therefore it is important to know which map projection is used. In the UTM system, the earth is divided into a series of zones along lines of longitude; the coast of BC is in Zones 8, 9, and 10.
NAD83 (CSRS)	=	The North American Datum of 1983 (NAD 83) is the horizontal and geometric control datum for the United States, Canada, Mexico, and Central America. The CSRS (Canadian Spatial Reference System) is the improved realization of NAD83 for Canada. The datum provides a common point of reference to define horizontal coordinates across the entire country.

1.3 References

The following references were used for the preparation of this memorandum:

1. BC Ministry of Environment, Water Management Branch. (1984). Map 5532-1, 5532-2 and 5532-3. *Preliminary Floodplain Mapping, Oyster River.*
2. Cascadia Coast Research. (October 2020). *Storm Wave Analysis: Comox Valley Regional District, BC.*
3. GeoBC. (2017). *Specifications for LiDAR V3.1.* Ministry of Forests, Lands and Natural Resource Operations.
4. Kerr Wood Leidal Associates Ltd. (2013). *City of Courtenay, Integrated Flood Management Study, Hydrodynamic Model Development and Flood Management Options Evaluation.*

2. Base Mapping Sources

The objective of the Coastal Flood Mapping Project is to map flood inundation levels and water depths over the coastal areas of the CVRD, along the Oyster River downstream of Highway 19 to its mouth at the Strait of Georgia and along the lower reaches of the Courtenay River, Puntledge River (downstream of BC Hydro Powerhouse) and Tsolum River (downstream of Piercy Road Bridge/North Courtenay Connector).

A variety of data sources were collated to generate the base mapping used for this project including bathymetric data collected in deep water, topographic data collected by LiDAR and topographic and bathymetric data collected by ground survey.

2.1 Topographic Mapping

LiDAR Data

The base mapping made extensive use of data collected through LiDAR (Light Detection And Ranging) technology. Two distinct data sources were used; the geographic extents of the data sources are shown in Figure 1; information on each data set is provided in Table 1.

Table 1: LiDAR Data Information

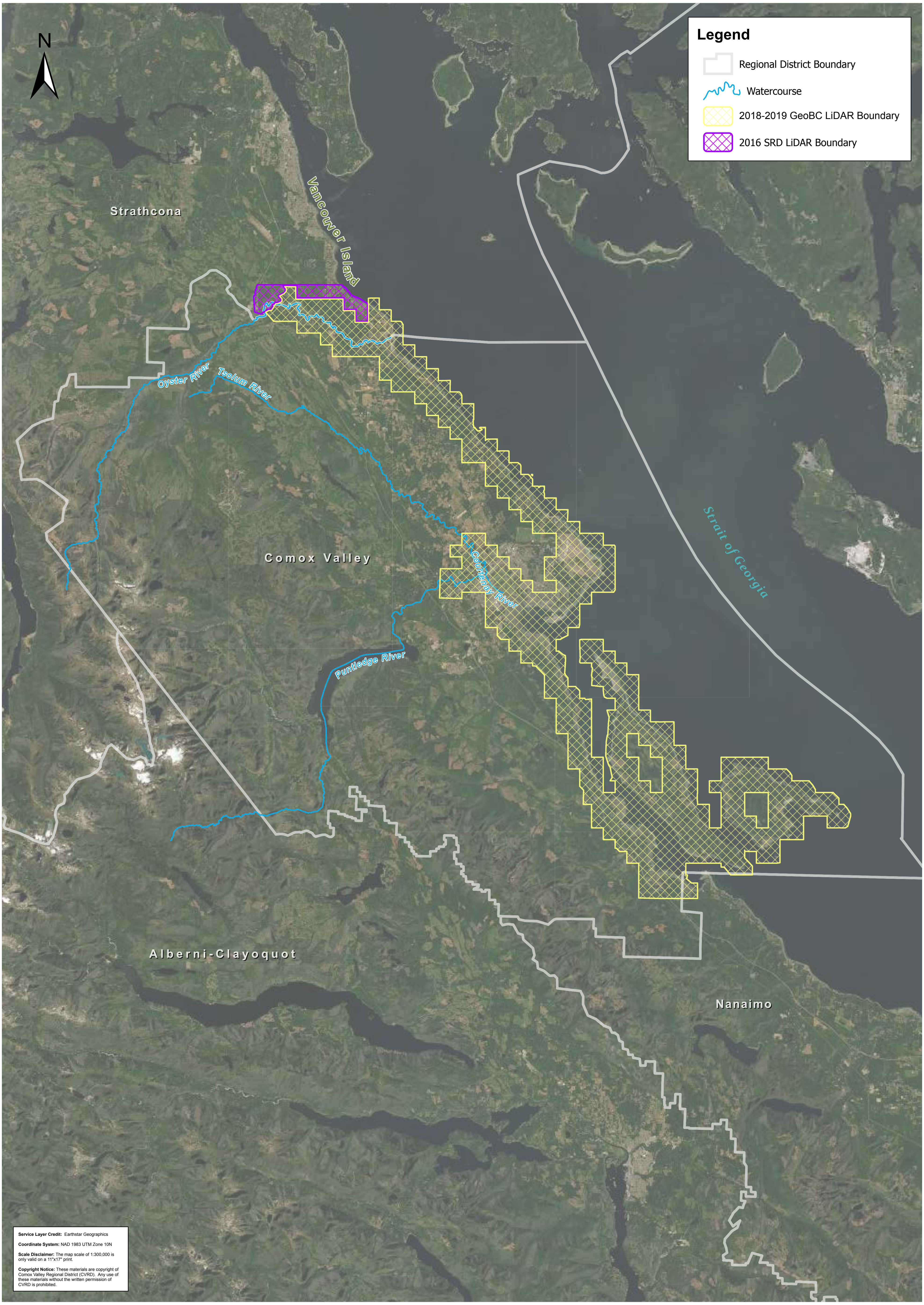
Item	Dataset	
	2016 SRD	2018/2019 GeoBC
Commissioned by	Strathcona Regional District (SRD)	GeoBC
Specifications	N/A	GeoBC, Specifications for LiDAR V3.1
Flown By	Eagle Mapping	Unknown (2018 data) Airborne Imaging (2019 data)
Dates Flown	4/08/2015, 04/07/2016	10/14/2018 – 10/1/2019
Target Point Density	8 pulses/m^2	8 pulses/m^2
Projection	UTM10	UTM10
Horizontal Datum	NAD83 (CSRS)	NAD83 (CSRS)
Vertical Datum	CGVD28 (HTv2.0)	CGVD2013
Format Received In	Processed Bare Earth	Classified LAS (2018 data) Raw Unclassified LAS (2019 data)
Formats Received In	Contours (*shp)	LAS, MKP, TIN
Classified By	Eagle Mapping	Unknown (2018 data) Dudley Thompson Mapping and Airborne Imaging (2019 data)
Non-Vegetated Vertical Accuracy	0.102 m	0.120 m

Path: Z:\2000-2999\2600-2699\2623-014\430-GIS\Pro Projects\2623014_Memo_1_Figures\2623014_Memo_1_Figures.aprx Date Saved: 4/16/2021 3:32 PM | Author: TSoh

Comox Valley Regional District

Coastal Flood Mapping Project

KERR WOOD LEIDAL consulting engineers



Project No.	2623-014
Date	April 2021
Scale	1:300,000

0 1 2 4 Kilometres

LiDAR Data Extents

Figure 1

2.2 Bathymetric Mapping

Ground Survey

Ground survey of the lower Oyster River was conducted as part of the scope of this project by Bazett Land Surveying from October 8, 2019 to October 18, 2019. As noted previously, no ground survey was conducted for the Courtenay River as an existing fluvial model was used for modelling the Courtenay River.

Cross-sections in the upper reaches of the Oyster River were collected from Highway 19 to approx. 1.5 km upstream of Highway 19A at approximately the same locations as the cross sections collected by Eco Cat in 1982 as part of the 1984 Ministry of Environment Floodplain Mapping (Ministry of Environment, 1984). A Global Navigation Satellite System (GNSS) was used to position the sections and collect the data and various methods were used to measure the cross-sectional data depending on tree cover and water depth (wading, offsets). The extent of the survey is shown in Figure 2 along with the locations of sections collected by Eco Cat in 1982.

In the lower reaches of the river from approximately 1.5 km upstream of Highway 19A to the mouth of the river, a small boat fitted with a depth sounder was used to obtain bathymetric data where water depth permitted. Exposed (dry) gravel bars were not included in the bathymetric survey as they were above the water level and were captured by LiDAR. This sounding data was captured in a laptop which also integrates positions from the GNSS system. The bathymetry of the lower Oyster River is shown in Figure 3.

Geodetic elevations were derived using GNSS technology. Leica dual frequency VIVA receivers were used in Real Time Kinematic (RTK) mode with a stationary base unit broadcasting corrections in real time to a rover unit. In shallow water or open gravel bars, the rover was used on a staff and measurements were taken to the bed of the river by wading. In deeper water, the rover was mounted on an inflatable boat and data was streamed to a laptop which was also connected to a dual frequency Knudsen Engineering BP320 digital sounder.

In order to tie the survey into global coordinates, three days of satellite data was collected at the main base station and post processed using Natural Resources Canada's Precise Point Positioning (PPP) service. The accuracy of the base station position was within 1 cm horizontally and 15 mm vertically. The horizontal datum is UTM Zone 10 NAD83 (CSRS) 1997 and the vertical datum is CGVD2013.

Spot elevations collected in open terrain are expected to have an uncertainty in the order of +/- 2 cm. Where there is extensive tree cover, the uncertainty increases to about +/- 5 cm. For bathymetric depths collected by sounder, the uncertainty is in the order of 2 to 5 cm. These uncertainties are considered to be acceptable for development of topographies and bathymetries for use in hydraulic modelling.

As part of the survey, the local conversion between the CGVD28 vertical datum and the CGVD2013 vertical datum was established by submission of GPS Base Station data submitted to CSRS-PPP with responses in both CGVD2013 and CGVD28. The occupation time of the GPS base was a minimum of six hours over several days occupations of the benchmarks used for the survey. It was determined that, to convert to the CGVD2013 vertical datum, 0.114 m must be added to CGVD28 values, i.e.:

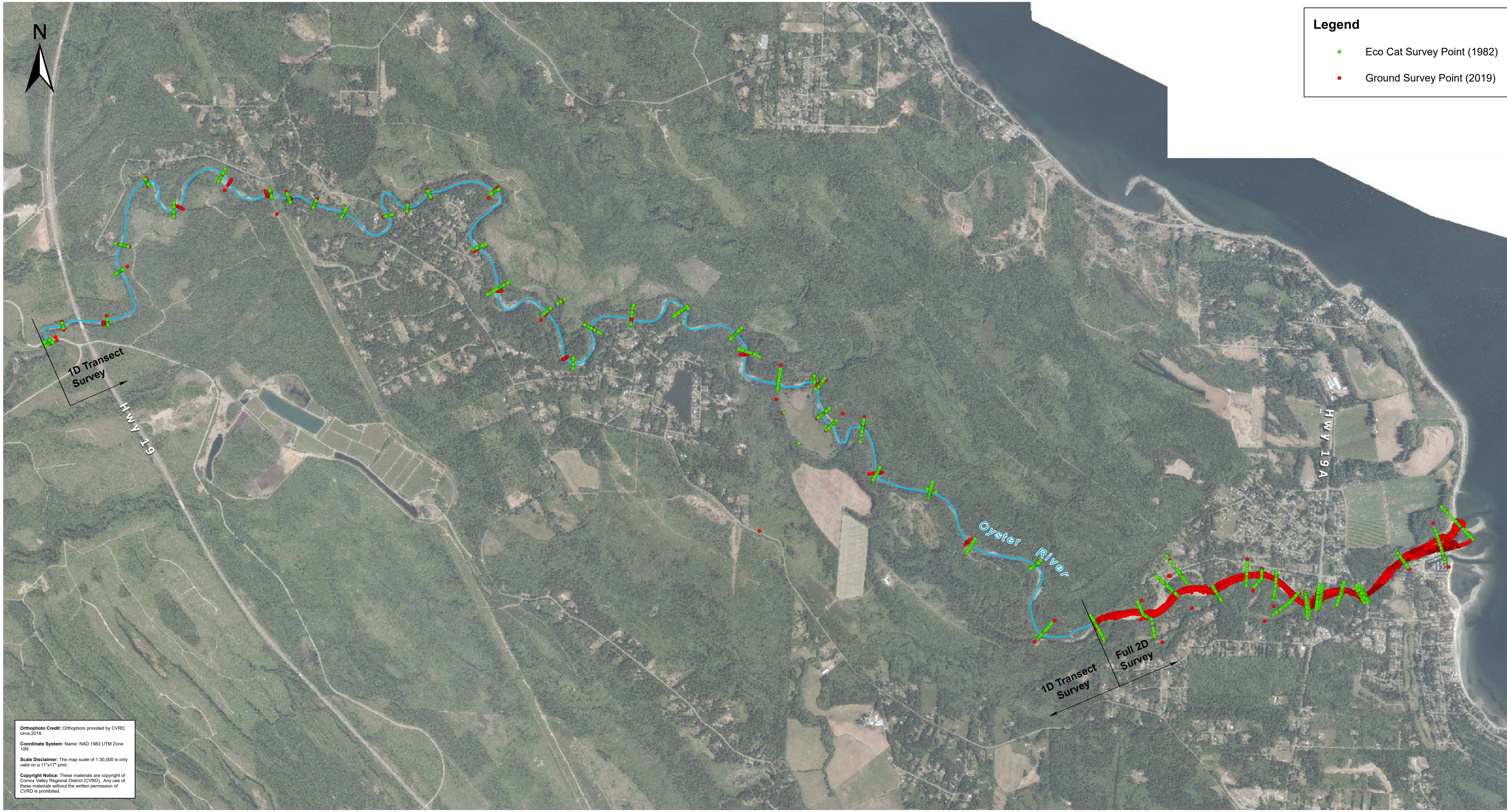
$$H_{CGVD2013} = H_{CGVD28} + \alpha$$

Where the offset, α is 0.114 m.

Path: Z:\2000-2999\2600-2699\2623-014\430-GIS\Pro Projects\2623014_Memo_1_Figures\2623014_Memo_1_Figures.aprx Date Saved: 2021-04-19 7:42 PM | Author: TSoh

Comox Valley Regional District
Coastal Flood Mapping Project

KERR WOOD LEIDAL
consulting engineers



Orthophoto Credit: Orthophoto provided by CVRD, circa 2018.

Coordinate System: Name: NAD 1983 UTM Zone 10N

Scale Disclaimer: The map scale of 1:30,000 is only valid on a 11"x17" print.

Project No. 2623-014
Date April 2021
Scale 1:30,000
0 200 400 800 Metres

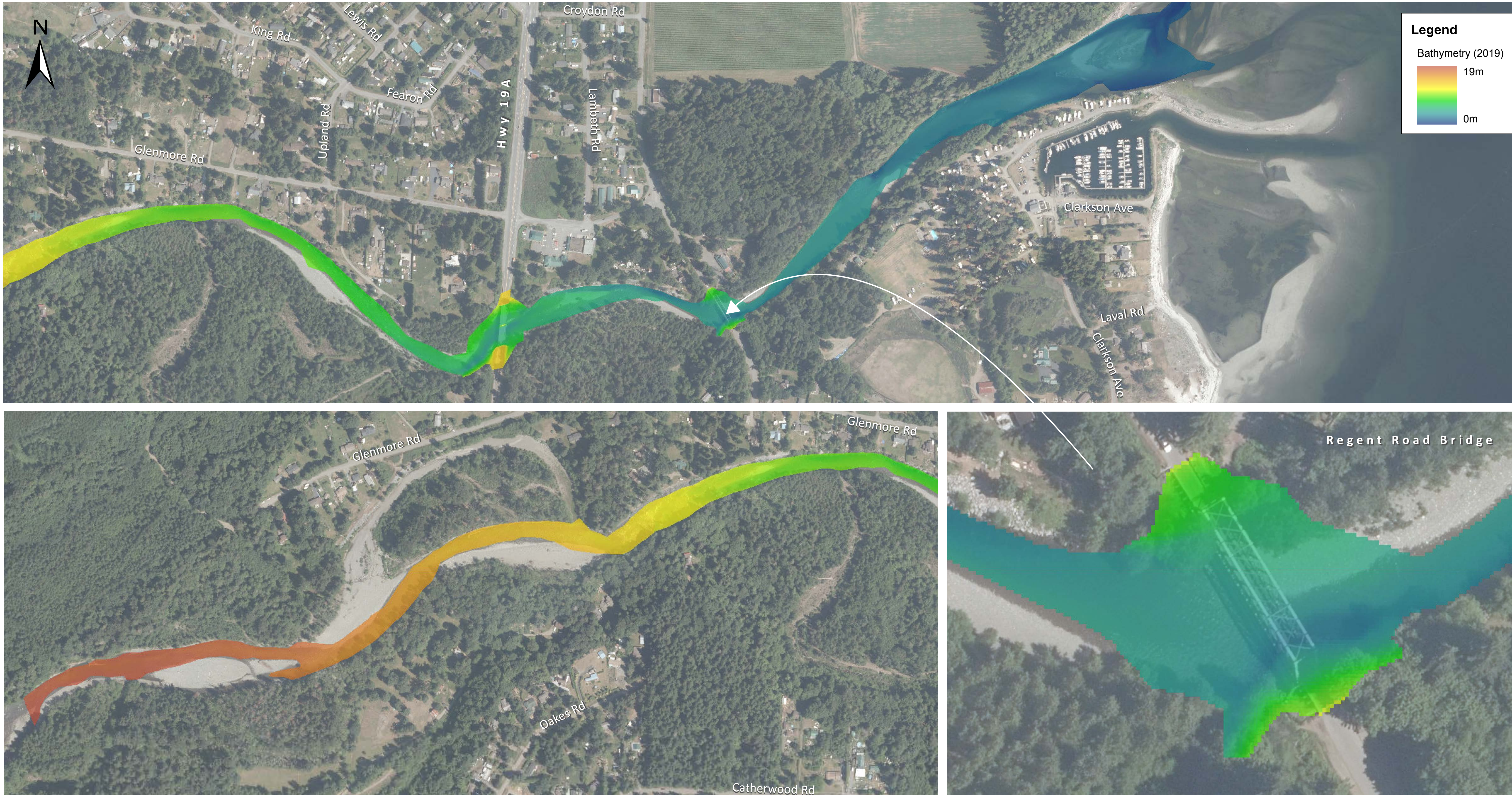
Oyster River Ground (Bathymetric) Survey

Figure 2

Path: Z:\2000-2999\2600-2699\2623-014\430-GIS\Pro Projects\2623014_Memo_1_Figures\2623014_Memo_1_Figures.aprx Date Saved: 4/19/2021 7:42 PM | Author: TSoh

Comox Valley Regional District
Coastal Flood Mapping Project

KERR WOOD LEIDAL
consulting engineers



Project No.	2623-014
Date	April 2021
Scale	1:6,000

0 50 100 200 Metres

Lower Oyster River Bathymetry

Figure 3

Canadian Hydrographic Service

Bathymetric data was obtained from the Canadian Hydrographic Service (CHS) in a variety of formats including electronic navigation charts (ENCs), a high-water data set (shoreline) for the Pacific, and a compilation of single and multi-beam survey data covering the CVRD coast out to about 70 m depth. The bathymetric datasets are summarized in Table 2 below; the extents of the data sets are shown in Figure 4.

Table 2: Canadian Hydrographic Service Data Sources

Data Description	Coverage	Datum
Navigation Chart (ENC) Soundings and Contours	Mid-Island Coastal Waters	Chart
High Water Contour (Shoreline)	BC Coastal Waters	Chart
Single and Multi-beam Bathymetric Surveys	CVRD Coast to About 70 m Depth	Chart

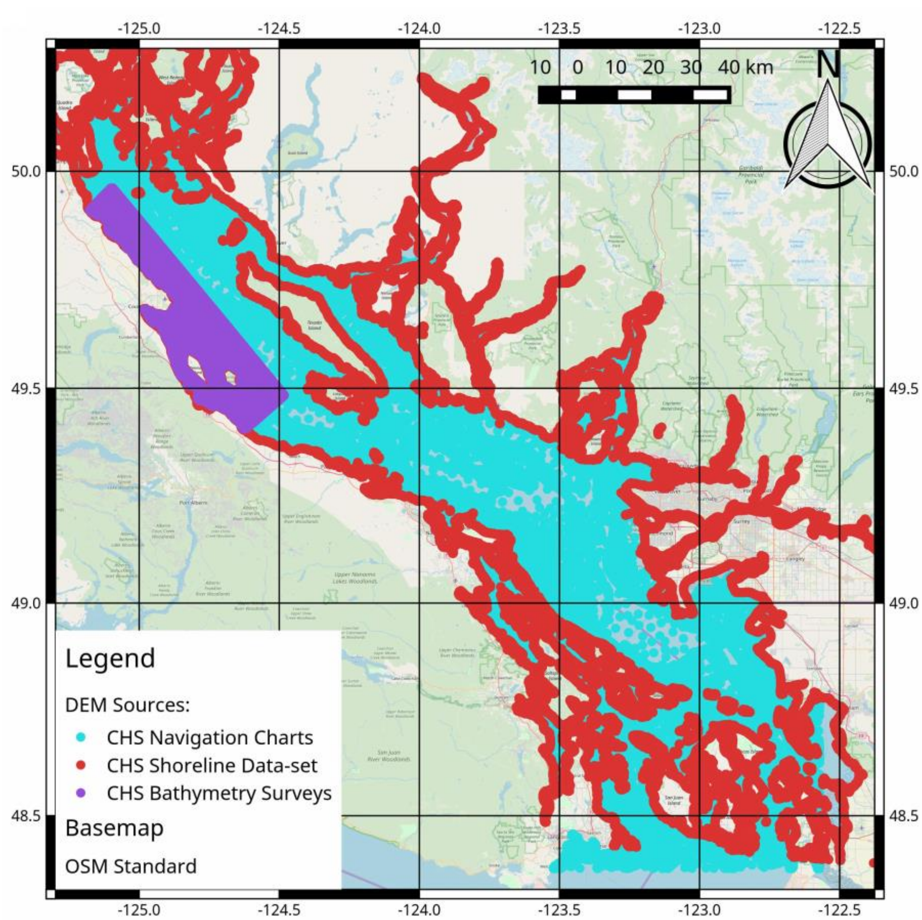


Figure 4: Canadian Hydrographic Service Data Sources (source: Cascadia Coast Research)

Details on how the different data sets were integrated are provided in Section 3.1. Further details on the bathymetric base mapping used in this study can be found in the Cascadia Coast Research Report "Storm Wave Analysis: Comox Valley Regional District, BC" (Cascadia Coast Research, 2020).

2.3 Orthophotos

Two different sets of orthophotos were used for the project as outlined in Table 3; sample images of the 2018 CVRD orthophotos are provided in Figure 5.

Table 3: Orthophoto Data and Uses

Item	2017 SRD	2018 CVRD
Source	SRD	CVRD
Date Collected	2017	2018
Resolution	50 cm	20 cm
Use	Geomorphologic Assessment of Oyster River	Building Footprint Tracing

2.4 Other Mapping Data

The additional data used in the preparation of the mapping is summarized in Table 4.

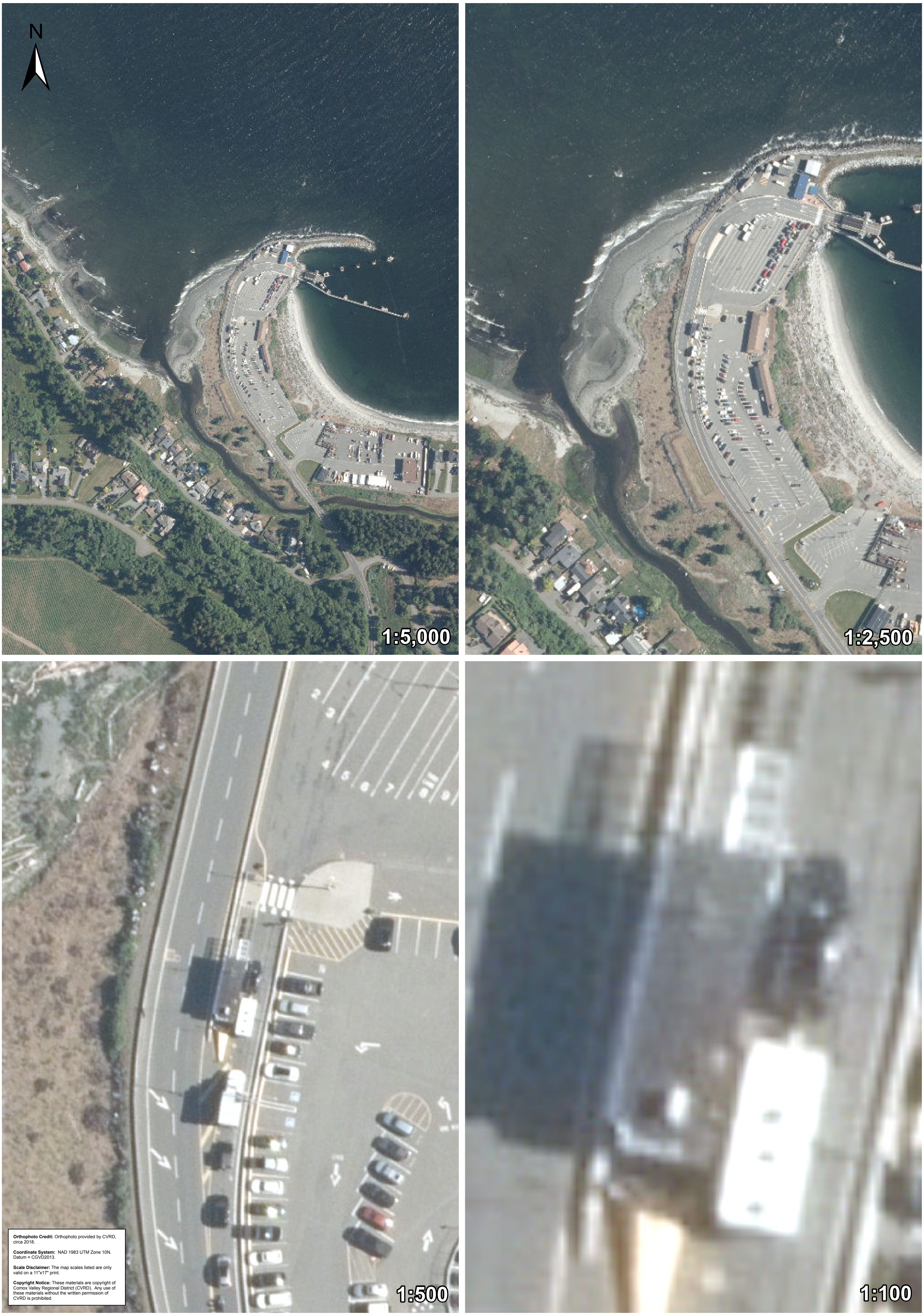
Table 4: Additional Mapping Data

Item	Description	Source and Retrieval Date
Administrative Areas Boundary	"AdministrativeAreas" shapefile	Obtained from CVRD 2020/04/01
Parcels	"Parcels" shapefile	Source is ParcelMap BC/Land Title and Survey Authority of British Columbia. Retrieved from DataBC 2020/03/04. https://catalogue.data.gov.bc.ca/dataset/parcelmap-bc-parcel-fabric
Landmarks	"Landmarks" shapefile containing the names and locations of significant landmarks	Obtained from CVRD 2020/04/09
Roads	"Roads" shapefile obtained via DataBC	Source is Digital Road Atlas of British Columbia. Retrieved 2020/03/04. https://catalogue.data.gov.bc.ca/dataset/digital-road-atlas-dra-master-partially-attributed-roads
Hydrology	"Watercourse and waterbody" shapefiles	Source is from the National Hydrology Network of Canada. Retrieved 2017/06/29. https://www.nrcan.gc.ca/science-and-data/science-and-research/earth-sciences/geography/topographic-information/geobase-surface-water-program-geeau/national-hydrographic-network/21361

Item	Description	Source and Retrieval Date
BC Parks, Ecological Reserves, and Protected Areas	"BC Parks, Ecological Reserves, and Protected Areas" shapefile	Retrieved from DataBC 2019/05/16. https://catalogue.data.gov.bc.ca/dataset/bc-parks-ecological-reserves-and-protected-areas
Building Outlines	"BuildingFootprints" shapefile for City of Courtenay supplemented with building outlines digitized by KWL as part of this study for areas outside of the City of Courtenay but excluding the Town of Comox	City of Courtenay Dataset obtained from City of Courtenay 2020/06/04. http://data-courtenay.opendata.arcgis.com/datasets/buildingfootprints KWL Dataset based on 2018 orthophotos.

Comox Valley Regional District
Coastal Flood Mapping Project

KERR WOOD LEIDAL
consulting engineers



Orthophoto Credit: Orthophoto provided by CVRD, circa 2018.

Coordinate System: NAD 1983 UTM Zone 10N. Datum = CGVD2013.

Scale Disclaimer: The map scales listed are only valid on a 11"x17" print.

Project No.	2623-014
Date	April 2021
Scale	Various

2018 Orthophoto Samples

Figure 5

3. Mapping Integration

3.1 Geodetic Datum Conversion

The ocean bathymetric and 2016 LiDAR datasets are in CGVD28 datum whereas the project datum is CGVD2013. As a result, these datasets needed to be shifted to CGVD2013 datum before they could be merged and integrated.

The 2016 LiDAR dataset is for the Oyster River area, and therefore KWL has shifted the dataset by the offset value measured as part of the Oyster River survey (0.114 m, see Section 2.2).

The ocean bathymetric dataset covers the entire shoreline extents of the district. The values of the datum offset between CGVD28 and CGVD2013 at several regional tide gauge stations based on CHS data are provided in Table 5. The offset value varies throughout the CVRD because the CGVD28 and CGVD2013 datum surfaces (geoids) are not parallel to each other and do not have a constant offset; the datum conversion varies by as much as 5.6 cm across the study area.

Table 5: Geodetic Datum Conversions from CHS

CHS Tide Station	Geodetic Datum Conversion, α^1
Little River	0.097 m
Comox Harbour	0.139 m
Denman Island	0.153 m
Notes: 1. $H_{CGVD2013} = H_{CGVD28} + a$	

Given that the variation of the datum offset value is within the accuracy of the ocean bathymetric dataset, the datum conversion has been performed by uniformly shifting the dataset by the value measured as part of the Oyster River survey (0.114 m, see Section 2.2). The consequence of this uniform shift is that the dataset is “warped’ by approximately 2 cm in the north of the CVRD and 4 cm in the south of the CVRD; this warping is considered to be inconsequential to the results of this study.

3.2 Mapping for Deep Water Wave Modelling

The deep-water modelling was performed using a two-dimensional spectral wave model called SWAN (Simulating WAves Nearshore). The model uses a Digital Elevation Model (DEM) of the bathymetry as a foundation for the analysis; the DEM was assembled as described below:

Electronic Navigation Charts:

- Extract contour and sounding data as xyz points;
- Convert elevations from chart datum to CGVD28;
- Merge the data from each chart, preferencing data from higher resolution charts; and
- Trim some data points where bathymetric survey data is available.

High Water (Shoreline) Dataset:

- Extract xyz points from high water dataset;
- Convert elevations from chart datum to CGVD28; and
- Trim high-water data where bathymetric survey data is available.

CHS bathymetric survey data:

- Extract scatter from files as xyz points; and
- Convert elevations from chart datum to CGVD28.

The xyz points from all sources were then merged and the points were triangulated using the Delaunay triangulation to create a TIN file.

The CGVD28 datum was used for the deep-water wave modelling work. This datum is used for two reasons:

1. It is the most commonly available geodetic datum available at the CHS tide stations and therefore elevations can be readily converted from chart datum to geodetic datum.
2. The conversion to project datum (CGVD2013) was not available when the deep-water wave modelling work was initiated.

Elevations in chart datum may be converted to CGVD28 through the following transformation:

$$H_{CGVD28} = H_{CD} + \beta$$

Based on CHS surveys at the Little River tide station, the offset, β is -3.135 m.

Further information on deep water wave modelling is provided in Technical Memorandum #4 – Coastal Modelling.

3.3 Mapping for Nearshore Wave Modelling

The nearshore wave modelling was performed using a one-dimensional “transect” based approach using KWL’s in-house “SHORLAX” wave run-up model. The entire shoreline of the CVRD was divided into 233 transects, oriented roughly perpendicular to the shoreline. The transect locations were selected to be representative of the surrounding coastal “zone” in terms of both topography and wave exposure; as such, the transects are not evenly spaced.

The transects were created by combining the LiDAR and the bathymetric mapping prepared for the deep-water wave modelling. Given that the CGVD28 datum was used for the deep-water wave modelling and the “project” datum is CGVD2013, the deep-water bathymetry needed to be “shifted” as discussed in Section 3.1 before the datasets could be merged.

The bathymetric mapping typically extends to Chart Datum and the LiDAR data was captured at lower ocean water levels but not necessarily the lowest tidal elevation. As a result, there is typically a “gap” in the data between the two data sets that must be filled. This gap was filled through a manual process involving reviewing each transect along with aerial photography to determine, as best as possible, local shallow-water bathymetric conditions and the likely bathymetry in the “gap” area. For this project, linear interpolation across the gap was deemed to be appropriate for all transects.

Development of the transect topography was complicated by the fact that the LiDAR data, at the time that the transects were created, contained false signal returns from the water surface which needed to be removed to allow for merging with the bathymetry. The "water surface" data was removed by a manual exercise consisting of noting the time the LiDAR data was captured relative to ocean water levels measured at that time and identifying corresponding topographic "plateaus" that could be attributed to water rather than land. The transect data was then "trimmed" to eliminate the "water" data and allow for merging with the adjacent bathymetric data set. It should be noted that this "trimming" exercise would normally be performed in plan (rather than section) by trimming the LiDAR at the land/water boundary as determined by review of orthophotos taken at the same time as the LiDAR; however, these orthophotos were not available to facilitate this exercise.

Further information on nearshore wave modelling is provided in Technical Memorandum #4 – Coastal Modelling.

3.4 Mapping for River Modelling

The Oyster River modelling was performed using both one-dimensional transect-based modelling and two-dimensional modelling using the HEC-RAS software package.

The mapping for the one-dimensional model was created by defining the channel alignment, floodplain alignment, and user-defined cross section locations by using 1984 Ministry of Environment floodplain mapping as a guide (Ministry of Environment, 1984). Cross sections were then created at the user-defined locations using a combination of the ground survey data collected by Dave Bazett and the LiDAR data (both the 2016 SRD as well as the 2018/2019 GeoBC datasets).

The mapping for the two-dimensional model was created by using a combination of the ground survey data collected by Dave Bazett in 2019 and the 2018/2019 GeoBC LiDAR dataset for the floodplain areas.

Detailed information on the integration of the topographic and bathymetric datasets for both the one-dimensional and two-dimensional models is provided in Technical Memorandum #3A – Fluvial Modelling – Oyster River Hydrology and Model Assumptions.

As noted previously, this memorandum does not describe the mapping used to develop the model of the Courtenay River system because the model was developed under a separate project; reference should be made to the KWL memorandum *City of Courtenay, Integrated Flood Management Study, Hydrodynamic Model Development and Flood Management Options Evaluation, November 29, 2013* prepared for McElhanney Engineering for further details on the base mapping used for model development (KWL, 2013).

4. Closing

We trust that this summary of the preparation of the base mapping used for the Coastal Flood Mapping Project provides the Comox Valley Regional District with the information required. If you have any questions, please contact the undersigned at (250) 595-4223.

KERR WOOD LEIDAL ASSOCIATES LTD.

Prepared by:

2021-04-23

Eric Morris, M.A.Sc., P.Eng.
Senior Coastal Engineer

Prepared by:

Craig Sutherland, M.Sc., P.Eng.
Senior Water Resources Engineer

Reviewed by:

Mike V. Currie, M.Eng., P.Eng., FEC
Principal, Senior Water Resources Engineer

EM/aah

Statement of Limitations

This document has been prepared by Kerr Wood Leidal Associates Ltd. (KWL) for the exclusive use and benefit the Comox Valley Regional District. No other party is entitled to rely on any of the conclusions, data, opinions, or any other information contained in this document.

The document contains proprietary and confidential information that shall not be reproduced in any manner or disclosed to or discussed with any other parties without the express written permission of the Comox Valley Regional District. Information in this document is considered the intellectual property of the Comox Valley Regional District in accordance with copyright law.

This document represents KWL's professional judgement based on the information available at the time of its completion and as appropriate for the project scope of work. Services performed in developing the content of this document have been conducted in a manner consistent with that level and skill ordinarily exercised by members of the engineering profession currently practising under similar conditions. No warranty, express or implied, is made.

Copyright Notice

Revision History

Revision #	Date	Status	Revision Description	Author
0	April 23, 2021	FINAL		EM

OQM CERTIFIED