Appendix C
Geotechnical Report

Earth Solutions NW LLC
Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

January 16, 2020
ES-7104

BSCBN, Inc.
21828 – 87th Avenue Southeast
Woodinville, Washington 98072

Attention: Mr. Bill Cowin

Subject: Infiltration Evaluation
Proposed Vantage Bay PUD
Huntzinger Road
Kittitas County (Vantage), Washington

Reference: D.R. Strong Consulting Engineers
Boundary and Topographic Survey, dated November 14, 2019

ESM Consulting Engineers LLC
Conceptual Grading and Utility Plan Sheets, dated May 17, 2019

RH2
Vantage Bay Hydrogeologic Evaluation

Stephen P. Reidel and Karl R. Fecht
Geologic Map of the Priest Rapids Quadrangle, Washington, September 1994

Department of Ecology Stormwater Management Manual for Eastern Washington

Dear Mr. Cowin:

As requested, Earth Solutions NW, LLC (ESNW) has prepared this infiltration evaluation report for the proposed project. Our scope of services included subsurface exploration, laboratory testing, engineering analyses, and preparation of this report.

Project Description

The subject site is located on the east side of Huntzinger Road, about 1,000 feet south of I-90, in the Vantage area of Kittitas County, Washington (Plate 1). The site consists of two tax parcels (Kittitas County parcel numbers 622933 and 272933) totaling 57.21 acres. The site is currently undeveloped. The site topography descends to the east with some moderately to steeply sloped topography located in the southern half of the site.

We understand the project will consist of 104 new residential lots, 10 townhome buildings, community buildings, access roads, and associated improvements. We understand infiltration will be pursued to the extent feasible. The referenced conceptual grading and utility plan sheets show currently proposed stormwater facility locations.

If the above design assumptions are incorrect or change, ESNW should be contacted to review the recommendations in this infiltration evaluation. ESNW should review the final design to verify the geotechnical recommendations provided in this report have been incorporated into the plans.

Subsurface Conditions

As part of this infiltration evaluation, an ESNW representative observed, logged, and sampled 12 test pits on January 2, 2020, excavated within vicinity of the proposed stormwater facility locations, using a trackhoe and operator retained by our firm. The approximate locations of the test pits are depicted on Plate 2 (Test Pit Location Plan). Please refer to the test pit logs (attached) for a more detailed description of subsurface conditions. Representative soil samples collected at the test pit locations were analyzed in general accordance with the Unified Soil Classification System (USCS) and United States Department of Agriculture methods and procedures.

Topsoil

Where encountered, topsoil extended to approximately six inches below the existing ground surface (bgs). The topsoil was characterized by dark brown color and fine organic material.

Native Soil

Native soil conditions at the test pit locations were observed to consist primarily of gravel with varying amounts of silt, sand, and cobbles (USCS: GM, GW, GP, SM). The fines content of the native soil generally decreased with depth. The native soil was observed to generally be in a medium dense and damp condition. Light to heavy caving was observed within the native gravel soils exposed in the test pits.

Bedrock

Basalt bedrock was encountered at the terminus of test pits TP-9 through TP-12 which caused refusal at depths of four and one-half to eight feet bgs. The basalt was observed to be very hard, moist, and porphyritic.

Groundwater

Groundwater seepage was not observed at the test pit locations. Groundwater seepage may be encountered in site excavations, depending on the time of year.

Geologic Mapping

Geologic mapping of the area indicates the site is underlain by outburst flood deposits (Qfs). The native gravel soils encountered at the test pit locations are generally consistent with outburst flood deposits.

Infiltration Evaluation

The purpose of the subsurface exploration was to evaluate infiltration feasibility at the proposed stormwater facility locations. Based on the subsurface exploration, infiltration within the upper gravel soils encountered at test pit locations TP-1 through TP-8 is feasible from a geotechnical standpoint; infiltration near test pits TP-9 through TP-12 may be difficult or infeasible due to shallow depth to bedrock. Based on the results of our investigation, the following infiltration design parameters are recommended:

Test Pit Location	Design Infiltration Rate	Depth to Impermeable Layer
TP1 through TP-8	20.0 inches per hour (iph)	Not observed to 10 to 15 feet
TP-9 and TP-10	3.8 iph	4 to 7.5 feet
TP-11 and TP-12	1.3 iph	4.5 feet

The design infiltration rates were calculated based on the soil grain size analysis method developed by Massman. A total correction factor of 0.12 was used to calculate the design rate with a maximum recommended design infiltration rate of 20.0 iph. The design recommendations are suitable for facilities designed within the vicinity of the test pit locations; ESNW should complete additional testing if alternative locations are proposed. ESNW should observe construction of the infiltration facilities and complete confirmation testing as necessary.

Limitations

The recommendations and conclusions provided in this infiltration evaluation report are professional opinions consistent with the level of care and skill that is typical of other members in the profession currently practicing under similar conditions in this area. A warranty is not expressed or implied. Variations in the soil and groundwater conditions observed at the test pit locations may exist, and may not become evident until construction. ESNW should reevaluate the conclusions in this infiltration evaluation report if variations are encountered.

Should you require additional information, or have questions, please call.

Sincerely,

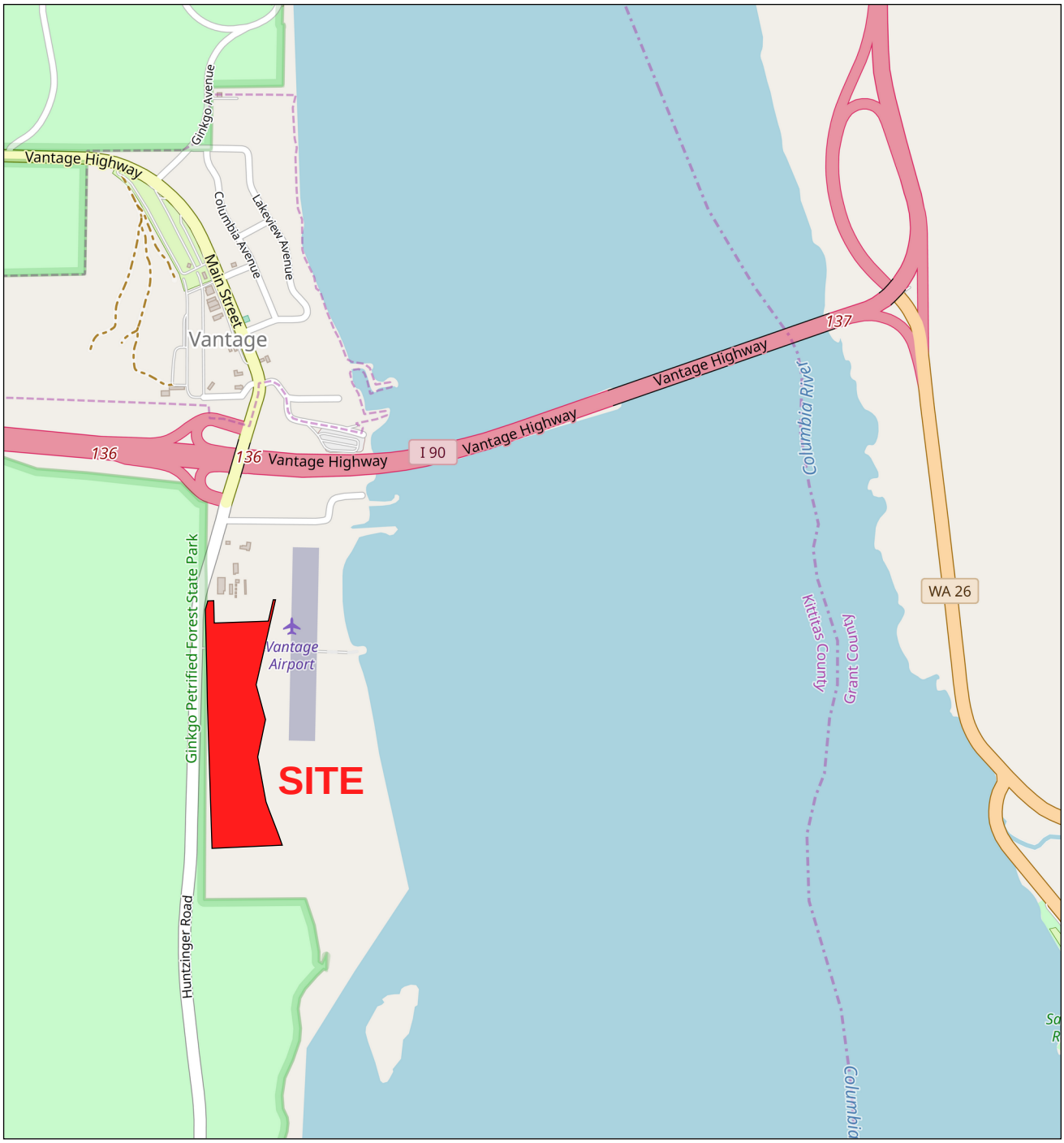
EARTH SOLUTIONS NW, LLC

Henry T. Wright, P.E.
Senior Project Manager

Attachments: Plate 1 – Vicinity Map
Plate 2 – Test Pit Location Plan
Test Pit Logs
Grain Size Distribution

cc: D.R. Strong Consulting Engineers
Attention: Mr. Maher Joudi, P.E. (Email only)

Mr. Skip Coddington (Email only)



Reference:
Kittitas County, Washington
OpenStreetMap.org

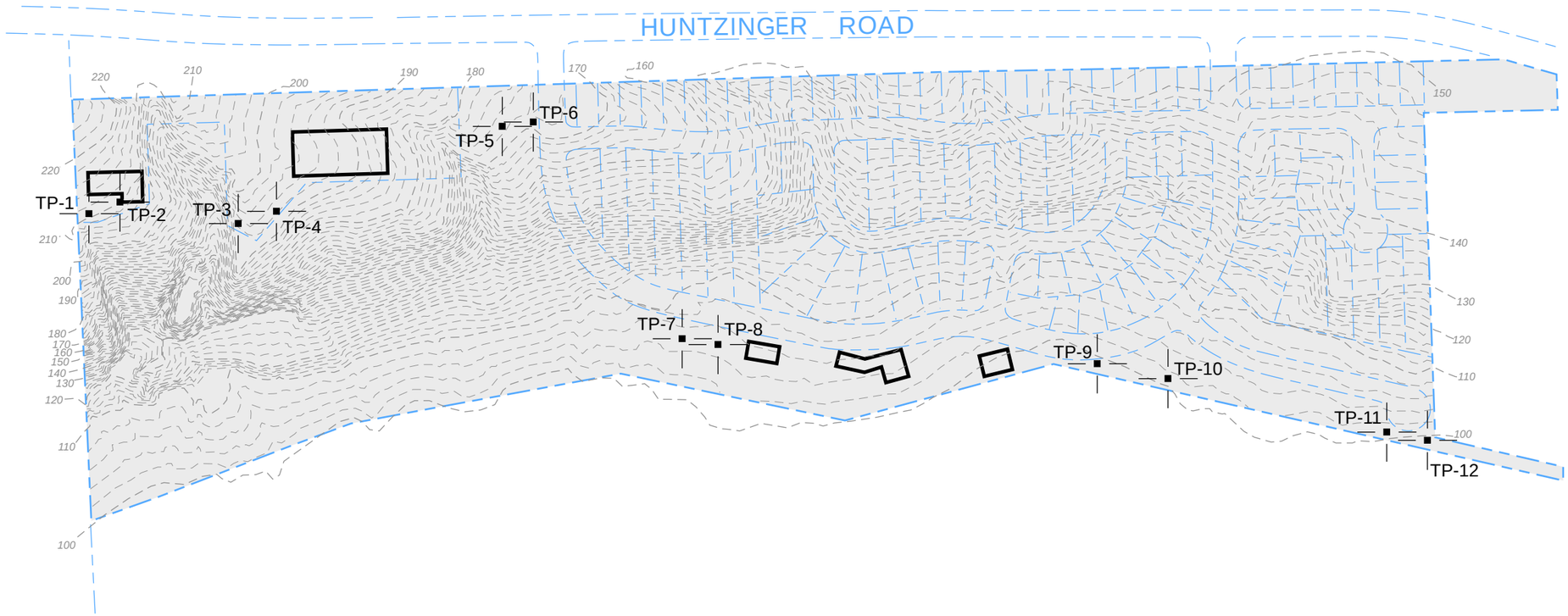
NORTH

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Vicinity Map
Vantage Bay
Kittitas County (Vantage), Washington

Drwn. MRS	Date 01/13/2020	Proj. No. 7104
Checked AZS	Date Jan. 2020	Plate 1



NORTH

1"=400'

0 200 400

Scale in Feet

LEGEND

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-7104, Jan. 2020

Subject Site

Proposed Building

NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided by the client at the time of our study. ESNW cannot be responsible for subsequent design changes or interpretation of the data by others.

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

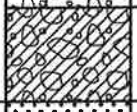
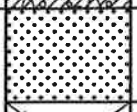
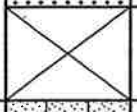
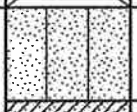
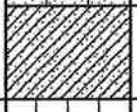
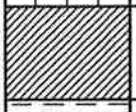
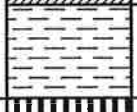
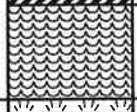
Test Pit Location Plan
Vantage Bay
Kittitas County (Vantage), Washington

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Drwn. By	MRS
Checked By	AZS
Date	01/09/2020
Proj. No.	7104
Plate	2

Earth Solutions NW LLC

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

DUAL SYMBOLS are used to indicate borderline soil classifications.

The discussion in the text of this report is necessary for a proper understanding of the nature of the material presented in the attached logs.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-1

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Surface Conditions: brush/exposed soil **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					
		MC = 3.60%	GM		Brown silty GRAVEL, medium dense, damp -light caving to BOH
5					
		MC = 4.00%		6.0	
			GW		Gray well-graded GRAVEL with sand, medium dense, damp
		MC = 4.30% Fines = 3.00%			[USDA Classification: extremely gravelly coarse SAND]
10					
15		MC = 3.30%		15.0	
					Test pit terminated at 15.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from TOH to BOH. Bottom of test pit at 15.0 feet.

Earth Solutions NW
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TEST PIT NUMBER TP-2

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Surface Conditions: brush/exposed soil **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND, loose to medium dense, damp -light caving to BOH
					2.0
		MC = 3.60%	GP		Gray poorly graded GRAVEL with sand, medium dense, damp
5		MC = 4.20%			
10		MC = 3.30%			
15		MC = 3.60%			15.0
					Test pit terminated at 15.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from TOH to BOH. Bottom of test pit at 15.0 feet.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
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TEST PIT NUMBER TP-3

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Surface Conditions: brush/exposed soil **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND, loose to medium dense, moist
				1.0	-roots, light caving to BOH
					Gray poorly graded GRAVEL with sand, medium dense, damp
		MC = 2.40%			
5					
		MC = 3.50% Fines = 1.10%	GP		[USDA Classification: extremely gravelly coarse SAND]
10		MC = 3.50%			
15		MC = 3.20%		15.0	
					Test pit terminated at 15.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from TOH to BOH.
					Bottom of test pit at 15.0 feet.

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TEST PIT NUMBER TP-4

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Surface Conditions: brush/exposed soil **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND, loose to medium dense, damp -light caving to BOH
					3.0
		MC = 2.40%	GP		Gray poorly graded GRAVEL with sand, medium dense, damp
5					
		MC = 2.90%			
10					
15		MC = 3.50%			15.0
					Test pit terminated at 15.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from TOH to BOH. Bottom of test pit at 15.0 feet.

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TEST PIT NUMBER TP-5

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Surface Conditions: brush/exposed soil **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					
		MC = 6.30%	SM		Brown silty SAND, loose to medium dense, moist -light caving to BOH
5					5.0
		MC = 6.10%	GP		Gray poorly graded GRAVEL with sand, dense, damp to moist
10		MC = 3.30%			-large cobbles
15		MC = 2.80%			15.0 Test pit terminated at 15.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from TOH to BOH. Bottom of test pit at 15.0 feet.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
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TEST PIT NUMBER TP-6

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Surface Conditions: brush/exposed soil **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			SM		Brown silty SAND, loose to medium dense, damp -light caving to BOH
				3.0	
		MC = 3.20%	GP		Gray poorly graded GRAVEL with sand, medium dense, damp
5					
		MC = 3.00% Fines = 0.80%			[USDA Classification: extremely gravelly coarse SAND]
10					
		MC = 2.70%		15.0	
15					Test pit terminated at 15.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from TOH to BOH. Bottom of test pit at 15.0 feet.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-7

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": field grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, light caving to 6.5'
				0.5	
			SM		Brown silty SAND, loose to medium dense, damp
				2.5	
			GP		Gray poorly graded GRAVEL with sand, medium dense, damp
5		MC = 4.00%			
					-heavy caving 6.5' to BOH
		MC = 2.80% Fines = 1.30%			[USDA Classification: extremely gravelly loamy coarse SAND]
10		MC = 3.00%		10.0	
					Test pit terminated at 10.0 feet below existing grade due to heavy caving. No groundwater encountered during excavation. Caving observed from TOH to BOH. Bottom of test pit at 10.0 feet.

Earth Solutions NW
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Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-8

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": field grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	Dark brown TOPSOIL, moderate caving to BOH
		MC = 3.60%	SM	3.0	Brown silty SAND, loose to medium dense, damp
5		MC = 3.10%	GP	9.0	Gray poorly graded GRAVEL with sand, loose to medium dense, damp
		MC = 2.90%			Test pit terminated at 9.0 feet below existing grade due to heavy caving. No groundwater encountered during excavation. Caving observed from TOH to BOH. Bottom of test pit at 7.0 feet.

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TEST PIT NUMBER TP-9

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": field grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	Dark brown TOPSOIL, caving to BOH
			SM	2.0	Brown silty SAND, loose to medium dense, damp
		MC = 1.80% Fines = 6.80%	GM	7.5	Gray poorly graded GRAVEL with silt and sand, medium dense, damp [USDA Classification: extremely gravelly very fine sandy LOAM]
5		MC = 2.40%			
			Basalt	8.0	Dark brown BASALT, very hard, moist -porphyritic
					Test pit terminated at 8.0 feet below existing grade due to refusal on very hard bedrock. No groundwater encountered during excavation. Caving observed from TOH to BOH. Bottom of test pit at 8.0 feet.

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TEST PIT NUMBER TP-10

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": field grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL
0.5			SM		Brown silty SAND, loose to medium dense, damp
2.0			GM		Gray silty GRAVEL, dense, damp
4.0		MC = 2.80%	Basalt		Dark brown BASALT, very hard, moist -porphyritic
4.5					Test pit terminated at 4.5 feet below existing grade due to refusal on very hard bedrock. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 4.5 feet.

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TEST PIT NUMBER TP-11

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": field grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	Dark brown TOPSOIL
			SM	2.0	Brown silty SAND, loose to medium dense, damp
		MC = 4.60%	SM	4.5	Gray silty SAND, dense to very dense, damp -weakly cemented
5		MC = 8.00%	Basalt	5.0	Dark brown BASALT, very hard, moist -porphyritic
					Test pit terminated at 5.0 feet below existing grade due to refusal on very hard bedrock. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 5.0 feet.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-12

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

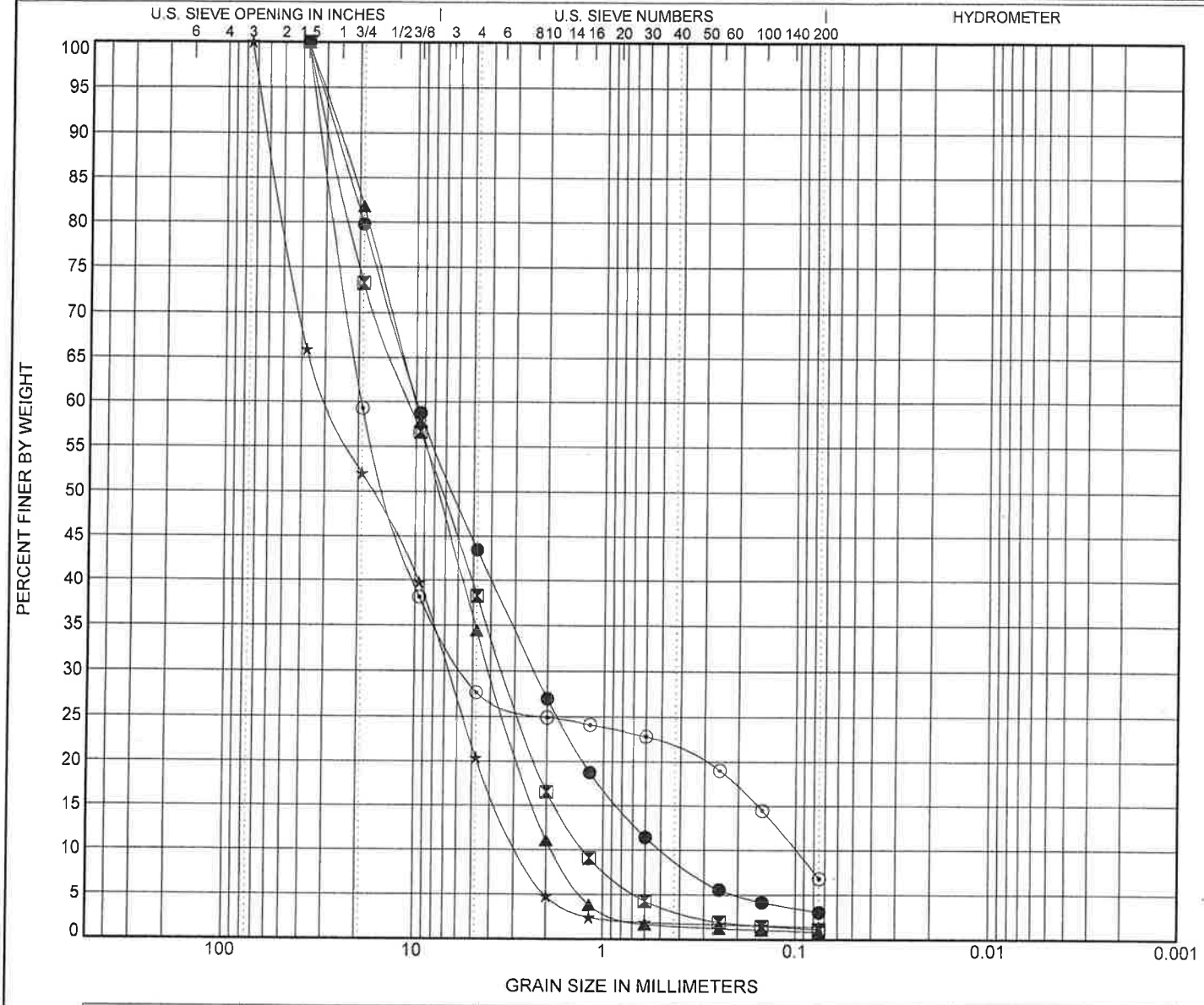
NOTES Depth of Topsoil & Sod 6": field grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL
				0.5	
			SM		Brown silty SAND, loose to medium dense, damp
				2.0	
			SM		Gray silty SAND with gravel, dense, damp -weakly cemented [USDA Classification: very gravelly loamy coarse SAND]
		MC = 4.60% Fines = 13.90%			
				4.5	
5		MC = 6.30%	Basalt	5.0	Dark brown BASALT, very hard, moist -porphyritic
					Test pit terminated at 5.0 feet below existing grade due to refusal on very hard bedrock. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 5.0 feet.

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	Cc	Cu
● TP-01	9.0ft.	USDA: Gray Extremely Gravelly Coarse Sand. USCS: GW with Sand.	1.14	20.40
⊠ TP-03	7.0ft.	USDA: Gray Extremely Gravelly Coarse Sand. USCS: GP with Sand.	0.85	8.68
▲ TP-06	9.5ft.	USDA: Gray Extremely Gravelly Coarse Sand. USCS: GP with Sand.	0.86	5.48
★ TP-07	8.0ft.	USDA: Gray Extremely Gravelly Loamy Coarse Sand. USCS: GP with Sand.	0.60	10.51
⊙ TP-09	3.0ft.	USDA: Gray Extremely Gravelly Very Fine Sandy Loam. USCS: GP-GM with Sand.	16.06	192.49

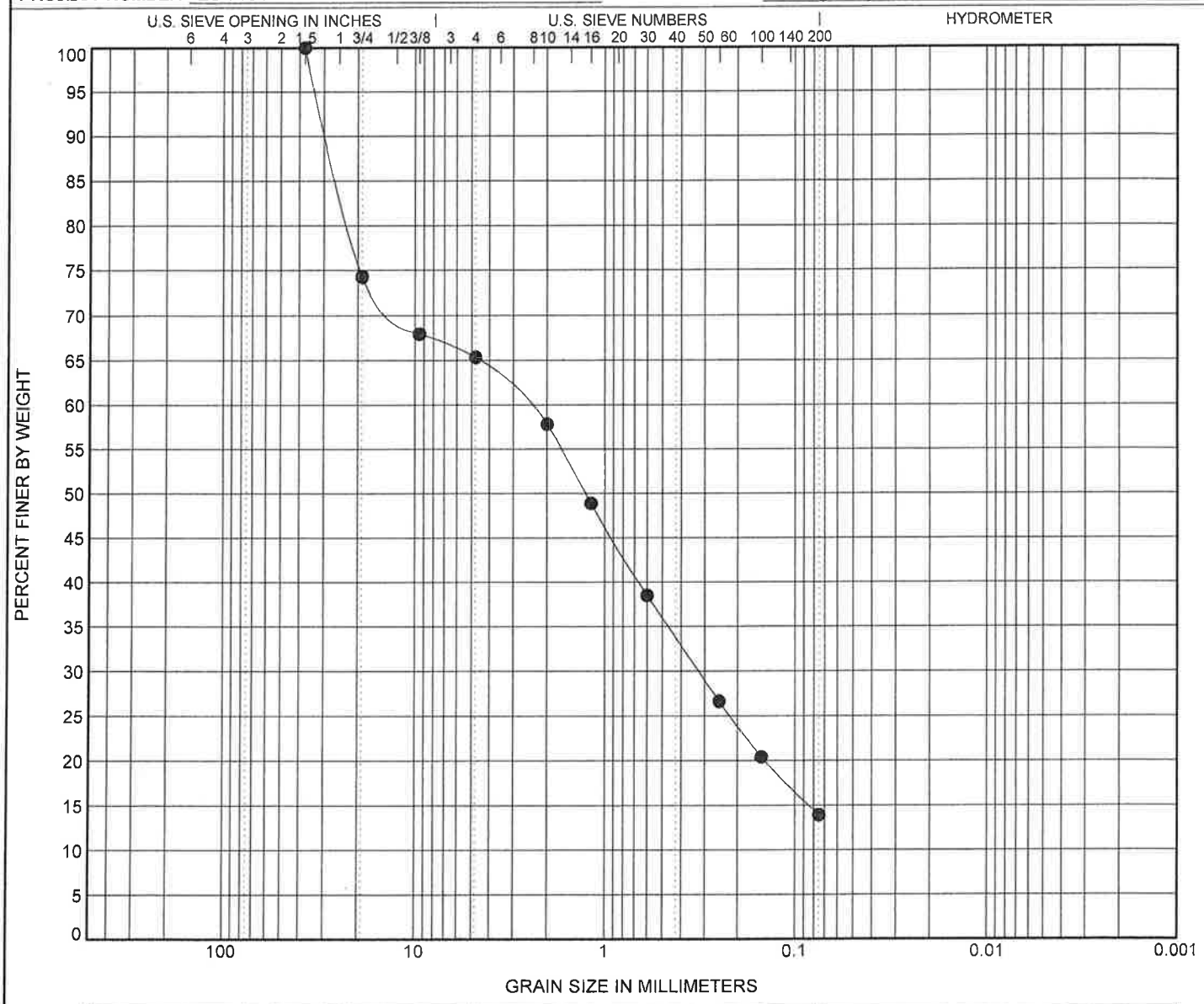
Specimen Identification		D100	D90	D60	D30	D10	LL	PL	PI	%Silt	%Clay
● TP-01	9.0ft.	37.5	26.796	9.906	2.346	0.486				3.0	
⊠ TP-03	7.0ft.	37.5	29.082	10.932	3.418	1.259				1.1	
▲ TP-06	9.5ft.	37.5	25.83	10.163	4.034	1.856				0.8	
★ TP-07	8.0ft.	75	61.21	28.098	6.704	2.673				1.3	
⊙ TP-09	3.0ft.	37.5	31.736	19.236	5.556	0.1				6.8	

GRAIN SIZE USDA WITH D90 ES-7104 VANTAGE BAY.GPJ GINT US LAB.GDT 1/7/20

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	Cc	Cu
● **TP-12**	**3.0ft.**	**USDA: Gray Very Gravelly Loamy Coarse Sand. USCS: SM with Gravel.**		

Specimen Identification		D100	D90	D60	D30	D10	LL	PL	PI	%Silt	%Clay
● **TP-12**	**3.0ft.**	**37.5**	**28.785**	**2.571**	**0.321**					**13.9**	

GRAIN SIZE USDA WITH D90 ES-7104 VANTAGE BAY.GPJ GINT US LAB.GDT 1/7/20

Appendix D
EPA Labor Cost Estimate

Project Name: Vantage Bay WRF **Date:** 6-Mar-20
Design Flow (mgd): 0.05
Hours/Day of Sludge Dewatering Operation 1.00
Productive Hours/Worker/Year 1,500

Table of Adjustment for Local Conditions

CATEGORY	LOCAL CONDITION	ADJUSTMENT					
		Operation	Maintenance	Supervisory	Clerical	Laboratory	Yardwork
PLANT LAYOUT	Compact	-10%	-10%				-50%
UNIT PROCESSES	Std. Equipt/Different Mfr	0%	0%				
LEVEL OF TREATMENT	Advanced	10%	-20%	2%	2%	2%	10%
TYPE OF WASTE REMOVAL REQUIREMENT	Effluent Concentration	5%				10%	
INDUSTRIAL WASTE	None or Constant	0%				0%	
PRODUCTIVITY OF LABOR	Average	0%	0%				
CLIMATE	Moderate Winters		0%				
TRAINING	Certification & Continuing Ed.	-5%		-10%			
AUTOMATIC MONITORING	Monitoring With Feedback	-5%	5%				
AUTOMATIC SAMPLING	Influent & Effluent	-5%				-5%	
OFF-PLANT LABORATORY WORK	None					0%	
OFF-PLANT MAINTENANCE	None		0%				
AGE AND CONDITION OF EQUIPMENT	Relatively new & well cared for		0%				
TOTAL		-10%	-25%	-8%	2%	7%	-40%

Annual Manhours

Unit Process/Category	Exists at Plant?	Operation	Maintenance	Supervisory	Clerical	Laboratory	Yardwork
Supervisory & Administrative				70			
Clerical					0		
Laboratory						100	
Yardwork							60
Raw Sewage Pumping at Plant	Yes		220				
Screening & Grinding	Yes	0	10				
Grit Removal	No	0	0				
Primary Clarification	No	0	0				
Aeration	Yes	130	70				
Secondary Clarification for Activated Sludge	Yes	10	110				
Chlorination	Yes	40	80				
Mixed Media Filtration	Yes	30	20				
Anaerobic Digestion	No	0	0				
Aerobic Digestion	Yes	10	0				
Gravity Thickening	No	0	0				
Flotation Thickening	No	0	0				
Sludge Drying Beds	No	0					
Sludge Dewatering	No	0	0				
Sludge Lagoons	No	0					
SUBTOTAL		220	510	70	0	100	60
SUBTOTAL ADJUSTED FOR LOCAL CONDITIONS		200	380	60	0	110	40
Number of Workers		0.1	0.3	0.0	0.0	0.1	0.0

Total Labor Hours/Year 790
Total Number of Workers 1

Appendix E
Enereau Systems Proposal

ENEREAU

Enereau nrPUR MBR System
Budget Proposal

For the project:

Vantage Bay WWTP

Submitted to:

Skip Coddington
GSC Development, Inc.

Submitted by:

James W. Hotchkies
Enereau Systems Group Inc.

Proposal No.:

ESP20002

Date: 2020-01-08

ENEREAU

Enereau Systems Group Inc. is pleased to submit this proposal for the supply of our advanced nrPUR Membrane BioReactor (MBR) system to treat the wastewater from the development at Vantage Bay, WA. Leveraging our team's experience on hundreds of successful MBR's in both North America and EMEA, on a diverse range of sectors (including municipal, commercial, institutional and industrial applications), our state-of-the-art treatment platforms combine the highest quality components with the best available process expertise to provide our clients with the most robust, reliable and cost-effective solutions in the industry.

Capable of treating highly variable and complex wastewater streams to consistently safe and dependable reuse quality, Enereau's nrPUR MBR platform offers best-in-class treatment at the most affordable cost of implementation and operation.

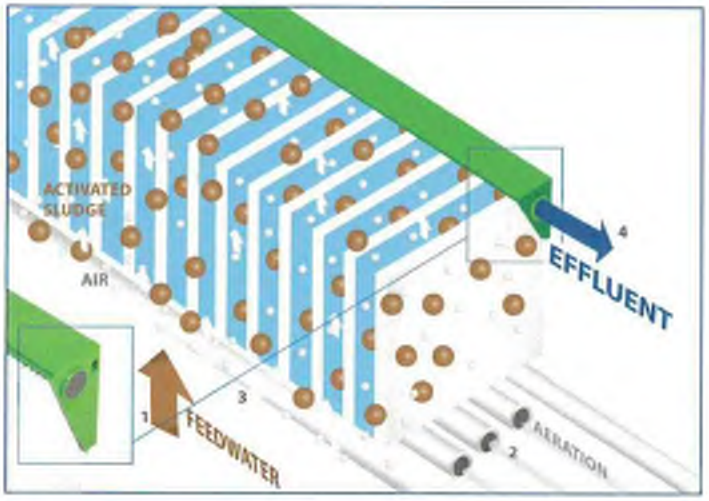
Key features and benefits of the Enereau nrPUR platform:

1. Standardized & Modular Design

   Developed around a series of standard, modular building blocks, the nrPUR family of systems offers unparalleled flexibility and reliability for wastewater treatment systems from less than 500 USgpd to over 100,000 USgpd (2-400 m^3/d). Factory assembled and tested prior to shipment, with integrated automation, permeate & CIP pumps, air scour blowers and instrumentation, the use of proven process modules to configure the specific treatment system for each unique application ensures that each platform goes together seamlessly on site and starts up with no complications.

2. nrPUR Technology: Best-in-Class Membrane Technologies

   - Ultrafiltration separation technology (less than 0.1 micron)
   - High flux with low pressure
   - Low-fouling hydrophilic membrane chemistry
   - Self cleaning (air scour with optional backpulse)
   - Temperature range: 10-50°C



UF membranes offer the optimal mechanism for the advanced separation of suspended solids and micro-organisms

3. nrPUR MBR Process Description

Wastewater from the facility should be screened to remove non-biodegradable solids larger than 1mm in diameter and collected in an Equalization (EQ) tank, where variations in flow and concentration are moderated and the pH is adjusted to the range between 6.5-7.5. A submersible pump in the EQ tank transfers the balanced influent to the BioReactor under level control. Wastewater is recirculated between the BioReactor tank and the Membrane tank at a rate of 4-5 times average daily flow.

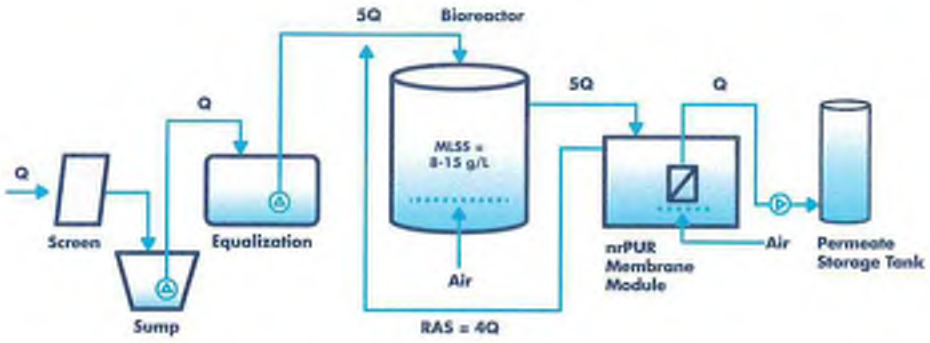
The BioReactor is a continuously-stirred, complete-mix reactor designed to ensure effective biological digestion of the organic materials in the secondary aeration step of the activated sludge process. The appropriate BioReactor volume is dictated by the Food to Micro-organism (F/M) Ratio (typically around 0.8) and the mass loading of BOD per cubic volume of reactor.

The activated sludge process converts the soluble organic material present in the wastewater into CO_2, H_2O and biological cell mass.

An aeration system, either regenerative blowers with a diffuser grid or jet aeration pumps, provides the oxygen required for this process. The mass of oxygen transferred is based upon the design daily influent BOD load. These aeration units also provide air scour for the membranes.

The liquid phase of the mixed liquor is pulled through the membrane at a predetermined rate, or flux, established for each specific application. The mixed liquor suspended solids (MLSS) are rejected and moved away from the membrane by the air scour and hydraulic action. Permeate will be pulled through the membranes under suction by permeate pumps and discharged to a clean water storage tank or for further polishing.

Surplus biomass generated by the conversion of BOD into cell mass will be wasted periodically from the system as Waste Activated Sludge (WAS). The sludge will be pumped directly from the reactor on an as-needed basis for further processing.



KEY : RAS = Return Activated Sludge
MLSS = Mixed Liquor Suspended Solids

ENEREAU

Project Criteria

The Vantage Bay project may be developed in phases over time, with each phase generating 25,000 GPD of wastewater. As such, it is recommended that the wastewater treatment plant be constructed in similar 25,000 GPD trains.

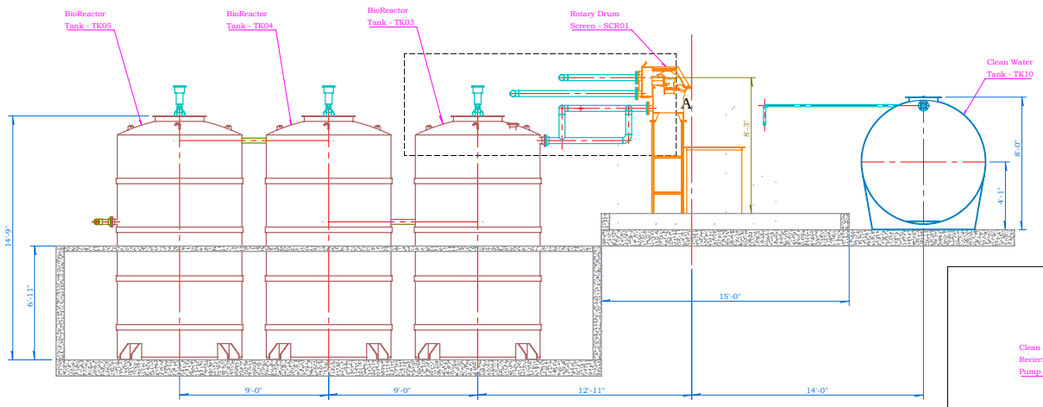
The key design parameters for this MBR system are:

Parameter	Raw Influent	Effluent	Units
Flow	25,000	25,000	GPD
BOD_5	300	<5	mg/L
TSS	300	<5	mg/L
TKN	70		mg/L
NH_3-N	47	<1	mg/L
TN		<10	mg/L
TP	8	<1	mg/L
Minimum Water Temperature	20	20	°C

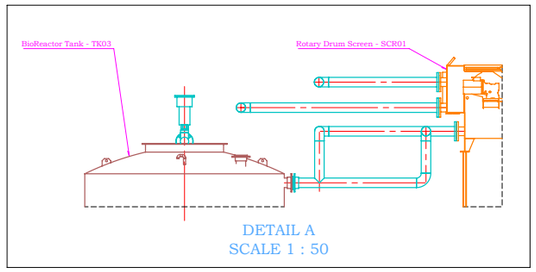
For each train, the system comprises four (4) process modules:

1. Collection & Pre-treatment
    a. Lift Stations (c/w Raw Wastewater Transfer Pumps)
    b. Screening
    c. Equalization
2. Biological Digestion
3. Membrane Filtration
4. Post-treatment
    a. UV disinfection

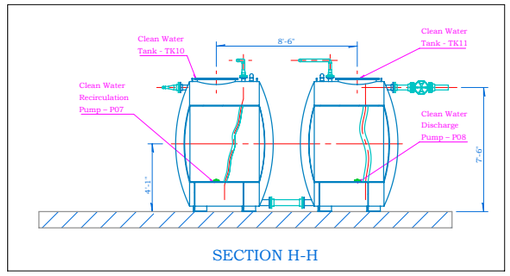
It is recommended that the Lift Stations and Primary Process Tankage – Equalization & BioReactor – be supplied and installed by the client & client's contractor.



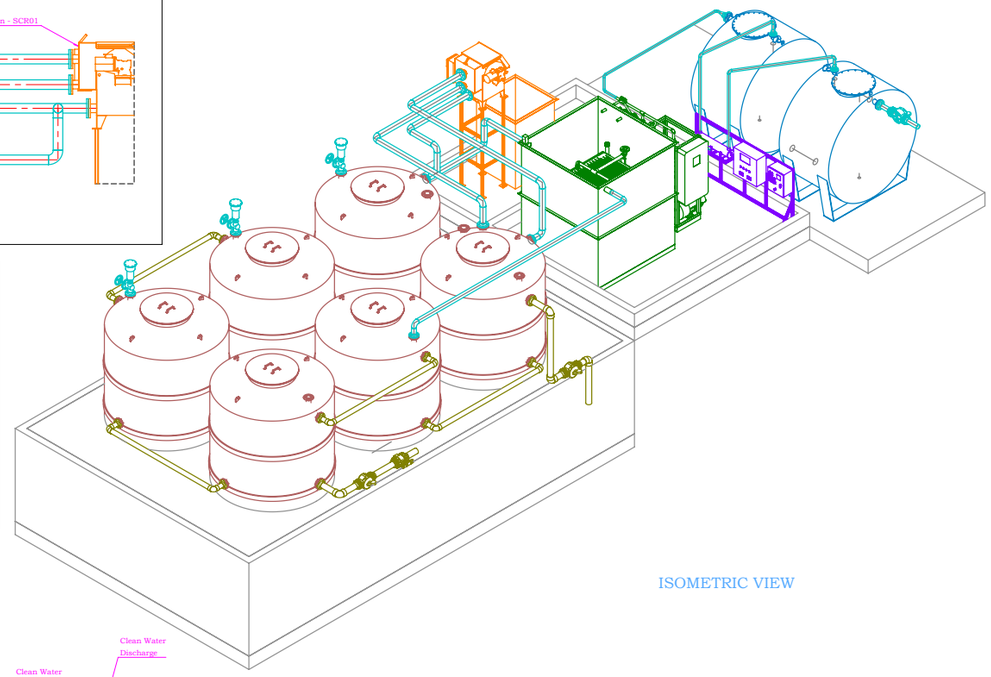
SECTION A-A



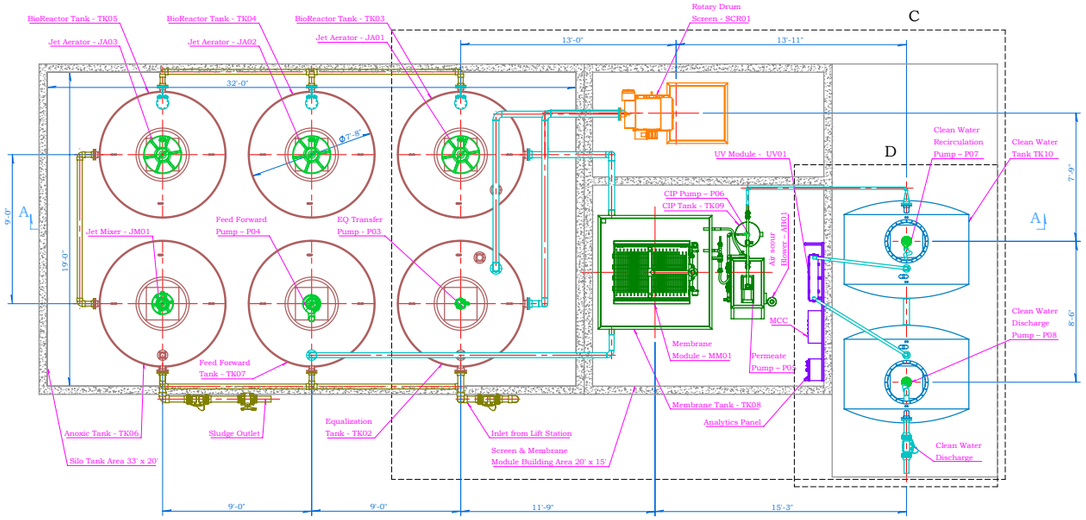
DETAIL A
SCALE 1 : 50



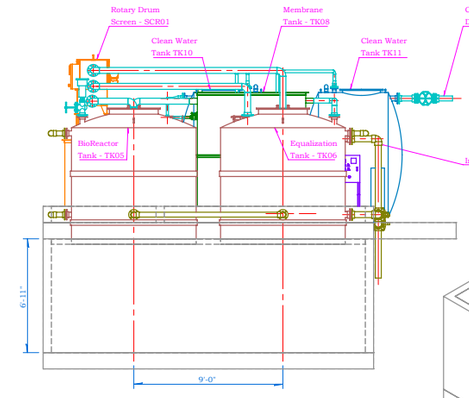
SECTION H-H



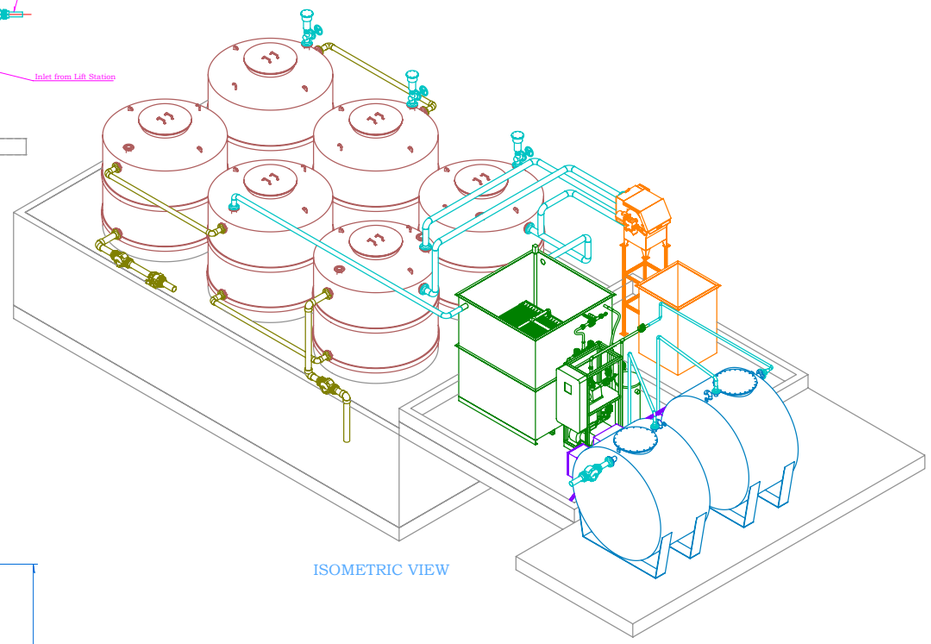
ISOMETRIC VIEW



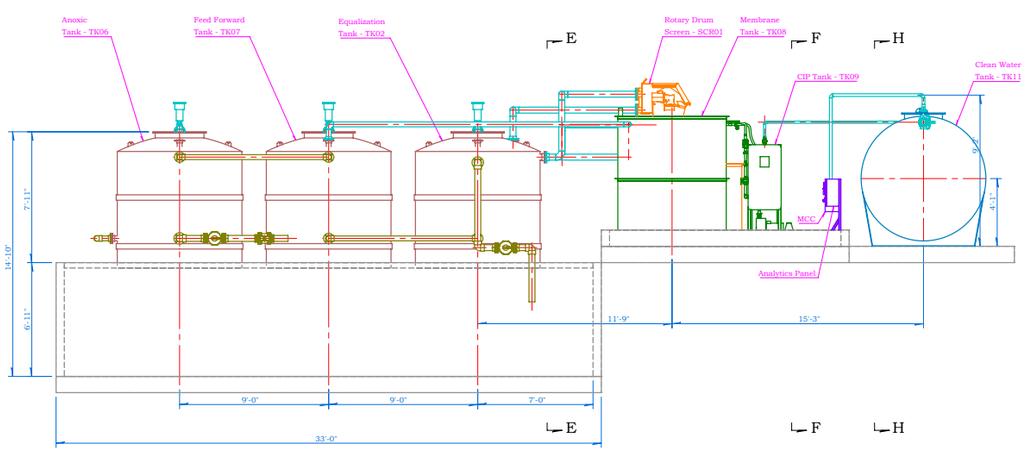
TOP VIEW



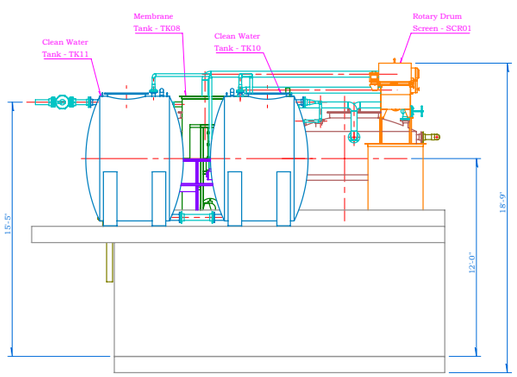
L.H.S. VIEW



ISOMETRIC VIEW



FRONT VIEW



R.H.S. VIEW

NOTE :
01. ALL DIMENSIONS ARE IN Feet & Inch.

	NAME	DATE
DRAWN	N. Wani	01/10/2020
CHECKED	S. Khan	01/10/2020
AS BUILD		
MGR APPR	C. Hotchkies	01/10/2020

ENEREAU SYSTEMS GROUP INC.
19 DRIFTWOOD TRAIL, RIDGEWAY ON
CANADA L0S 1N0 +1-289-321-0451

PROJECT TITLE : VANTAGE BAY

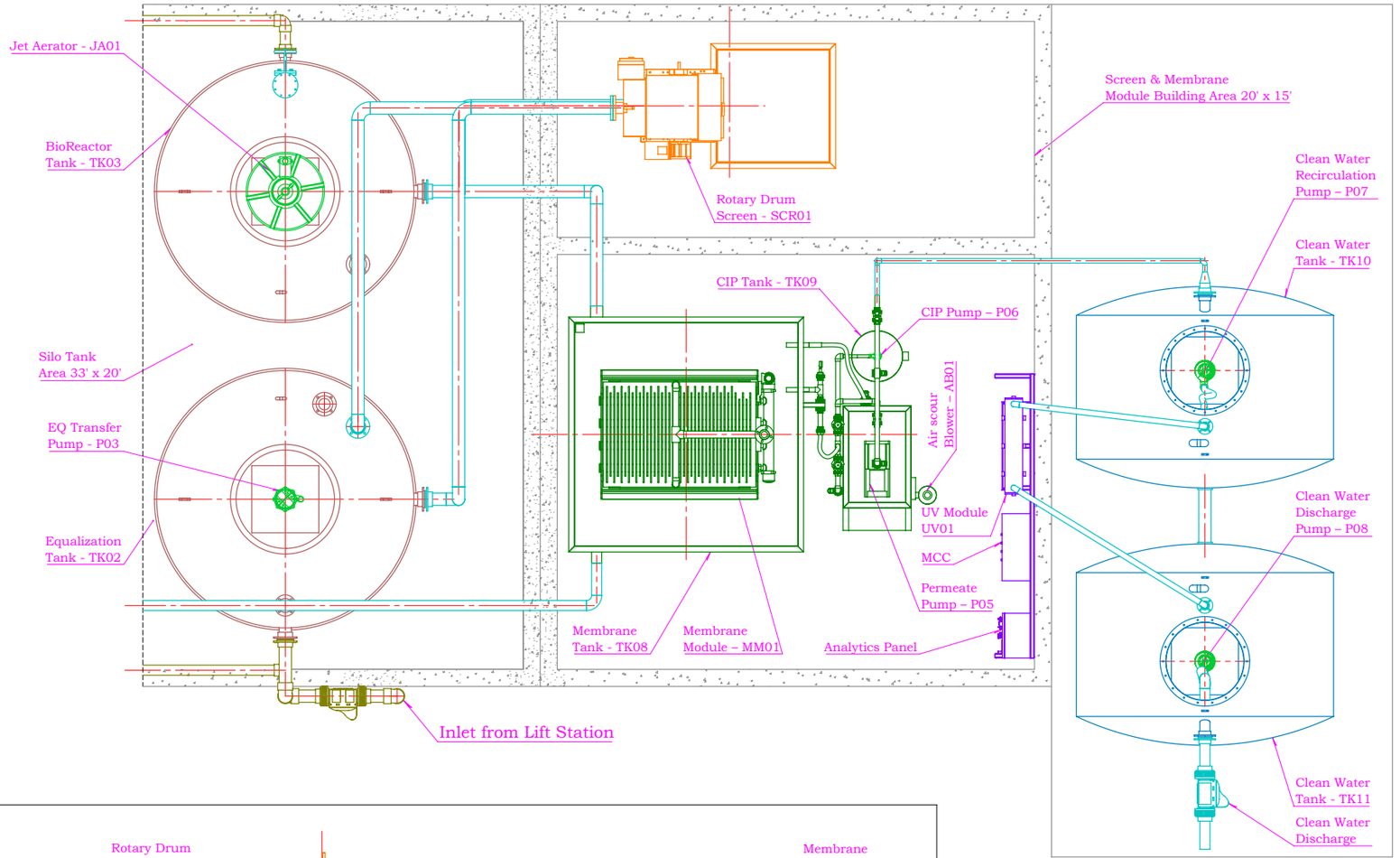
PROJECT No. ESP20002

ENEREAU

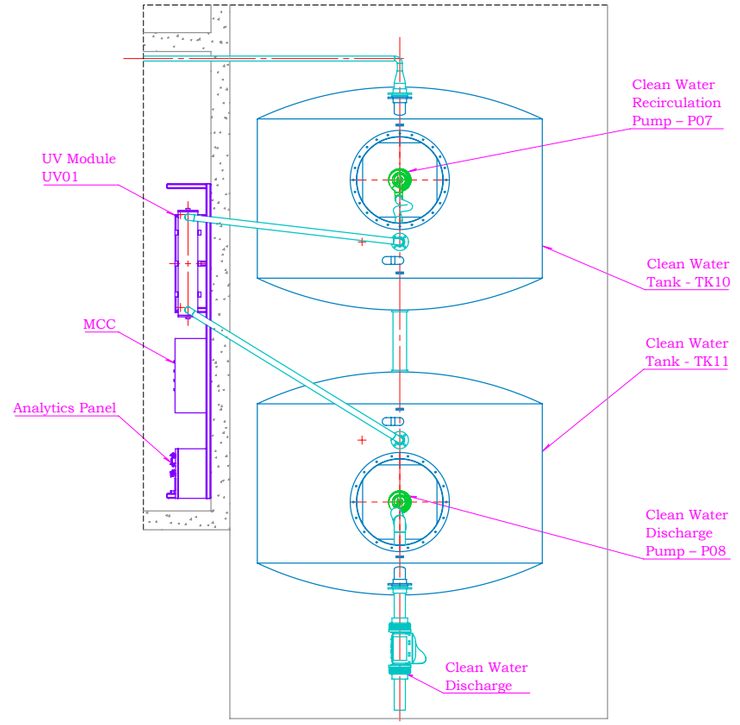
SIZE	DWG No.	REV
A2	ESP20002 GA - 001	1

MATERIAL :

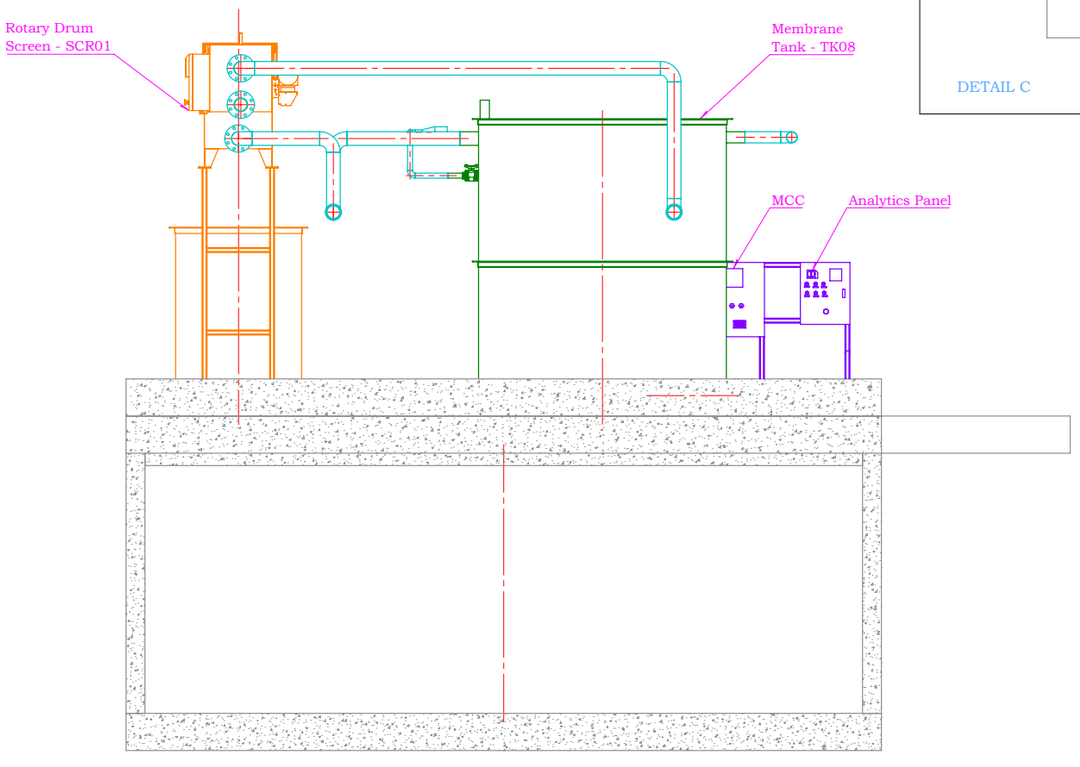
SCALE 1:80 SHEET: 1 OF 2



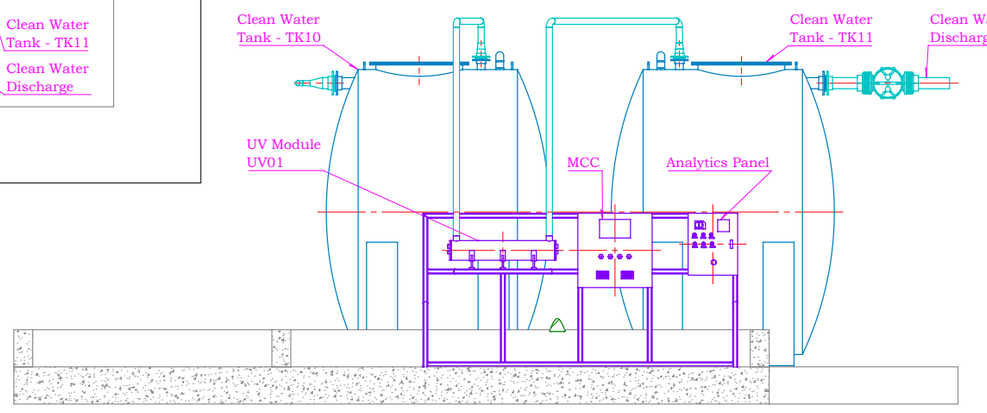
DETAIL C



DETAIL D



SECTION E-E



SECTION F-F

NOTE :
01. ALL DIMENSIONS ARE IN Feet & Inch.

	NAME	DATE
DRAWN	N. Wani	01/10/2020
CHECKED	S. Khan	01/10/2020
AS BUILD		
MGR APPR	C. Hotchkies	01/10/2020

ENEREAU SYSTEMS GROUP INC.
19 DRIFTWOOD TRAIL, RIDGEWAY ON
CANADA L0S 1N0 +1-289-321-0451

PROJECT TITLE : VANTAGE BAY

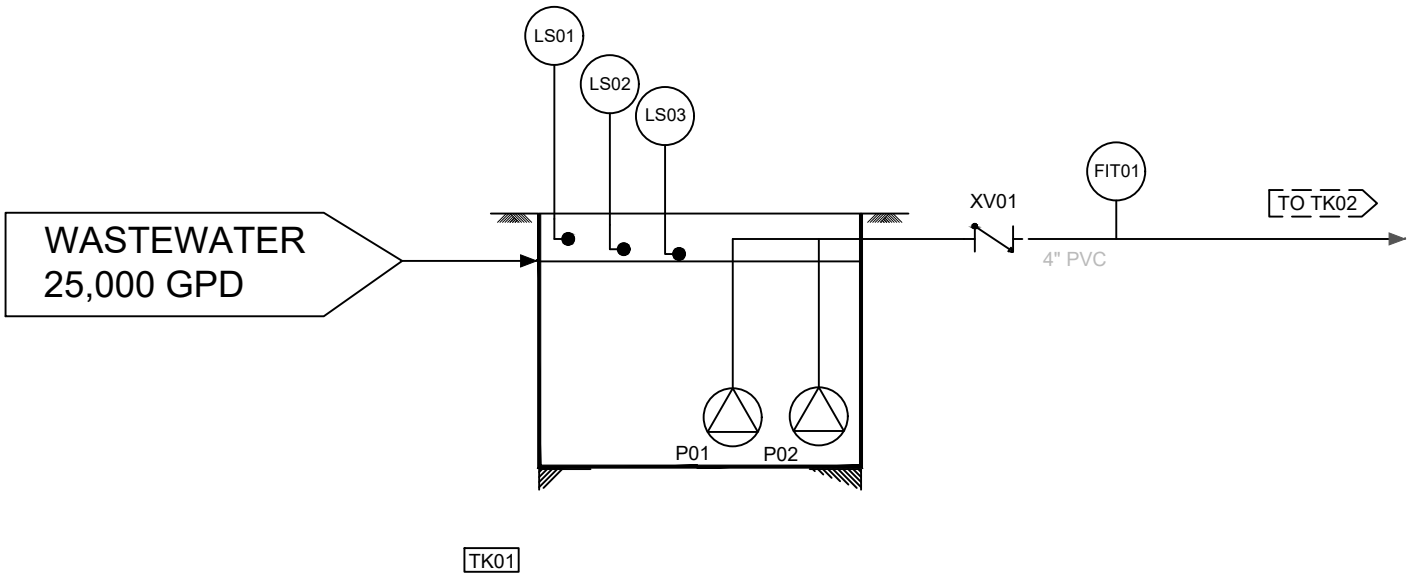
PROJECT No. ESP20002

ENEREAU

SIZE	DWG No.	REV
A2	ESP20002 GA - 001	1

MATERIAL :

SCALE	1:35	SHEET: 2 OF 2



ENEREAU

ENEREAU SYSTEMS GROUP INC.
19 DRIFTWOOD TRAIL
RIDGEWAY ONTARIO
L0S 1N0, CANADA

LEGEND

VG	VACUUM GAUGE	PG	PRESSURE GAUGE
pHT	pH SENSOR	FIT	FLOW INDICATOR TRANSMITTER
PIT	PRESSURE INDICATOR TRANS.	FM	ROTAMETER
	FLOAT		PVC BALL VALVE
	MANUAL DIAPHRAGM VALVE		MANUAL DIAGRAM VALVE
	AUTOMATED BALL VALVE		CHECK VALVE
	PRESSURE RELIEF VALVE		SCREEN
PC	PRIMING CHAMBER	UV	UV DISINFECTION
	RADIAL AERATOR/MIXER		MEMBRANE MODULE
	REGEN BLOWER		PUMP
	SILENCER		HOSE

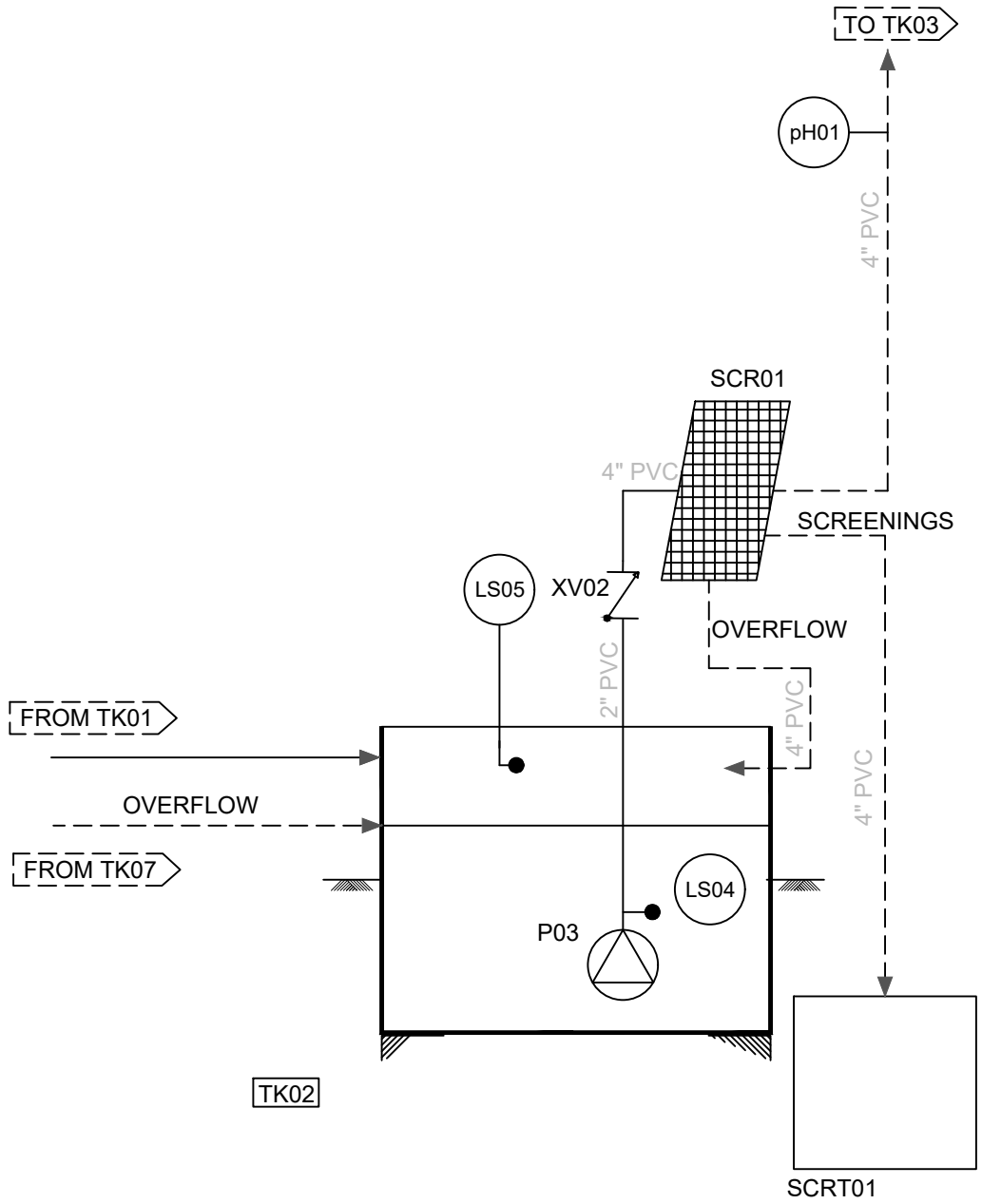
REVISION#:

REV01	20-04-06	YvP	PROCESS RECONFIGURATION
REV02	20-08-17	YvP	PROCESS RECONFIGURATION
REV03	20-09-23	YvP	PROCESS RECONFIGURATION

VANTAGE BAY

P&ID: LIFT STATION

PROJECT:	ESP20002
DATE:	20-04-06
DRAWN BY:	YvP
CHECKED BY:	CH
DRAWING #	P-001A-REV03



ENEREAU

ENEREAU SYSTEMS GROUP INC.
19 DRIFTWOOD TRAIL
RIDGEWAY ONTARIO
L0S 1N0, CANADA

LEGEND

VG	VACUUM GAUGE	PG	PRESSURE GAUGE
pHT	pH SENSOR	FIT	FLOW INDICATOR TRANSMITTER
PIT	PRESSURE INDICATOR TRANS.	FM	ROTAMETER
	FLOAT		PVC BALL VALVE
	MANUAL DIAPHRAGM VALVE		MANUAL DIAGRAM VALVE
	AUTOMATED BALL VALVE		CHECK VALVE
	PRESSURE RELIEF VALVE		SCREEN
PC	PRIMING CHAMBER	UV	UV DISINFECTION
	RADIAL AERATOR/MIXER		MEMBRANE MODULE
	REGEN BLOWER		PUMP
	SILENCER		HOSE

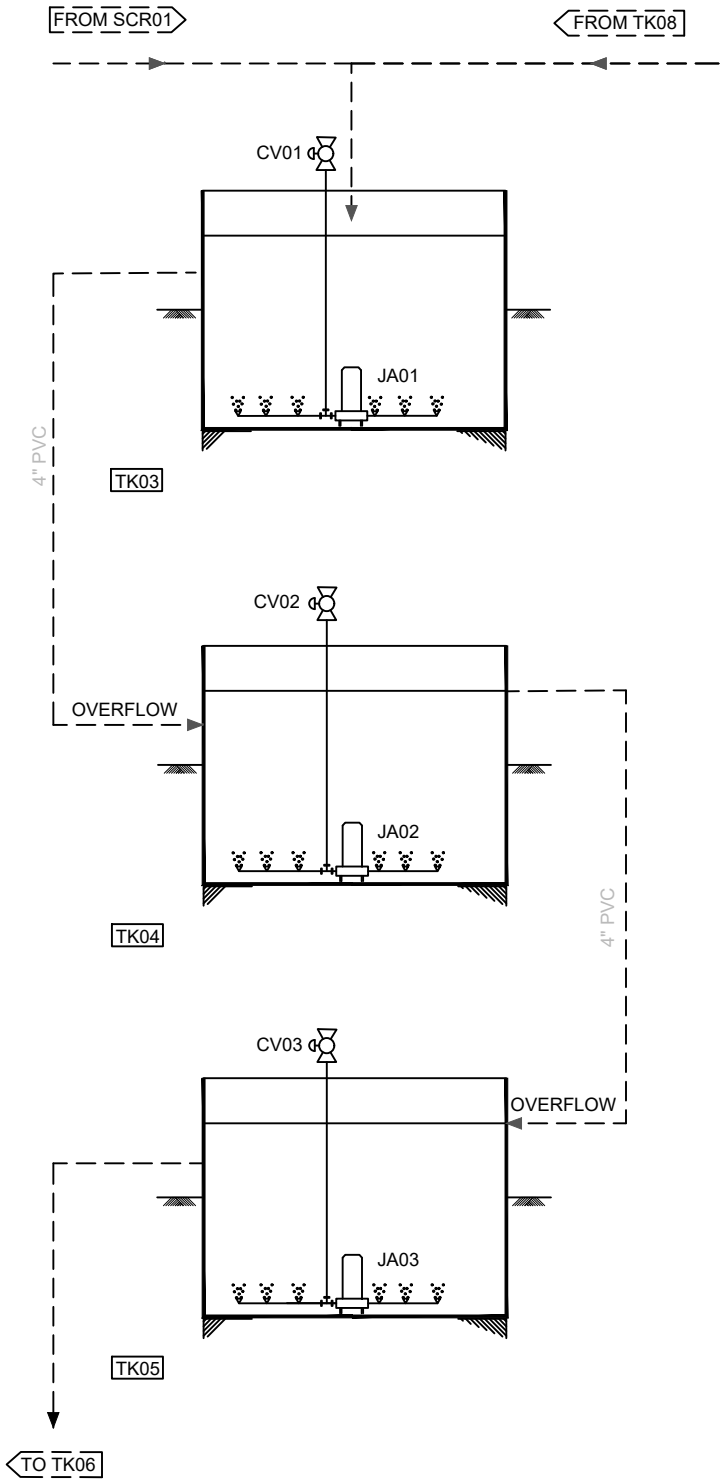
REVISION#:

REV01	20-04-06	YvP	PROCESS RECONFIGURATION
REV02	20-08-17	YvP	PROCESS RECONFIGURATION
REV03	20-09-23	YvP	PROCESS RECONFIGURATION

VANTAGE BAY

P&ID: EQUALIZATION

PROJECT:	ESP20002
DATE:	20-04-06
DRAWN BY:	YvP
CHECKED BY:	CH
DRAWING #	P-001B-REV03



ENEREAU SYSTEMS GROUP INC.
19 DRIFTWOOD TRAIL
RIDGEWAY ONTARIO
L0S 1N0, CANADA

LEGEND

VACUUM GAUGE		PRESSURE GAUGE	
pH SENSOR		FLOW INDICATOR TRANSMITTER	
PRESSURE INDICATOR TRANS.		ROTAMETER	
FLOAT		PVC BALL VALVE	
MANUAL DIAPHRAGM VALVE		MANUAL DIAGRAM VALVE	
AUTOMATED BALL VALVE		CHECK VALVE	
PRESSURE RELIEF VALVE		SCREEN	
PRIMING CHAMBER		UV DISINFECTION	
RADIAL AERATOR/MIXER		MEMBRANE MODULE	
REGEN BLOWER		PUMP	
SILENCER		HOSE	

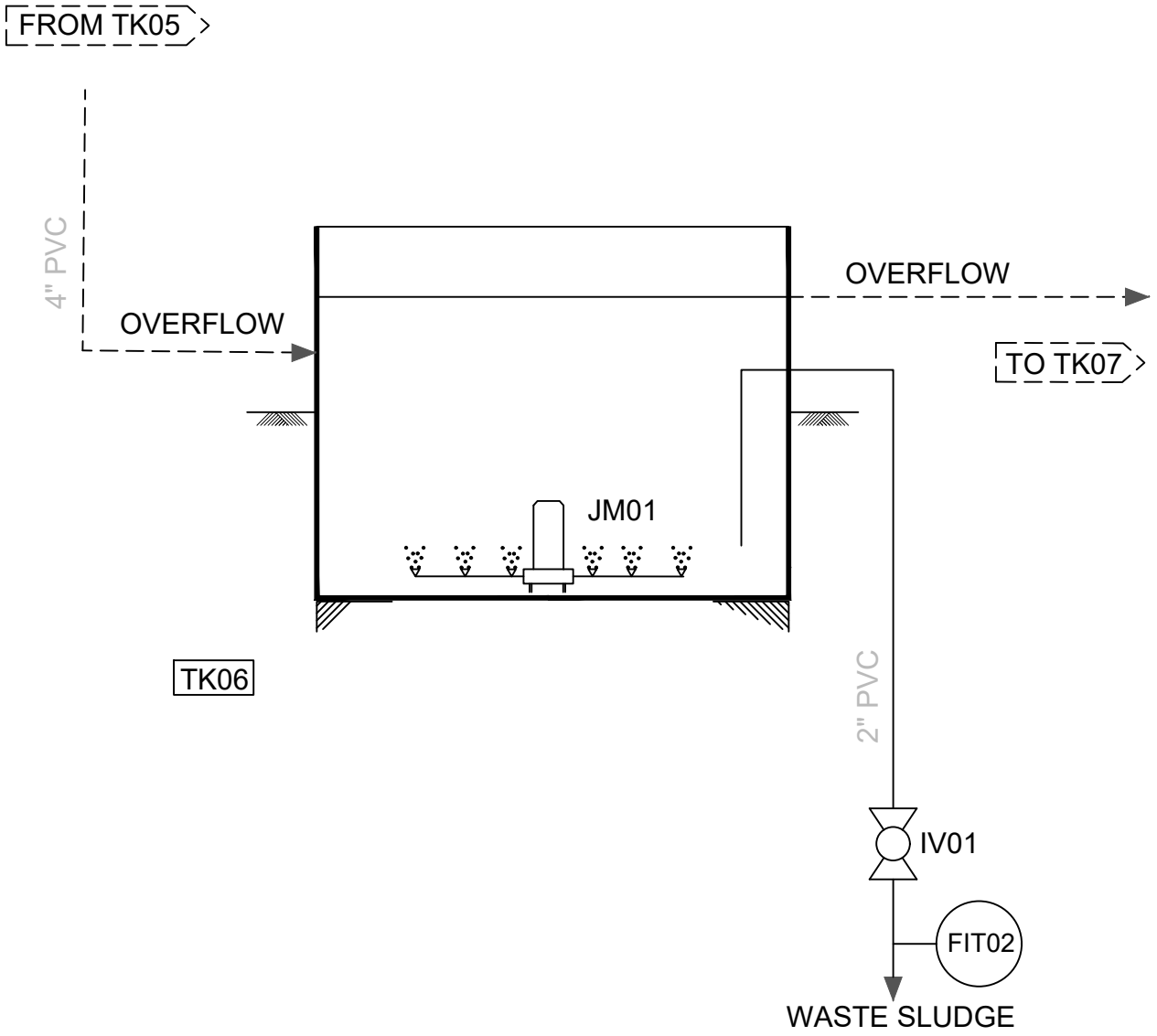
REVISION#:

REV01	20-04-06	YvP	PROCESS RECONFIGURATION
REV02	20-08-17	YvP	PROCESS RECONFIGURATION
REV03	20-09-23	YvP	PROCESS RECONFIGURATION

VANTAGE BAY

P&ID: BIOREACTOR MODULE

PROJECT:	ESP20002
DATE:	20-04-06
DRAWN BY:	YvP
CHECKED BY:	CH
DRAWING #	P-001C-REV03



ENEREAU

ENEREAU SYSTEMS GROUP INC.
19 DRIFTWOOD TRAIL
RIDGEWAY ONTARIO
L0S 1N0, CANADA

LEGEND

VG	VACUUM GAUGE	PG	PRESSURE GAUGE
pH	pH SENSOR	FIT	FLOW INDICATOR TRANSMITTER
PIT	PRESSURE INDICATOR TRANS.	FM	ROTAMETER
	FLOAT		PVC BALL VALVE
	MANUAL DIAPHRAGM VALVE		MANUAL DIAGRAM VALVE
	AUTOMATED BALL VALVE		CHECK VALVE
	PRESSURE RELIEF VALVE		SCREEN
PC	PRIMING CHAMBER	UV	UV DISINFECTION
	RADIAL AERATOR/MIXER		MEMBRANE MODULE
	REGEN BLOWER		PUMP
	SILENCER		HOSE

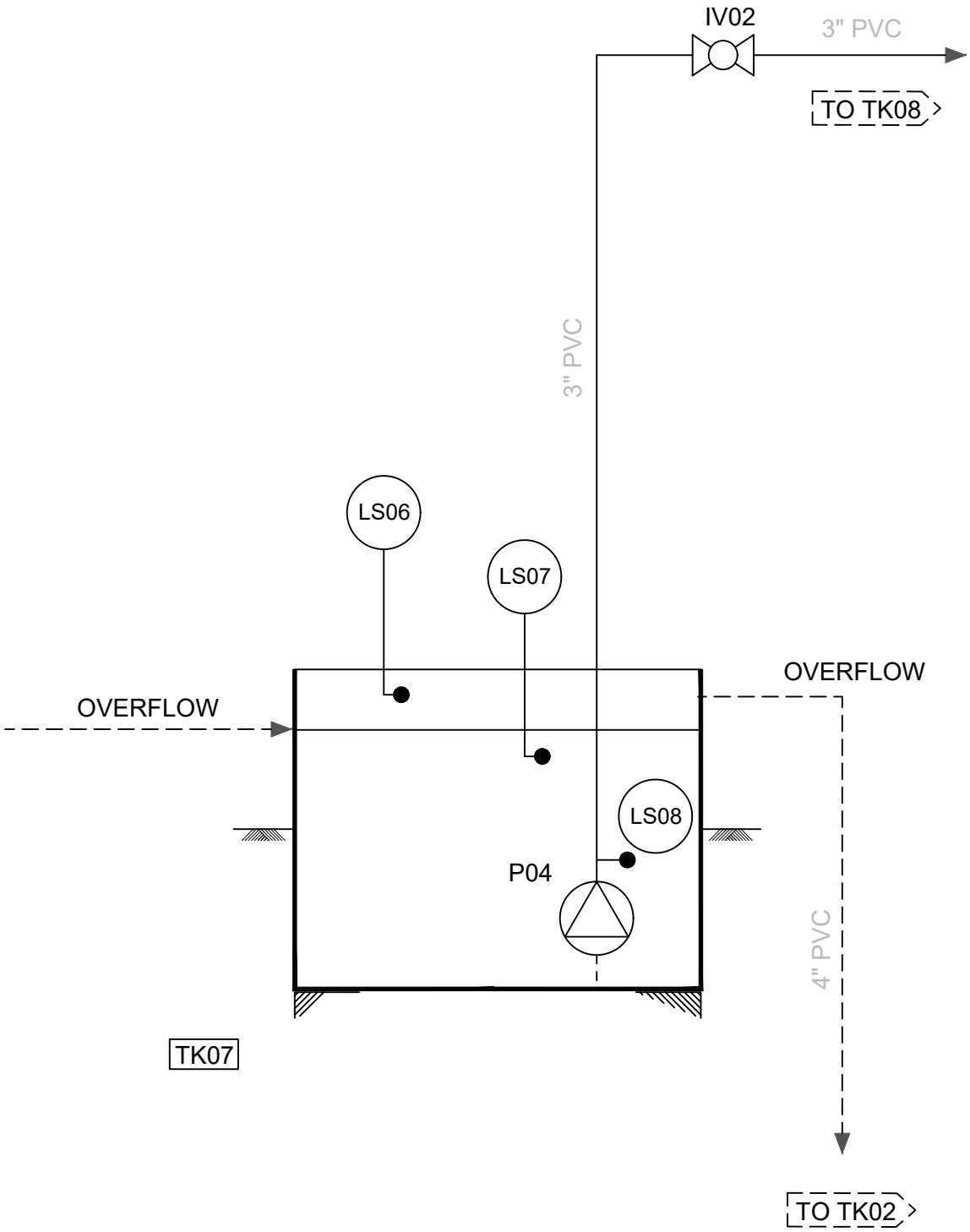
REVISION#:

REV01	20-04-06	YvP	PROCESS RECONFIGURATION
REV02	20-08-17	YvP	PROCESS RECONFIGURATION
REV03	20-09-23	YvP	PROCESS RECONFIGURATION

VANTAGE BAY

P&ID: ANOXIC MODULE

PROJECT:	ESP20002
DATE:	20-04-06
DRAWN BY:	YvP
CHECKED BY:	CH
DRAWING #	P-001D-REV03



ENEREAU

ENEREAU SYSTEMS GROUP INC.
19 DRIFTWOOD TRAIL
RIDGEWAY ONTARIO
L0S 1N0, CANADA

LEGEND

VG	VACUUM GAUGE	PG	PRESSURE GAUGE
pH	pH SENSOR	FIT	FLOW INDICATOR TRANSMITTER
PIT	PRESSURE INDICATOR TRANS.	FM	ROTAMETER
	FLOAT		PVC BALL VALVE
	MANUAL DIAPHRAGM VALVE		MANUAL DIAGRAM VALVE
	AUTOMATED BALL VALVE		CHECK VALVE
	PRESSURE RELIEF VALVE		SCREEN
PC	PRIMING CHAMBER	UV	UV DISINFECTION
	RADIAL AERATOR/MIXER		MEMBRANE MODULE
	REGEN BLOWER		PUMP
	SILENCER		HOSE

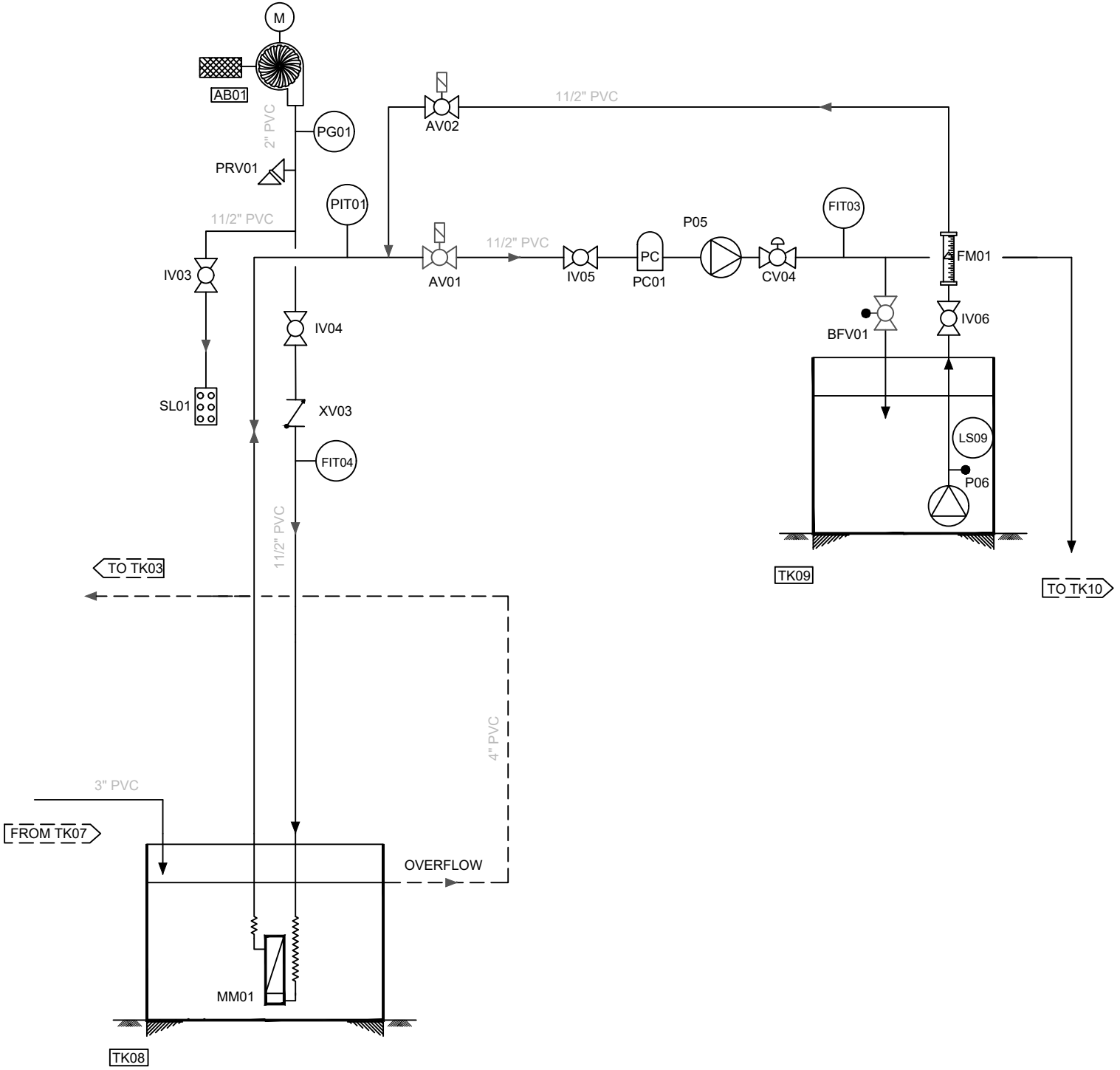
REVISION#:

REV01	20-04-06	YvP	PROCESS RECONFIGURATION
REV02	20-08-17	YvP	PROCESS RECONFIGURATION
REV03	20-09-23	YvP	PROCESS RECONFIGURATION

VANTAGE BAY

P&ID: VAR. D./ F.F. MODULE

PROJECT:	ESP20002
DATE:	20-04-06
DRAWN BY:	YvP
CHECKED BY:	CH
DRAWING #	P-001E-REV03



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ENEREAU SYSTEMS GROUP INC.
19 DRIFTWOOD TRAIL
RIDGEWAY ONTARIO
L0S 1N0, CANADA

LEGEND

VG	VACUUM GAUGE	PG	PRESSURE GAUGE
pH	pH SENSOR	FIT	FLOW INDICATOR TRANSMITTER
PIT	PRESSURE INDICATOR TRANS.	FM	ROTAMETER
	FLOAT		PVC BALL VALVE
	MANUAL DIAPHRAGM VALVE		MANUAL DIAGRAM VALVE
	AUTOMATED BALL VALVE		CHECK VALVE
	PRESSURE RELIEF VALVE		SCREEN
PC	PRIMING CHAMBER	UV	UV DISINFECTION
	RADIAL AERATOR/MIXER		MEMBRANE MODULE
	REGEN BLOWER		PUMP
	SILENCER		HOSE

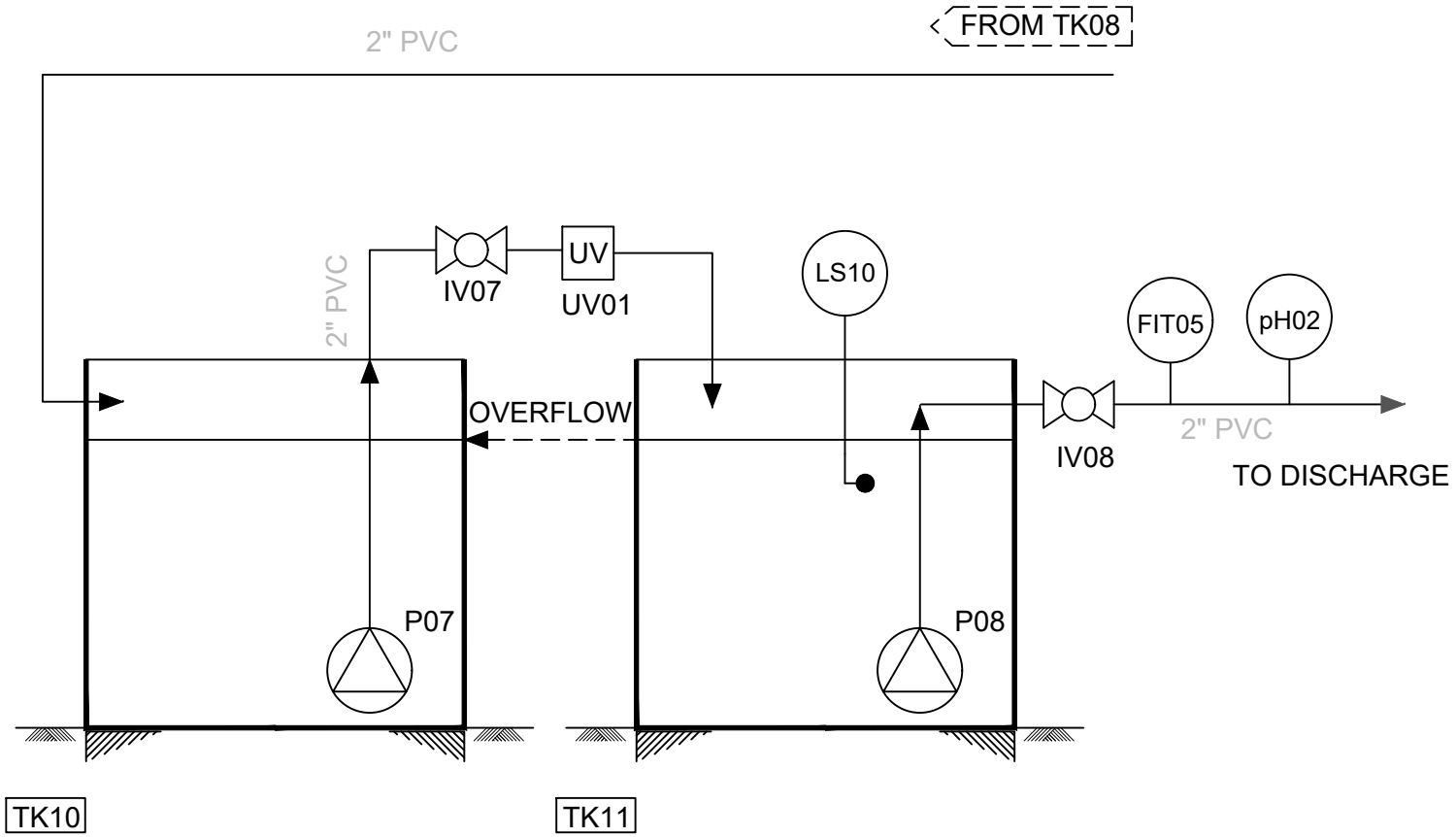
REVISION#:

REV01	20-04-06	YvP	PROCESS RECONFIGURATION
REV02	20-08-17	YvP	PROCESS RECONFIGURATION
REV03	20-09-23	YvP	PROCESS RECONFIGURATION

VANTAGE BAY

P&ID: MEM. FILTRATION MOD.

PROJECT:	ESP20002
DATE:	20-04-06
DRAWN BY:	YvP
CHECKED BY:	CH
DRAWING #	P-001F-REV03



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ENEREAU SYSTEMS GROUP INC.
19 DRIFTWOOD TRAIL
RIDGEWAY ONTARIO
L0S 1N0, CANADA

LEGEND

VG	VACUUM GAUGE	PG	PRESSURE GAUGE
pH	pH SENSOR	FIT	FLOW INDICATOR TRANSMITTER
PIT	PRESSURE INDICATOR TRANS.	FM	ROTAMETER
	FLOAT		PVC BALL VALVE
	MANUAL DIAPHRAGM VALVE		MANUAL DIAGRAM VALVE
	AUTOMATED BALL VALVE		CHECK VALVE
	PRESSURE RELIEF VALVE		SCREEN
PC	PRIMING CHAMBER	UV	UV DISINFECTION
	RADIAL AERATOR/MIXER		MEMBRANE MODULE
	REGEN BLOWER		PUMP
	SILENCER		HOSE

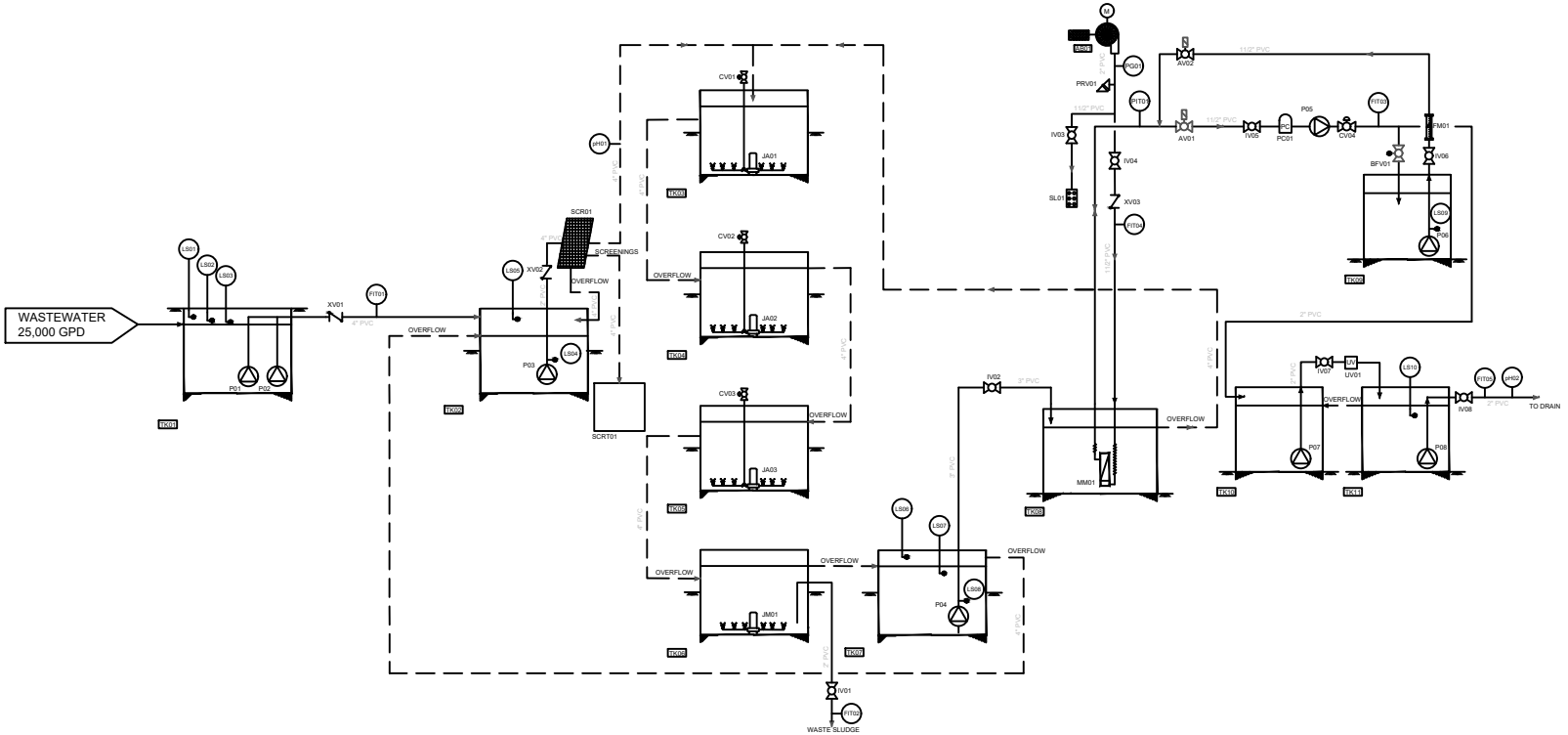
REVISION#:

REV01	20-04-06	YvP	PROCESS RECONFIGURATION
REV02	20-08-17	YvP	PROCESS RECONFIGURATION
REV03	20-09-23	YvP	PROCESS RECONFIGURATION

VANTAGE BAY

P&ID:CLEAN WATER MODULE

PROJECT:	ESP20002
DATE:	20-04-06
DRAWN BY:	YvP
CHECKED BY:	CH
DRAWING #	P-001G-REV03



ENEREAU

ENEREAU SYSTEMS GROUP INC.
19 DRIFTWOOD TRAIL
RIDGEWAY ONTARIO
L0S 1N0, CANADA

LEGEND

VG	VACUUM GAUGE	PG	PRESSURE GAUGE
pH	pH SENSOR	FIT	FLOW INDICATOR TRANSMITTER
PIT	PRESSURE INDICATOR TRANS.	FM	ROTAMETER
	FLOAT		PVC BALL VALVE
	MANUAL DIAPHRAGM VALVE		MANUAL DIAGRAM VALVE
	AUTOMATED BALL VALVE		CHECK VALVE
	PRESSURE RELIEF VALVE		SCREEN
PC	PRIMING CHAMBER	UV	UV DISINFECTION
	RADIAL AERATOR/MIXER		MEMBRANE MODULE
	REGEN BLOWER		PUMP
	SILENCER		HOSE

REVISION#:

REV01	20-04-06	YvP	PROCESS RECONFIGURATION
REV02	20-08-17	YvP	PROCESS RECONFIGURATION
REV03	20-09-23	YvP	PROCESS RECONFIGURATION

VANTAGE BAY

P&ID: OVERVIEW

PROJECT:	ESP20002
DATE:	20-04-06
DRAWN BY:	YvP
CHECKED BY:	CH
DRAWING #	P-001H-REV03

P&ID	EQUIPMENT	DISCRIPTION
LIFT STATION	LS01/02/03	LEVEL SENSOR
	P01	LIFT STATION PUMP 1
	P02	LIFT STATION PUMP 2
	XV01	CHECK VALVE
	FIT01	FLOW INDICATOR TRANSMITTER
EQUALIZATION	LS04/05	LEVEL SENSOR
	P03	EQUALIZATION TRANSFER PUMP
	XV02	CHECK VALVE
	SCR01	SCREEN
	pH01	pH SENSOR
	SCRT01	SCREENINGS TANK
BIOREACTOR MODULE	CV01/02/03	CONTROL VALVE
	JA01/02/03	JET AERATOR
ANOXIC MODULE	JM01	MIXER
	IV01	ISOLATION VALVE
	FIT02	FLOW INDICATOR TRANSMITTER
VARIABLE DEPTH/ FEED FORWARD MODULE	LS06/07/08	LEVEL SENSOR
	P04	FEED FORWARD PUMP
	IV02	ISOLATION VALVE
MEMBRANE FILTRATION MODULE	IV03/04/05/06	ISOLATION VALVE
	SL01	SILENCER
	PRV01	PERESSURE RELIEVE VALVE
	AB01	AIRSCOUR BLOWER
	PG01	PRESSURE GAUGE
	PIT01	PRESSURE INDICATOR TRANSMITTER
	FIT03/04	FLOW INDICATOR TRANSMITTER
	XV03	CHECK VALVE
	MM01	MEMBRANE MODULE
	AV01/02	AUTOMATED BALL VALVE
	PC01	PRIMING CHAMBER
	CV04	CONTROL VALVE
	P05	PERMEATE PUMP
	P06	CIP PUMP
	BFV01	BALL FLOAT VALVE
	FM01	FLOW METER
	LS09	LEVEL SENSOR
CLEAN WATER MODULE	P07	RECIRCULATION PUMP
	P08	CLEAN WATER DISCHARGE PUMP
	IV07/08	ISOLATION VALVE
	UV01	UV FILTER
	LS10	LEVEL SENSOR
	FIT05	FLOW INDICATOR TRANSMITTER
	pH02	pH SENSOR

ENEREAU

ENEREAU SYSTEMS GROUP INC.
19 DRIFTWOOD TRAIL
RIDGEWAY ONTARIO
L0S 1N0, CANADA

LEGEND

VG	VACUUM GAUGE	PG	PRESSURE GAUGE
pH	pH SENSOR	FIT	FLOW INDICATOR TRANSMITTER
PIT	PRESSURE INDICATOR TRANS.	FM	ROTAMETER
	FLOAT		PVC BALL VALVE
	MANUAL DIAPHRAGM VALVE		MANUAL DIAGRAM VALVE
	AUTOMATED BALL VALVE		CHECK VALVE
	PRESSURE RELIEF VALVE		SCREEN
PC	PRIMING CHAMBER	UV	UV DISINFECTION
	RADIAL AERATOR/MIXER		MEMBRANE MODULE
	REGEN BLOWER		PUMP
	SILENCER		HOSE

REVISION#:

REV01	20-04-06	YvP	PROCESS RECONFIGURATION
REV02	20-08-17	YvP	PROCESS RECONFIGURATION
REV03	20-09-23	YvP	PROCESS RECONFIGURATION

VANTAGE BAY

P&ID: EQUIPMENT LIST

PROJECT:	ESP20002
DATE:	20-04-06
DRAWN BY:	YvP
CHECKED BY:	CH
DRAWING #	P-001I-REV03

Control Narrative

Client **Vantage Bay**
Project Number **ESP20002**

Equipment Item	Tag	Vendor	Model	Power	Duty/Function	Description
Independent Motor Controls						
Lift station transfer pump 1	P01	Tsurumi	TOS 100C42.2	460/3/60 - 3 HP	<50% duty	Independent Tsurumi controller
Lift station transfer pump 2	P02	Tsurumi	TOS 100C42.2	460/3/60 - 3 HP	<50% duty	Independent Tsurumi controller
EQ Transfer Pump	P03	Tsurumi	50PUA2.4	460/3/60 - 0.5 HP	<50% duty	H-O w/ float
TK03 Jet aerator	JA01	Tsurumi	50TRN42.2-62	460/3/60 - 3 HP	100% duty	H-O
TK04 Jet aerator	JA02	Tsurumi	50TRN42.2-62	460/3/60 - 3 HP	100% duty	H-O
TK05 Jet aerator	JA03	Tsurumi	50TRN42.2-62	460/3/60 - 3 HP	100% duty	H-O
Anoxic Tank Mixer	JM01	Tsurumi	32TRN2.75-62	460/3/60 - 1 HP	100% duty	H-O
Clean Water Recirculation Pump	P07	Tsurumi	50PUA2.75S	2"	0	H-O
Treated Water Discharge Pump	P08	Tsurumi	50PUA2.75S	2"	0	H-O-A on CP
Rotary drum screen	SCR01	Toro	TR40/50	460/3/60 - 0.33 HP	<50% duty	Independent control on screen unit
Motor Controls in Enereau Controller						
Feed-forward Pump	P04	Tsurumi	80PUA21.5	460/3/60 - 2 HP	100% duty	H-O w/ cut-off float
Permeate Pump	P05	Serfilco	GNOK 1-1/2"/2"	120/1/60 - 0.5 HP	<50% duty	H-O-A on CP: control by LS07 in Auto
CIP Pump	P06	Tsurumi	50PUA2.25S	120/1/60 - 0.33 HP	<10% duty	H-O-A on CP: control by LS07 in Auto
Air scour blower	AB01	FPZ	KM05	460/3/60 - 4 HP	100% duty	H-O-A on CP
Sensors						
Lift station sensor - Hi-Hi	LS01	Tsurumi	Integral to Tsurumi lift station controller			Lift Station High Level Alarm
Lift station sensor - Hi	LS02	Tsurumi	Integral to Tsurumi lift station controller			Starts transfer from lift station
Lift station sensor - Lo	LS03	Tsurumi	Integral to Tsurumi lift station controller			Stops transfer from lift station
P03 Level Control	LS04	Tsurumi	Integral to P03			Starts/stops P03
TK02 High Level Alarm	LS05	MDI	3-wire ball float	24VDC (NO)	High water level alarm	Digital output
TK06 High level alarm	LS06	MDI	3-wire ball float	24VDC (NO)	High water level alarm	
Permeate Cycle level sensor	LS07	MDI	3-wire ball float	24VDC (NO)	Starts P05 >L1 & stops P05<L1	Digital input to MFM Controller
P04 Lo-Level Cut-off Control	LS08	Tsurumi	Integral w/ P04			
CIP tank level sensor	LS09	Tsurumi	Integral w/ P06		Low-level cut-off	

Process Narrative

Client **Vantage Bay**

Project No. **ESP20002**

1 Wastewater (WW) from the development is collected in an Enereau-supplied lift station (TK01) and transferred to the variable-depth Equalization (EQ) cell, TK
sensor on the discharge from P01/P02 measures and logs flow on a continuous basis.

Lift station transfer pump 1	P01	Tsurumi	TOS 100C42.2	460/3/60 - 3 HP
Lift station transfer pump 2	P02	Tsurumi	TOS 100C42.2	460/3/60 - 3 HP
	Independent Tsurumi Controller for the duplex-configuration pumps, w/ Lo, Hi & HI-Hi level controls			
Lift station sensor - Hi-Hi	LS01	Tsurumi	Lift Station High Level Alarm	
Lift station sensor - Hi	LS02	Tsurumi	Starts transfer from lift station	
Lift station sensor - Lo	LS03	Tsurumi	Stops transfer from lift station	
Raw WW check valve	XV01	GF	161 369 047	4"
Raw WW flow sensor	FIT01	ifm	SA4100	4-20mA

2 A submersible pump, with integral float control, is immersed in TK02 and transfers WW from TK02 through a rotary drum screen and discharges into the aerob
BioReactor cells whenever the water level rises above the LS04 low-level set-point and stops when the water level drops below the set-point. Screenings are c
closed-top screenings bin, SCRT01 for periodic off-site disposal. A sensor on the discharge from P03 measures and logs pH on a continuous basis.

EQ Transfer Pump	P03	Tsurumi	50PUA2.4	460/3/60 - 0.5 HP
	Independent H-O starter			
P03 Level Control	LS04	Tsurumi	Starts/stops P03	
P03 check valve	XV02	GF	161 369 044	2"
Raw WW pH sensor	pH01	Seko		
Rotary Drum Screen	SCR01	Toro	TR40/50	460/3/60 - 0.33 HP
	Independent H-O starter			

3 A level sensor in TK02 monitors the water level and activates an alarm when the water rises above the high water level.

TK02 High Level Alarm	LS05	MDI	3-wire ball float	24VDC (NO)

4 The aerobic BioReactor is configured as three (3) cells in series, TK03, TK04 & TK05 respectively, inter-connected to establish a gravity flow from TK02 to TK03
Each cell is a vertical Fiberglass Reinforced Plastic (FRP) silo.

5 Submersible jet aerators, complete with air inlet control valves, immersed in each BioReactor cell, provide a continuous supply of air (oxygen) to the mixed liqu
TK04 & TK05.

TK03 Jet aerator	JA01	Tsurumi	50TRN42.2-62	460/3/60 - 3 HP
TK04 Jet aerator	JA02	Tsurumi	50TRN42.2-62	460/3/60 - 3 HP
TK05 Jet aerator	JA03	Tsurumi	50TRN42.2-62	460/3/60 - 3 HP
	Independent H-O starters for each aerator			
JA01 air inlet control valve	CV01	Tsurumi		
JA02 air inlet control valve	CV02	Tsurumi		
JA03 air inlet control valve	CV03	Tsurumi		

6 WW flows by gravity via inter-connecting piping from TK05 to the anoxic BioReactor tank, TK06. A submersible jet mixer is immersed in TK06 to ensure adequ
of the mixed liquor.

Anoxic Tank Mixer	JM01	Tsurumi	32TRN2.75-62	460/3/60 - 1 HP

Independent H-O starter

7 A valved discharge port on TK06 is used to waste sludge from the system when required. A sensor on the discharge line may be used to measure the Waste A Sludge (WAS) flow.

WAS Isolation Valve	IV01	GF	161 375 007	2"
WAS Flow Sensor	FIT02	ifm	SA4100	4-20mA

8 WW flows by gravity via inter-connecting piping from TK06 to the Feed-forward (FF) tank, TK07. A submersible pump, with integral float for low level cut-off a valve, is immersed in TK07 and recirculates mixed liquor continuously from TK07 to the Membrane Tank, TK08, at a rate of 5-6x the Average Daily Flow (ADF) c stream flows by gravity back to TK03 and and is termed Return Activated Sludge (RAS). A high level overflow from TK07 discharges into TK02.

Feed-forward Pump	P04	Tsurumi	80PUA21.5	460/3/60 - 2 HP
	H-O-A control from the Enereau Control Panel			
	Motor starter in Enereau MCC			
P04 Lo-Level Cut-off Control	LS08	Tsurumi	Integral w/ P04	
P04 Isolation Valve	IV02	GF	161 375 009	3"

9 A level sensor monitors the water level in TK07 and sends a digital signal to the Enereau Controller. When the water level in TK07 rises above the L1 set-point, controller initiates the Permeate Cycle, described below. When the water level drops below L1, the Permeate Cycle is terminated. A separate level sensor in T activates an alarm when the water level rises above the L2 set-point.

Permeate Cycle level sensor	LS07	MDI	3-wire ball float	24VDC (NO)
TK06 High level alarm	LS06	MDI	3-wire ball float	24VDC (NO)

10 A rack of ultrafiltration membranes, MM01, is submerged in TK08

11 An air scour blower on the Permeate Skid, c/w isolation valve, pressure gauge, flow meter, check valve, by-pass valve and by-pass check valve, is connected to a diffuser grid installed at the base of the MM01 rack

Membrane air scour blower	AB01	FPZ	KM05	460/3/60 - 4 HP
	H-O-A control from the Enereau Control Panel			
	Motor starter in Enereau MCC			
Air scour isolation valve	IV04	GF	161 375 006	1-1/2"
Pressure relief valve	PRV01	FPZ		2"
Air scour pressure gauge	PG01	Medina		
Air scour flow meter	FIT04	ifm	SA5004	4-20mA
Air scour check valve	XV03	FPZ		2"
Air scour by-pass valve	IV03	GF	161 375 006	1-1/2"
Air scour by-pass silencer	SL01	McMaster-Carr		1-1/2"

12 A permeate pump on the Permeate Skid, complete with priming chamber, inlet isolation valve, flow meter and discharge control valve, is connected to a perm at the top of the MM01 rack and draws ultrafiltered water through the membranes in MM01 under suction and discharges the treated water to the Clean Wat Module, TK10 & TK11, with a float-controlled by-pass into the Backpulse/CIP Tank, TK09. In Auto, P05 operation is described in Permeate Cycle section.

Permeate Pump	P05	Serfilco	GNOK 1-1/2"/2"	120/1/60 - 0.5 HP
	H-O-A control from the Enereau Control Panel			
	Motor starter in Enereau MCC			
Priming chamber	PC01	Serfilco		
P04 inlet isolation valve	IV05	GF	151 375 006	1-1/2"
Permeate Flow meter	FIT03	ifm	SBN257	4-20mA
Permeate discharge valve	CV04	GF	151 514 616	1-1/2"
By-pass Valve to TK09	BFV01	ChemLine	BFB005-HF	1/2" x 3/8"

13 A Mororized Ball Valve on the permeate line functions as an isolation valve when CIP is being performed.

Permeate isolation valve	AV01	GF	S199167427	1-1/2"

14 A Motorized Ball Valve on the CIP line functions as an isolation valve when system is in permeation mode.

CIP isolation valve	AV02	GF	S199167427	1-1/2"

15 A Trans-membrane Pressure (TMP) sensor on the permeate line is used to monitor the TMP across the membranes during the Permeate & CIP cycles

TMP Sensor	PIT01	ifm	PA3509	-1 to +1 bar

16 A submersible pump, complete with flow control valve, flow meter and integral low-level cut-off, is submerged in TK09 and is used for Clean-in-Place (CIP) ope
For CIP, P05 is energized to pump cleaning solution in a reverse flow direction through the permeate piping to the MM01 membranes.

CIP Pump	P06	Tsurumi	50PUA2.25S	120/1/60 - 0.33 HP
	H-O-A control from the Enereau Control Panel			
	Motor starter in Enereau MCC			
P06 flow control valve	IV06	GF	161 375 006	1-1/2"
P06 flow meter	FM01	Kona		1-1/2"
CIP tank level sensor	LS09	Tsurumi	Integral w/ P06	

17 The Clean Water Storage Module is an inter-connected dual-tank configuration. A submersible pump, with isolation valve, is submerged in TK10 and pumps w
continuous basis through a Ultra-violet (UV) disinfection module and discharges into TK11. TK 10 & TK11 are inter-connected such that water recircualtes freel
the two tanks. A submersible pump, with isolation valve, is submerged in TK11 and, when activated by a level control in TK11, discharges to a drainage field (b
Sensors on the discharge from P08 measure and log flow & pH on a continuous basis.

Clean Water Recirculation Pump	P07	Tsurumi	50PUA2.75S	2"
	Independent H-O starter			
P07 Isolation Valve	IV07	GF	161 375 007	2"
UV Disinfection Module	UV01	Wyckomar	UV-5000	2"
Treated Water Discharge Pump	P08	Tsurumi	50PUA2.75S	2"
	H-O-A control from LS10			
P08 Isolation Valve	IV08	GF	161 375 007	2"
TK11 Level Sensor	LS10	MDI	3-wire ball float	24VDC (NO)
Treated Water Flow Sensor	FIT05	ifm	SA4100	4-20mA
Treated Water pH Sensor	pH02	Seko		

18 The **Permeate Cycle** is a four (4) step sequence of operations that repeats on a typical 10-minute cycle until terminated by signals from LS07

Step 1 (Permeation)	T1 (~480 sec)	Open AV01 and start P05 for the duration of T1
Step 2 (Relaxation 1)	T2 (~30 sec)	Close AV01 and stop P05
Step 3 (Backpulse)	T3 (~60 sec)	Open AV02 and start P06 for the duration of T3
Step 4 (Relaxation 2)	T4 (~30 sec)	Close AV02 and stop P06

19 The Mixed Liquor Suspended Solids (MLSS) in the system will range typically from 7 mg/L to 15 mg/L. As the MLSS approaches the 15 mg/L level, sludge shou
from the system. This is termed Waste Activated Sludge (WAS). WAS may be discharged from the system by pumping mixed liquor from the aerobic BioReac
Typically, about 25-33% of the overall mixed liquor volume (TK02+TK03+TK04) will be removed on each WAS cycle.

Electrical Vantage Bay ESP20002

Module	Item	Tag	Vendor	Model/Description	Power/Size	Quantity
Lift Station	Lift station transfer pump 1	P01	Tsurumi	TOS 100C42.2	460/3/60 - 3 HP	**1**
	Lift station transfer pump 2	P02	Tsurumi	TOS 100C42.2	460/3/60 - 3 HP	**1**
Process Tankage	EQ Transfer Pump	P03	Tsurumi	50PUA2.4	460/3/60 - 0.5 HP	1
	Rotary Drum Screen	SCR01	Toro	TR40/50	460/3/60 - 0.33 HP	1
Bioreactor	TK03 Jet aerator	JA01	Tsurumi	50TRN42.2-62	460/3/60 - 3 HP	1
	TK04 Jet aerator	JA02	Tsurumi	50TRN42.2-62	460/3/60 - 3 HP	1
	TK05 Jet aerator	JA03	Tsurumi	50TRN42.2-62	460/3/60 - 3 HP	1
	Anoxic Tank Mixer	JM01	Tsurumi	32TRN2.75-62	460/3/60 - 1 HP	1
	Feed-forward Pump	P04	Tsurumi	80PUA21.5	460/3/60 - 2 HP	1
Filtration	Permeate Pump	P05	Serfilco	GNOK 1-1/2"/2"	120/1/60 - 0.5 HP	1
	Membrane air scour blower	AB01	FPZ	KM05	460/3/60 - 4 HP	1
	CIP Pump	P06	Tsurumi	50PUA2.25S	120/1/60 - 0.33 HP	1
Post-treatment	Clean Water Recirculation Pump	P07	Tsurumi	50PUA2.75S	2"	1

Appendix F
WRF Cost Estimates

ENGINEER'S ESTIMATE

OWNER: Vantage Bay
PROJECT: Water Reclamation Facility - Phase 1
DATE: 10/1/2020
PLSA PROJECT NO: 19316

ITEM DESCRIPTION	ITEM UNIT	ITEM QTY.	ENGINEER'S ESTIMATE	
			UNIT PRICE	AMOUNT
Influent Lift Station Pumps and Structure	LS	1	$33,500	$33,500
Tank Excavation	CY	500	$25	$12,500
Tank Mounting Pad	LS	1	$20,000	$20,000
Enereau Scope of Supply	LS	1	$420,000	$420,000
Enereau Scope - Installation	LS	1	$21,000	$21,000
Mechanical Fine Screen Equipment Pad and Shelter	LS	1	$15,000	$15,000
Membrane System Equipment Pad and Shelter	LS	1	$20,000	$20,000
Rapid Infiltration Basin - Pipe	LF	360	$30	$10,800
Rapid Infiltration Basin - Gravel	CY	70	$35	$2,450
Discharge Force Main, 2 In. Diam.	LF	270	$40	$10,800
Additional Electrical and Controls	LS	1	$5,000	$5,000
Miscellaneous Metals	LS	1	$10,000	$10,000
Additional Site Piping	LS	1	$10,000	$10,000
SubTotal				$591,050
Tax 8.0%				$47,300
Construction Contingency (10%)				$63,800
Construction Total				**$702,150**

ENGINEER'S ESTIMATE

OWNER: Vantage Bay
PROJECT: Water Reclamation Facility - Phase 2
DATE: 10/1/2020
PLSA PROJECT NO: 19316

ITEM DESCRIPTION	ITEM UNIT	ITEM QTY.	ENGINEER'S ESTIMATE	
			UNIT PRICE	AMOUNT
Mobilization	LS	1	$12,200	$12,200
Erosion Control	LS	1	$5,000	$5,000
Lift Station Pump	LS	1	$7,500	$7,500
Tank Excavation	CY	500	$25	$12,500
Enereau Scope of Supply	LS	1	$294,000	$294,000
Enereau Scope - Installation	LS	1	$14,700	$14,700
Mechanical Fine Screen Equipment Pad and Shelter	LS	1	$15,000	$15,000
Membrane System Equipment Pad and Shelter	LS	1	$20,000	$20,000
Effluent Pump	LS	1	$5,000	$5,000
Rapid Infiltration Basin - Pipe	LF	180	$30	$5,400
Rapid Infiltration Basin - Gravel	CY	40	$35	$1,400
Additional Electrical and Controls	LS	1	$5,000	$5,000
Miscellaneous Metals	LS	1	$10,000	$10,000
Additional Site Piping	LS	1	$10,000	$10,000
SubTotal				$417,700
Tax 8.0%				$33,400
Construction Contingency (10%)				$45,100
Construction Total				**$496,200**

ENGINEER'S ESTIMATE

OWNER: Vantage Bay
PROJECT: Water Reclamation Facility - Phase 3
DATE: 10/1/2020
PLSA PROJECT NO: 19316

ITEM DESCRIPTION	ITEM UNIT	ITEM QTY.	ENGINEER'S ESTIMATE	
			UNIT PRICE	AMOUNT
Mobilization	LS	1	$2,700	$2,700
Erosion Control	LS	1	$5,000	$5,000
Enereau Scope of Supply	LS	1	$50,000	$50,000
Enereau Scope - Installation	LS	1	$10,000	$10,000
Membrane System Equipment Pad and Shelter	LS	1	$20,000	$20,000
Additional Electrical and Controls	LS	1	$5,000	$5,000
SubTotal				$92,700
Tax 8.0%				$7,400
Construction Contingency (10%)				$10,000
Construction Total				**$110,100**

Appendix G
RH2 Technical Memo

TECHNICAL MEMORANDUM

Client:	Ketchikan Drywall Services		
Project:	Vantage Bay Planned Unit Development		
Project File:	KDS 20-0097.00.0002	Project Manager:	Paul Cross, PE
Composed by:	Steve Nelson, LHG		
Reviewed by:	Paul Cross, PE		
Subject:	Hydrogeologic Evaluation of Class A Wastewater Discharge		
Date:	August 31, 2020		

State of Washington Hydrogeologist 1402 Licensed Geologist
STEPHEN ERIC NELSON

Signed: 08/31/2020

PAUL R. CROSS STATE OF WASHINGTON 22808 REGISTERED PROFESSIONAL ENGINEER

Signed: 08/31/2020

INTRODUCTION

The proposed residential Vantage Bay planned unit development (PUD) on approximately 58 acres of land near the Town of Vantage, Washington, will use an on-site wastewater treatment system with membrane bioreactor (MBR) technology to generate Class A wastewater that will be partially discharged to ground for reuse and partially reclaimed in the summer months for irrigation supply. The Class A wastewater will be discharged to an on-site infiltration system, and the wastewater will percolate into unconsolidated permeable soil, migrate laterally, and ultimately discharge into a mixing zone along an inlet (Inlet in this memorandum) of the nearby Columbia River and into the Columbia River mainstem. The wastewater discharge rate at full build-out is estimated to range from 37,600 to 66,300 gallons per day (gpd). The site is shown on **Figure 1.**

SITE CONDITIONS

Site Topography and Location

The Site is south of the town of Vantage in Kittitas County and accessible by Huntzinger Road immediately to the west of the Site. At the time of the site observation in July 2020, heavy equipment was grading the Site for the development, and there were several dirt access roads that lead onto the Site. The Site slopes generally to the east, with a terraced upland and slope area near Huntzinger Road and flat, broad terrain along the eastern portion of the Site. The elevation ranges from 650 feet above mean sea level (amsl) at Huntzinger Road to 580 feet amsl at the eastern property line. The Site is at latitude 46.933 W, longitude 119.988 E, and within Section 30 of Township 17N Range 23E. The main body of the Columbia River is approximately 1,000 to 1,300 feet east of the eastern Site boundary. However, a small Inlet of the Columbia River running north and south extends within 200 feet of the eastern property line (**Figure 1**). The Inlet is connected to the river approximately 1,100 feet southeast of the southern Site boundary. The Inlet is a shallow, partially excavated trough between 3 and 5 feet deep. Review of LiDAR imagery available on the Washington State Department of Natural Resources (WDNR) website indicates that the channel may have been used as a source of excavated soil borrow to construct the subgrade for the former disused airstrip that is immediately east of the north end of the Inlet.

The Site (before grading) was covered mostly with shrub-steppe vegetation consisting primarily of grass and sagebrush (**Photo 1**). Aquatic, shrub, and grass vegetation grows within 25 feet of the Inlet shoreline (**Photo 2**). The Site was lightly developed up until the grading activity, and included irrigated pasture, stock grazing, and soil borrow excavation. Property to the north is used for irrigated orchard. Property to the west and south is essentially undeveloped. Property to the east across the Inlet is owned by GCPUD and was developed with a paved airstrip but is otherwise undeveloped.

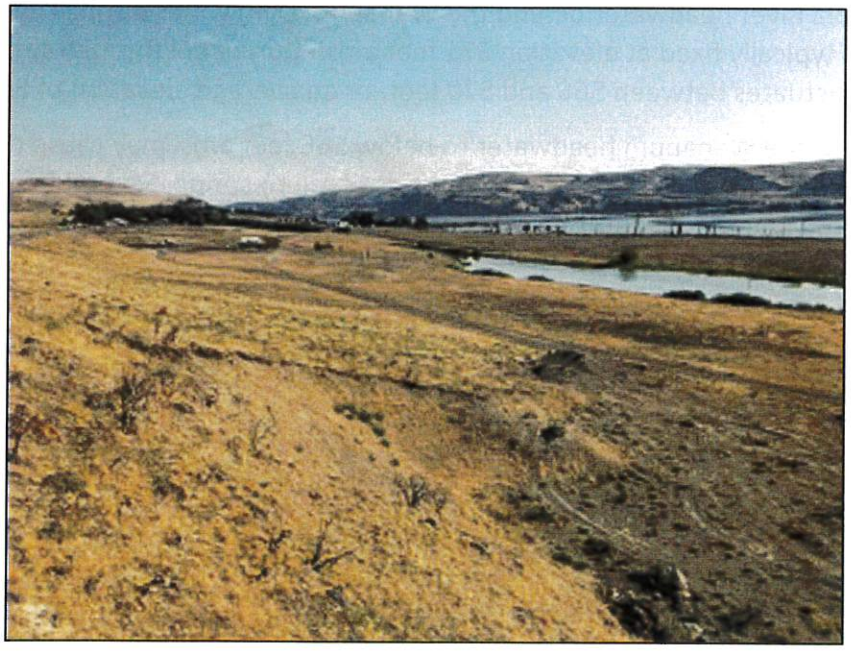


Photo 1. Vantage Bay PUD Site looking north. July 2020.

The water exhibited no indications of flow on the calm morning of the site visit. The shoreline was densely vegetated with grasses and low shrubs, and the Inlet bottom was covered with silt and fine sand.

Geology

Undisturbed Site soil observed during the site visit consists of cobbly silty sand lightly covered with windblow silt. Exposed gullies in the upper terraced and sloped area on the Site revealed stratified sand and gravel layers that were partially cemented with caliche.

Geologic mapping by WDNR indicates that the Site is immediately underlain by recent alluvium and ice-age flood deposits consisting of layers of coarse sand and gravel with silt. The unconsolidated sand and gravel deposits (surficial geologic unit) as described in ESNW (2020a, b) were encountered at all testing locations, indicating that the surficial geologic unit is extensive and continuous, and ranges in thickness from less than 5 feet to the east to more than 100 feet thick to the west. (Refer to **Attachment 2** for figure for locations and soil test pit/boring logs.) The thickness increases away from the Columbia River shoreline, reaching a maximum near Huntzinger Road. Test pit explorations encountered more than 10 feet of the surficial geologic unit at the southeastern Site boundary, and less than 5 feet of these deposits at the northeaster Site boundary. The thickness of the surficial geologic unit at the proposed Class A wastewater infiltration area (**Figure 1**) is estimated at 10 feet deep. No groundwater was observed at any of the test pit locations. Basalt was encountered at nearly all test pit locations at depths of 10 feet or less. Refer to **Attachment 2** for test pit logs and a soil boring log.

The basalt bedrock is mapped by WDNR as the Frenchman Springs Member of the Wanapum Basalt. It is described in ECNW (2020a, b) as hard and porphyritic [basalt minerals are visible]. The borehole that was drilled for the water supply well encountered hard, fractured, and vesicular basalt from a depth of 7 feet to 241 feet bgs (RH2, 2008; **Attachment 2**).

Groundwater

The surficial geologic unit is essentially dry and contains no measurable groundwater. The basalt unit underlying the surficial unit contains groundwater-bearing zones within fractures and open zones in the basalt, and hydraulically communicates with water in the Columbia River. Groundwater was encountered in the basalt boring at a depth of approximately 200 feet bgs. Groundwater level in the well is approximately the same as the nearby headwater level and fluctuates with the headwater elevation, generally between 550 and 571 feet amsl.

A thin water-bearing zone originating from surface water seepage into and out of the surficial geologic unit at high river levels likely extends from the Inlet shoreline to the west towards the eastern Site boundary. This water-bearing zone flows into and out of the surficial geologic unit as the headwater rises and falls with the elevation of the Columbia River. The extent of this thin zone depends on the topography of the contact between the surficial geologic unit and the top of the basalt. It is reasonable to assume that this contact slopes from west to east towards the centerline of the Columbia River, as suggested by the river bathymetry.

The operation of the dam, fluctuation of the water table, and the inflow and drainage of the Inlet indicates that the groundwater-surface water interaction at the Inlet is complex. As the headwater

The estimated volume of water in the Inlet is about 5,000,000 gallons, assuming an average water depth of 3 feet at maximum water level.

It is reasonable to assume that over time the wastewater/groundwater mound will develop a 1- to 2-foot-thick saturated layer above the basalt.

The shortest travel time for wastewater from the discharge area to mix with surface water can be estimated based on the shortest distance from the discharge area to the nearest surface water body (the Inlet), the elevation drop between the discharge area and the area of mixing, and the hydraulic conductivity of the surficial geologic unit.

Assuming a 420-foot distance from the infiltration area and an average height of groundwater above the Inlet elevation of 12 feet as the elevation drop from the groundwater mound, the estimated hydraulic gradient is 0.029 feet per foot. Using the soil grain-size analysis method of the Washington State Department of Ecology's *Stormwater Management Manual for Eastern Washington* and the sieve analysis results for soil samples collected at Test Pit 9, the estimated saturated hydraulic conductivity of the surficial geologic unit is 68 feet per day. Based on these data, the time of travel from the infiltration area to the nearest point on the Inlet shoreline is about 186 days or 6 months.

The elevation of the surface water in the Inlet varies with the fluctuation of the headwater elevation. The velocity of the wastewater/groundwater will increase as the water table drops and increases the gradient. As the water table rises, the gradient flattens and velocity decreases, and the radial dispersion or spreading of the wastewater/groundwater increases. Calculating the day to day changes in discharge rate, velocity, travel time, flow direction, and mixing rates is a complex problem, not reasonably possible with the limited data available. Therefore, average elevations were used to evaluate the travel time of the wastewater/groundwater flow.

Fate of Wastewater at Discharge Area

Wastewater infiltrating to the subsurface will accumulate below the infiltration area then flow predominantly to the east towards the Inlet. As the wastewater interacts with the unconsolidated soil, the water quality will improve through nutrient removal, soil absorption, and mineral precipitation, processes that are typical for all wastewater discharges to the subsurface. Portions of the infiltrated wastewater will discharge to the Inlet, and a portion will bypass the Inlet and flow towards and ultimately discharge along a broad mixing zone along the Columbia River shoreline (**Figure 4**).

The wastewater will be treated to Class A standards, which includes estimated total dissolved solids (TDS) of no more than 500 milligrams per liter (mg/L), nitrogen below groundwater drinking water standards (10 mg/L), and a turbidity of less than 1 NTU. For comparison, a sample of Inlet water collected in July 2020 contained a TDS of approximately 100 mg/L and a turbidity of 30 NTU.

Upon reaching the surface water at the Inlet, the wastewater (now technically, groundwater) will interact with surface water along the mixing zone near the Inlet shoreline (**Figure 4**). During the summer months, when the headwater level is relatively high and stable, the groundwater will mix with and discharge to the surface water along a relatively narrow zone along the north end of the Inlet shoreline. Since the water level in the Inlet is relatively stable, little or no flushing action of discharged wastewater/groundwater will occur during summer. During summer, the shoreline vegetation will be undergoing maximum growth and absorbing available nutrients from soil and wastewater/groundwater discharging along the shoreline.

References

Earth Solutions NW, LLC. (January 2020a).*Infiltration Evaluation, Proposed Vantage Bay PUD, Huntzinger Road, Kittitas County (Vantage), Washington*.

Earth Solutions NW, LLC. (June 2020b). *Geotechnical Consulting Services, Proposed Vantage Bay PUD, Huntzinger Road, Kittitas County (Vantage), Washington*.

RH2 Engineering, Inc. (2008). *Vantage Bay Hydrogeologic Evaluation*. Prepared for BCSCBN, Inc.

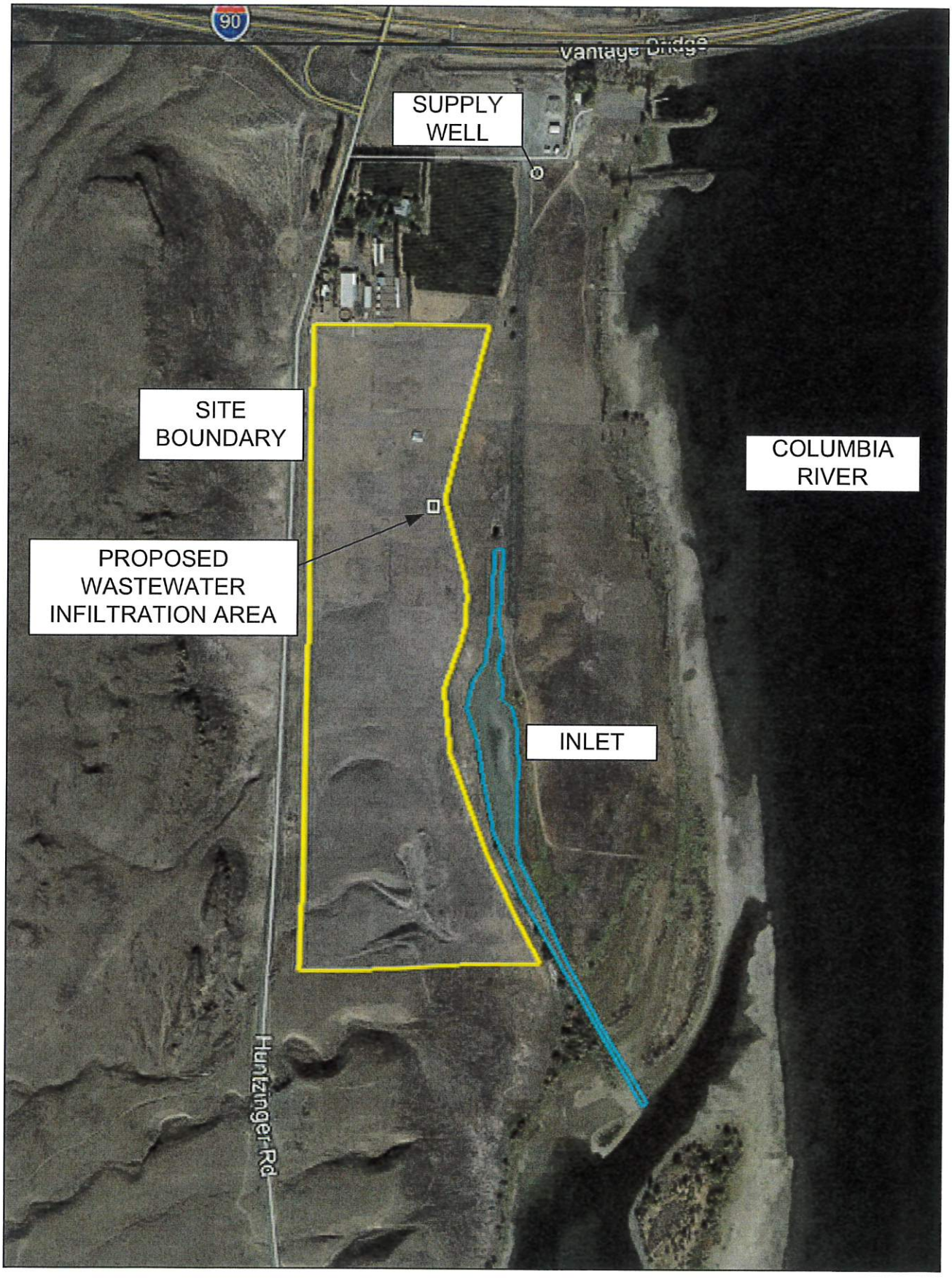
Figures

1. Figure 1 – Vantage Bay PUD Site Map
2. Figure 2 – Wanapum Headwater Elevation – August 2019 to August 2020
3. Figure 3 – Wanapum Headwater Elevation – Summer and Autumn, 2019
4. Figure 4 – Infiltration Area and Wastewater/Groundwater Flow Path

Attachments

1. Vantage Bay PUD Conceptual Site Plan
2. Site Investigation Map and Investigation Logs
3. Vantage Bay Bathymetry
4. Vantage Bay Historical Aerial Photographs

FIGURE 1
SITE MAP
VANTAGE BAY PUD

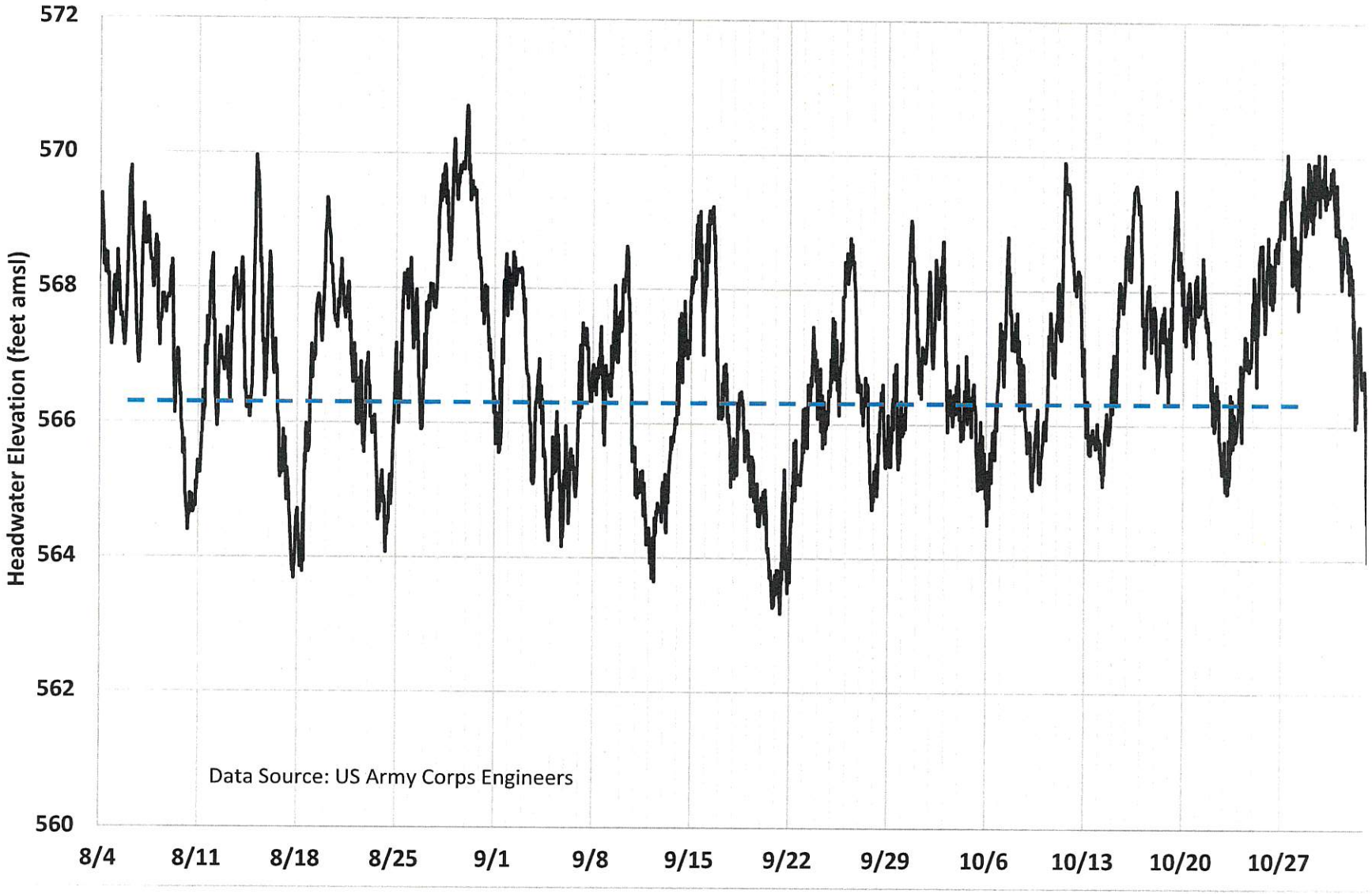


Source: Google Earth

1,000 feet

RH2 ENGINEERING, INC.

Figure 3
Wanapum Headwater Elevation - Summer and Autumn, 2019
Vantage Bay Hydrogeologic Evaluation



Attachment 1

Vantage Bay PUD Conceptual Site Plan

A PORTION OF THE EAST 1/2 OF SECTION 30, TOWNSHIP 17 N., RANGE 26 E., W.M.

n

SCALE: 1" = 120'

120 60 0 120 240

CONTOUR INTERVAL = 2'

OWNER/DEVELOPER
BCSCBN, INC. dba VANTAGE BAY
21828 87TH AVE SE, #200
WOODINVILLE, WA 98072
425-486-7825
CONTACT: BILL COWAN

BIOLOGIST
ENVIRONMENTAL ASSESSMENT SERVICES
PO BOX 265
RICHLAND, WA 99352
509-375-1481
CONTACT BRETT TILLER

WASTEWATER ENGINEER
PACE ENGINEERS, INC.
104 EAST 9TH STREET
WENATCHEE, WA 98801
509-662-1762
CONTACT ROBIN NELSON

SURVEYOR
TODD LOUKUS LAND SURVEYING, LLC
NO LONGER IN BUSINESS
BOUNDARY AND TOPOGRAPHIC SURVEY
DATED MARCH 31, 2006

TRAFFIC ENGINEER
TRANSPORTATION ENGINEERING NORTHWEST
818 6TH STREET S
KIRKLAND, WA 98033
206-361-7333
CONTACT: JEFF HAYNIE

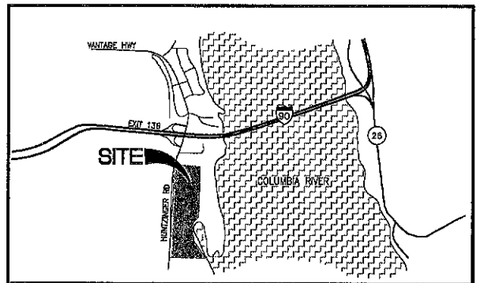
HYDROGEOLOGIST
RH2 ENGINEERS
300 SIMON STREET SE, SUITE 5
EAST WENATCHEE, WA 98802
509-886-2800
CONTACT: STEVE NELSON

PLANNER/CIVIL ENGINEER
ESM CONSULTING ENGINEERS, LLC
33400 8TH AVE S, #205
FEDERAL WAY, WA 98003
253-838-6113
CONTACT: ERIC LaBRIE

ARCHAEOLOGICAL SURVEY
NORTHWEST GEOCULTURAL CONSULTING
804 NORTH B STREET
ELLENSBURG, WA98926
509-925-5379
TUCKER CRVALD

SITE DATA

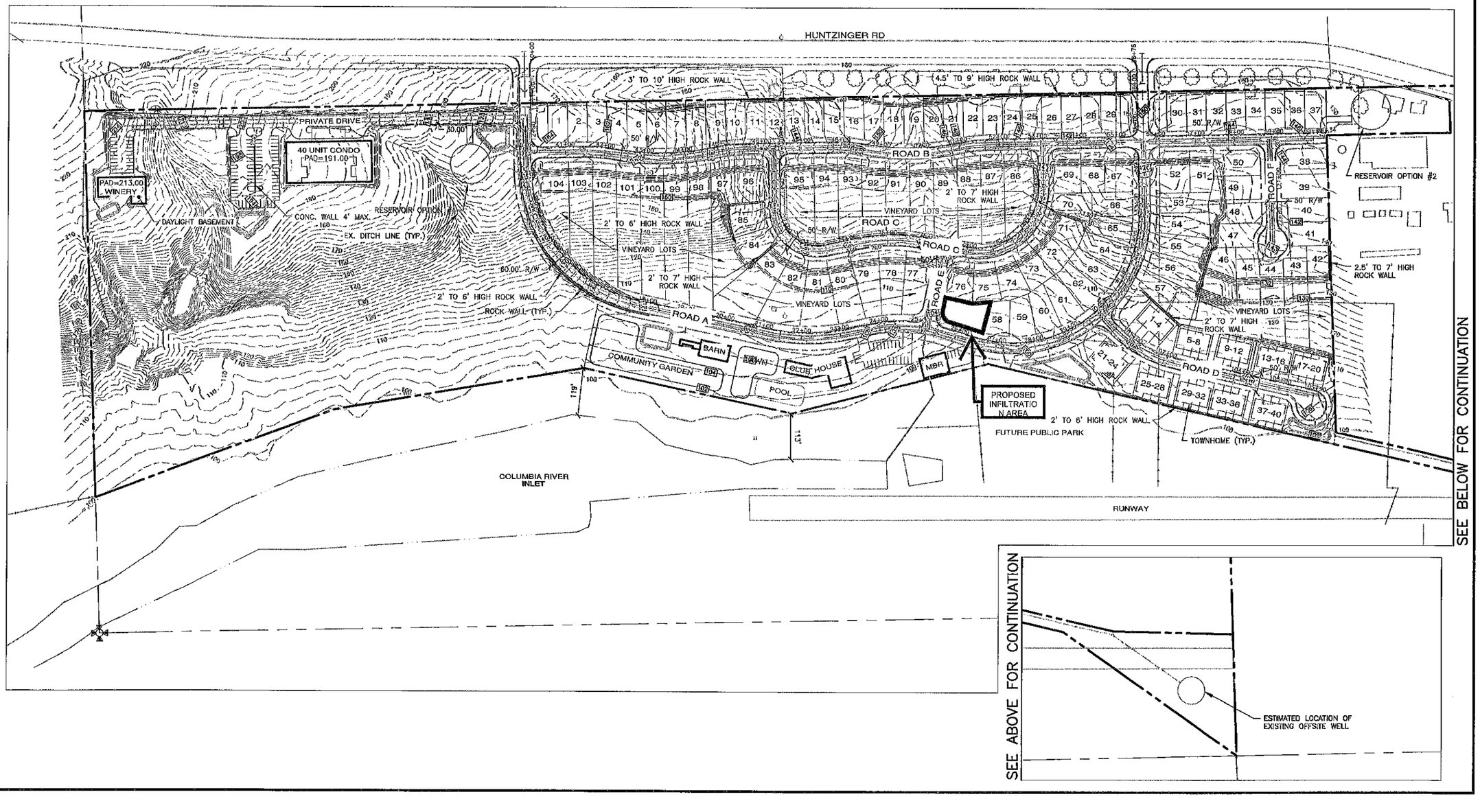
1. TAX PARCEL NOS.: 17-23-30000-0001, 17-23-30000-0003 AND 17-23-30010-0006
2. SITE AREA: 75.6 ACRES TOTAL
   PHASE 1 – 58.2 ACRES
   PHASE 2 – 17.4 ACRES
3. ZONING: PLANNED UNIT DEVELOPMENT (PUD)
4. LAND USE APPROVALS:
   KITTITAS COUNTY: ORDINANCE NO. 2006-60
   PUD / REZONE: FILE NO. Z-06-29
   PRELIMINARY PLAT: FILE NO. P-06-28
   SEPA MDNS: APPROVED AUG. 29, 2006
5. APPROVED DENSITY: 310 SINGLE-FAMILY RESIDENTIAL UNITS (±50'x90' TYP)
6. PROPOSED DENSITY: UP TO 310 SINGLE-FAMILY RESIDENTIAL UNITS (MIXED SIZES, INCLUDING ATTACHED TOWNHOMES)



VICINITY MAP — NOT TO SCALE

APPROXIMATE EARTHWORK QUANTITIES

CUT = 69,800 cu yds.
FILL = 56,600 cu yds.
TOTAL = 13,200 net cu yds. CUT



REVISIONS		
NO.	DESCRIPTION/DATE	BY

ESM CONSULTING ENGINEERS, LLC
33400 8th Ave S, Suite 205
Federal Way, WA 98003
www.esmcivil.com
(253) 838-6113
(425) 297-7813
FEDERAL WAY
EVERETT
Civil Engineering | Land Surveying
Public Works | Project Management
Land Planning
Landscape Architecture
WASHINGTON

BCSCBN, INC.

VANTAGE BAY PUD

CONCEPTUAL SITE PLAN

KITTITAS COUNTY

JOB NO.:	1306/001/014
DWG. NAME:	GR-02
DESIGNED BY:	
DRAWN BY:	TMA
CHECKED BY:	
DATE:	08/01/2017
DATE OF PRINT:	

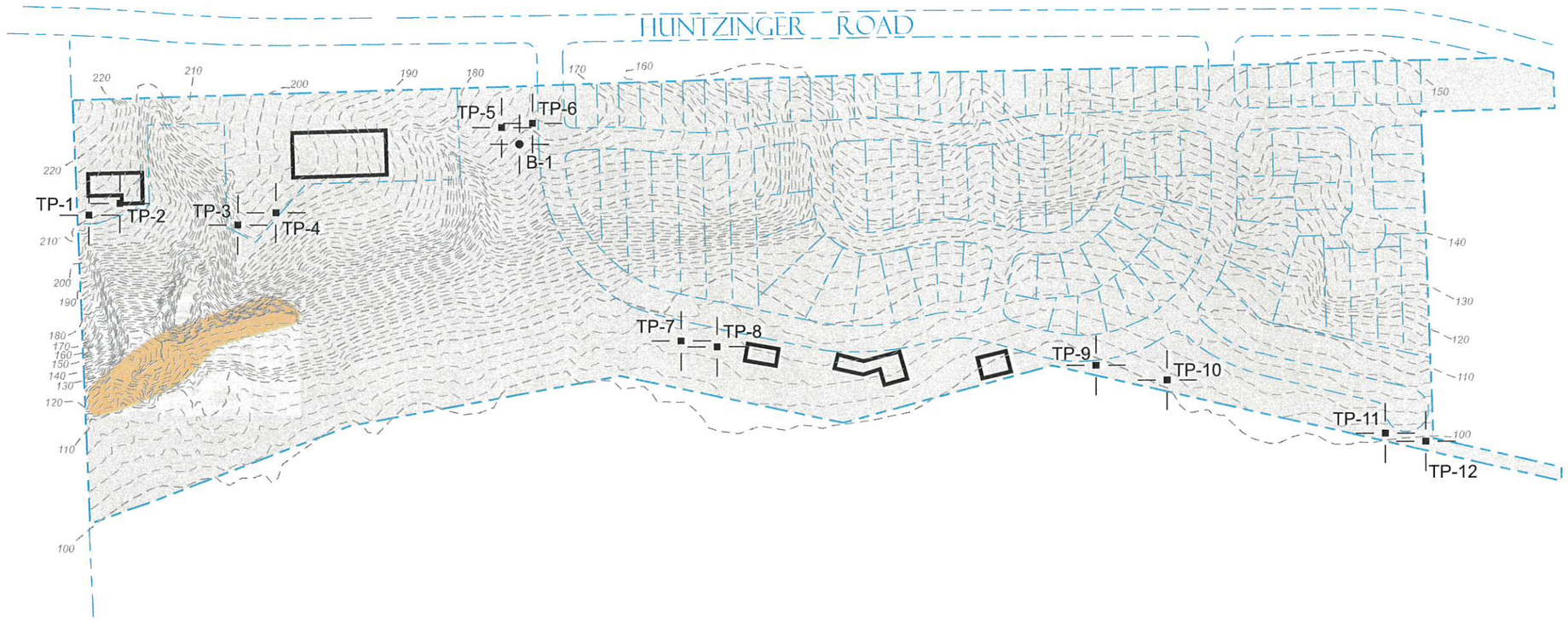
GR-02

1 OF 1 SHEETS

File: \\esm9\esm\ESM-2015\1306\001\014\plans\GR-02.dwg
Plotted: 8/1/2017 10:37 AM Plotted By: Tracy Ackerman

Attachment 2

Site Investigation Map and Investigation Logs



NORTH

1"=400'

0 200 400

Scale in Feet

LEGEND

B-1 — Approximate Location of ESNW Boring, Proj. No. ES-7104.01, May 2020

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-7104, Jan. 2020

Subject Site

Proposed Building

Area of Grab Samples SG-01 through SG-04

NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided by the client at the time of our study. ESNW cannot be responsible for subsequent design changes or interpretation of the data by others.

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Subsurface Exploration Plan
Vantage Bay
Kittitas County (Vantage), Washington

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Drwn. By	MRS
Checked By	HTW
Date	06/22/2020
Proj. No.	7104.01
Plate	2

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-9

PROJECT NUMBER ES-7104 **PROJECT NAME** Vantage Bay

DATE STARTED 1/2/20 **COMPLETED** 1/2/20 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR Advantage Dirt Contractors, Inc. **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY AZS **CHECKED BY** HTW **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": field grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, caving to BOH
0.5			SM		Brown silty SAND, loose to medium dense, damp
2.0		MC = 1.80% Fines = 6.80%	GM		Gray poorly graded GRAVEL with silt and sand, medium dense, damp [USDA Classification: extremely gravelly very fine sandy LOAM]
5		MC = 2.40%			
7.5			Basalt		Dark brown BASALT, very hard, moist -porphyritic
8.0					Test pit terminated at 8.0 feet below existing grade due to refusal on very hard bedrock. No groundwater encountered during excavation. Caving observed from TOH to BOH. Bottom of test pit at 8.0 feet.

WATER WELL REPORT

Original & 1st copy - Ecology, 2nd copy - owner, 3rd copy - driller

Construction/Decommission ("x" in circle) 298679

[X] Construction

[ ] Decommission *ORIGINAL INSTALLATION*

Notice of Intent Number _____

PROPOSED USE: [X] Domestic [ ] Industrial [ ] Municipal [ ] DeWater [ ] Irrigation [ ] Test Well [ ] Other _____

TYPE OF WORK: Owner's number of well (if more than one) _____

[X] New well [ ] Reconditioned *Method* [ ] Dug [ ] Bored [ ] Driven [ ] Deepened [ ] Cable [X] Rotary [ ] Jetted

DIMENSIONS: Diameter of well 10 inches, drilled 241 ft

Depth of completed well 241 ft

CONSTRUCTION DETAILS

Casing Installed: [X] Welded 10 " Diam from +2 ft to 26 ft

[ ] Liner installed _____ " Diam from _____ ft to _____ ft

[ ] Threaded _____ " Diam From _____ ft to _____ ft

Perforations: [ ] Yes [X] No

Type of perforator used _____

SIZE of perfs _____ in by _____ in and no of perfs _____ from _____ ft to _____ ft

Screens: [ ] Yes [X] No [ ] K-Pac Location _____

Manufacturer's Name _____

Type _____ Model No _____

Diam _____ Slot size _____ from _____ ft to _____ ft

Diam _____ Slot size _____ from _____ ft to _____ ft

Gravel/Filter packed: [ ] Yes [X] No Size of gravel/sand _____

Materials placed from _____ ft to _____ ft

Surface Seal: [X] Yes [ ] No To what depth? 26 ft

Material used to seal BENTONITE CHIPS

Did any strata contain unusable water? [ ] Yes [X] No

Type of water? _____ Depth of strata _____

Method of sealing strata off _____

PUMP: Manufacturer's Name _____

Type _____ H.P _____

WATER LEVELS: Land-surface elevation above mean sea level _____ ft

Static level 17 ft below top of well Date 5/14/08

Artesian pressure _____ lbs per square inch Date _____

Artesian water is controlled by _____ (cap, valve, etc)

WELL TESTS: Drawdown is amount water level is lowered below static level

Was a pump test made? [ ] Yes [X] No If yes, by whom? _____

Yield _____ gal/min with _____ ft drawdown after _____ hrs

Yield _____ gal/min with _____ ft drawdown after _____ hrs

Yield _____ gal/min with _____ ft drawdown after _____ hrs

Recovery data (time taken as zero when pump turned off) (water level measured from well top to water level)

Time	Water Level	Time	Water Level	Time	Water Level

Date of test _____

Bailer Test _____ gal/min with _____ ft drawdown after _____ hrs

Airtest 150 gal/min with stem set at 241 ft for 2 hrs

Artesian flow _____ g p m Date _____

Temperature of water _____ Was a chemical analysis made? [ ] Yes [X] No

CURRENT

Notice of Intent No. WE08192

Unique Ecology Well ID Tag No. BAJ036

Water Right Permit No CS-ADJ73029

Property Owner Name B C S C B N INC

Well Street Address HUNTZINGER ROAD

City VANTAGE BAY County KITTITAS

Location SE 1/4-1/4 NE 1/4 Sec 30 Twn 17N R 23E EWM [X] Check Or WWM [ ] One

(s, t, r Still REQUIRED)

Lat/Long Lat Deg _____ Lat Min/Sec _____

Long Deg _____ Long Min/Sec _____

Tax Parcel No. (Required) 142933

CONSTRUCTION OR DECOMMISSION PROCEDURE

Formation: Describe by color, character, size of material and structure, and the kind and nature of the material in each stratum penetrated, with at least one entry for each change of information (USE ADDITIONAL SHEETS IF NECESSARY)

MATERIAL	FROM	TO
BROWN FINE SAND, LOOSE, DRY WITH	0	
BLACK BASALT CHUNKS		7
WEATHERED BASALT, DRY	7	9
BLACK BASALT, WEAK, DRY,	9	32
FRACTURED BLACK & BROWN BASALT	32	35
BLACK BASALT, WEAK, DRY	35	46
BROWN & BLACK BASALT, FRACTURED	46	66
BLACK BASALT, MODERATE, DRY	66	80
BLACK BASALT, OCCASIONAL FRACTURE,	80	94
BLACK BASALT, DENSE, DRY	94	118
BLACK BASALT, FRACTURES, DRY	118	122
BLACK BASALT, DENSE, DRY	122	162
BLACK, GREEN, BLUE BASALT,FRACTURED	162	
WATER BEARING		194
BLACK BASLAT, MODERATE, DRY	194	217
DARK GRAY BASALT, DENSE, HARD, DRY	217	221
BLACK & GRAY BASALT, FRACTURED,	221	
WATER BEARING		223
BLACK & RED BASALT, FRACTURED,	223	
WATER BEARING		224
BROWN WEATHERED BASALT, FRACTURED	224	
WATER BEARING		231
BLACK BASALT, MODERATE, DRY	231	241

JUN 17 2008

Department of Ecology

Start Date 5/12/08 Completed Date 5/14/08

WELL CONSTRUCTION CERTIFICATION: I constructed and/or accept responsibility for construction of this well, and its compliance with all Washington well construction standards. Materials used and the information reported above are true to my best knowledge and belief.

[X] Driller [ ] Engineer [ ] Trainee Name (Print) ROGERAY BUYTHIAN

Driller/Engineer/Trainee Signature _____

Driller or trainee License No 2053

IF TRAINEE Driller's License No _____

Driller's Signature _____

Drilling Company ARCADIA DRILLING INC

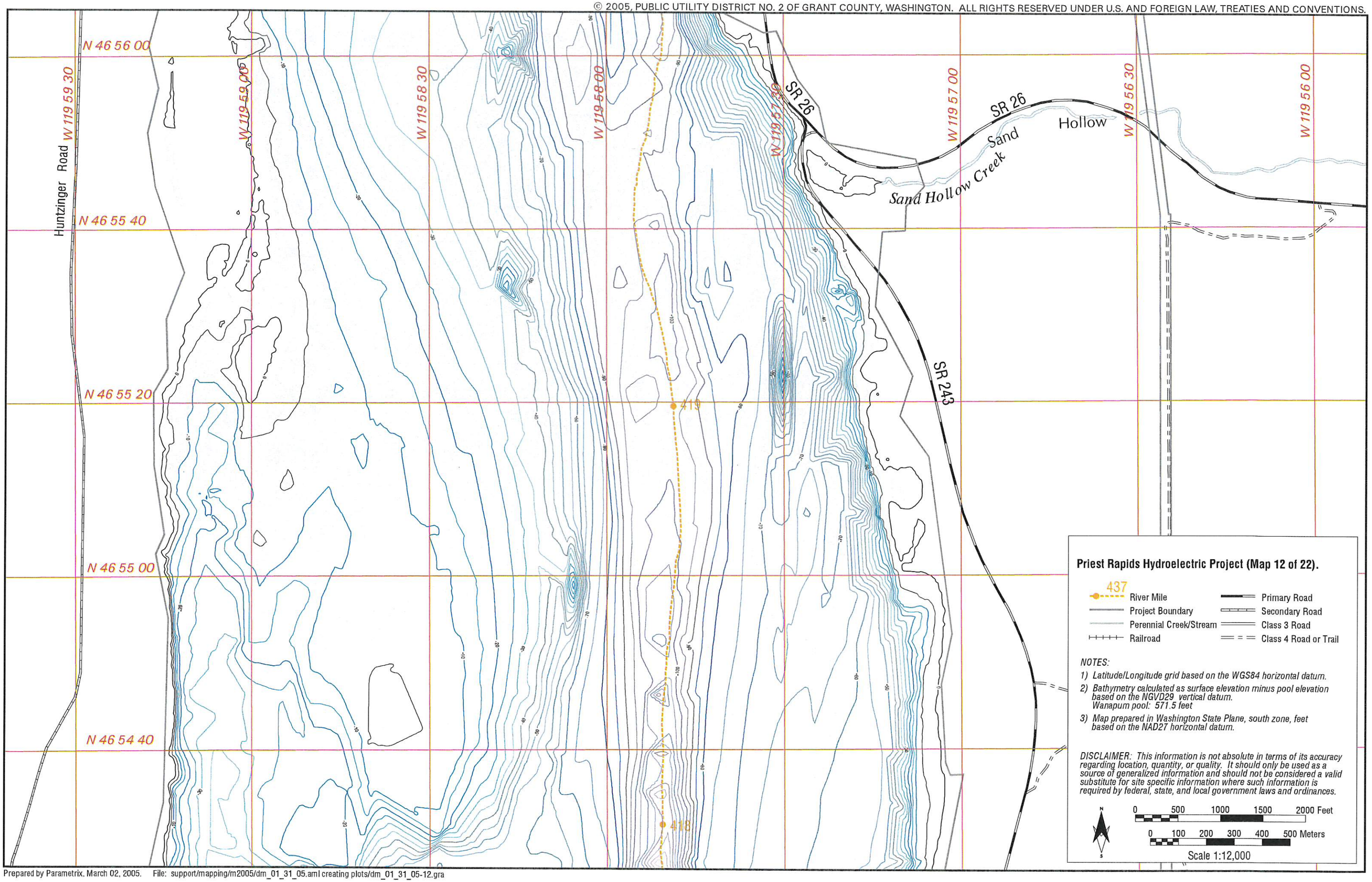
Address PO BOX 1790

City, State, Zip SHELTON , WA , 98584

Contractor's Registration No ARCADD1098K1 Date 5/20/08

ECY 050-1-20 (Rev 4/07)

Ecology is an Equal Opportunity Employer



Priest Rapids Hydroelectric Project (Map 12 of 22).

437 River Mile
Project Boundary
Perennial Creek/Stream
Railroad
Primary Road
Secondary Road
Class 3 Road
Class 4 Road or Trail

NOTES:

1) *Latitude/Longitude grid based on the WGS84 horizontal datum.*
2) *Bathymetry calculated as surface elevation minus pool elevation based on the NGVD29 vertical datum. Wanapum pool: 571.5 feet*
3) *Map prepared in Washington State Plane, south zone, feet based on the NAD27 horizontal datum.*

DISCLAIMER: This information is not absolute in terms of its accuracy regarding location, quantity, or quality. It should only be used as a source of generalized information and should not be considered a valid substitute for site specific information where such information is required by federal, state, and local government laws and ordinances.

0 500 1000 1500 2000 Feet
0 100 200 300 400 500 Meters
Scale 1:12,000

Prepared by Parametrix, March 02, 2005. File: support/mapping/m2005/dm_01_31_05.aml creating plots/dm_01_31_05-12.gra

Attachment 4

Vantage Bay Historical Aerial Photographs

Vantage Bay Historic Aerial Photographs