TECHNICAL MEMORANDUM

Groundwater Study in Support of a Large Capacity Septic System, Cascade RV Co-Op, McKenzie Bridge, Lane County, Oregon

To: Shawn McFadden / Oregon Cascade RV Co-Op

From: Matt Kohlbecker, RG / GSI Water Solutions, Inc.
Jesse Hall, GIT / GSI Water Solutions, Inc.

Cc: Tim Gross, PE / Civil West Engineering, Inc.
Michael Faught / Oregon Cascade RV Co-Op

Date: July 28, 2023

1. Background

Oregon Cascade RV Co-op (Oregon Cascade), located on Highway 126 in McKenzie Bridge, Oregon, manages sanitary and residential waste streams with a septic system. The septic system serves 52 full hookup RV spaces, 11 mobile home spaces, a coin operated laundry facility, and a shower facility.

Oregon Cascade is planning to replace its septic system. DEQ regulations[1] require a written assessment of the impact of the proposed system on the quality of groundwater (called a "groundwater study" in this scope of work). This technical memorandum (TM) documents a groundwater study using the Large Onsite Septic System (LOSS) model, which was developed by the Washington State Department of Ecology and simulates nitrate attenuation due to mixing in groundwater. Specifically, wastewater is mixed with groundwater in the aquifer, groundwater entering the aquifer from upgradient, and infiltrating precipitation. Inputs to the LOSS model include certain characteristics of the wastewater, physical dimensions of the site, and subsurface soil properties. Output from the LOSS model is the nitrate concentration in groundwater some distance from the septic drainfield.

2. Model Input Parameters

Model input parameters are summarized in Table 1. The following subsections describe the methods that were used to develop the model input parameters and the value of the model input parameters used in the LOSS model. Model input parameters were developed based on scientific literature, default values in the LOSS model developed by the Washington Department of Ecology, septic system designs provided by Civil West Engineering, property maps, and water well driller records from the Oregon Department of Water Resources.

[1] OAR 340-071-0520(6)

Table 1. LOSS Model Input Parameters.

Model Input Parameter	Symbol	Value	Units	Subsection in the Text
Nitrate Concentration in Precipitation	N_R	0.24	mg/L	Subsection 2.1
Total Nitrogen Concentration in Wastewater	N_W	24.0	mg/L	Subsection 2.2
Soil Denitrification	d	0.10	percent	Subsection 2.3
Aquifer Thickness	b	20	feet	Subsection 2.4
Drainfield Area	A_D	20,000	ft^2	Subsection 2.5
Distance from Drainfield to Property Boundary	D_{pb}	782	feet	Subsection 2.6
Aquifer Width	W_A	220	feet	Subsection 2.7
Aquifer Hydraulic Conductivity	K	1,000	feet/day	Subsection 2.8
Hydraulic Gradient	i	0.01	feet/feet	Subsection 2.9
Recharge	R	28	inches/year	Subsection 2.10
Nitrate Concentration of Upgradient Groundwater	N_B	0.24	mg/L	Subsection 2.11
Wastewater Volume	V_W	7,000	gpd	Subsection 2.12

Notes

mg/L = milligrams per liter gpd = gallons per day ft^2 = square feet

2.1 Nitrate Concentration in Precipitation (N_R)

Precipitation contains a small amount of nitrate from anthropogenic and natural sources. The default value for N_R of 0.24 milligrams per liter (mg/L) from DOH (2021) was used in the LOSS model.

2.2 Total Nitrogen Concentration in Wastewater (N_W)

The total nitrogen concentration in wastewater (N_W) used in the LOSS model is 24 mg/L. This value reflects the DOH (2021) default value for residential strength nitrogen concentration in wastewater (60 mg/L)[2] reduced 60 percent by treatment. Oregon Cascade plans to achieve the 60 percent reduction by using a single stage AdvanTex system.

2.3 Soil Denitrification (d)

After discharge from the septic drainfield, denitrification in soil reduces the nitrate concentration that reaches groundwater. The default value for d of 10 percent from DOH (2021) was used in the LOSS model.

2.4 Aquifer Thickness (b)

The alluvial aquifer in McKenzie Bridge, Oregon, is characterized by a saturated thickness of over 75 feet (see well log LANE 70704, located at the Upper McKenzie Rural Fire Protection District Facility adjacent to the Oregon Cascade property, and included in Attachment A). However, the DOH (2021) guidance requires that the maximum aquifer thickness that can be used for modeling purposes is 20 feet. Therefore, a value for b of 20 feet was used in the LOSS model.

2.5 Drainfield Area (A_D)

The available area for the drainfield is 26,136 square feet (ft^2), as shown on the site plan provided by Civil West (see orange-hatched area in Attachment B). A drainfield area of 20,000 ft^2 was used in the LOSS

[2] For systems that do not have advanced treatment and are not treating high strength waste.

model based on a 10 foot spacing between laterals, and a lateral length of 45 linear feet per 150 gallons per day capacity (Civil West, 2023a).

2.6 Distance from Drainfield to Downgradient Property Boundary (D_{pb})

Groundwater at Oregon Cascade flows north, towards the McKenzie River. The distance from the septic drainfield to the downgradient (northern) property boundary (see Figure 1) was measured based on the site plan provided in Attachment B. A distance of 782 feet for D_{pb} was used in the LOSS model.

2.7 Aquifer Width (W_A)

Groundwater at Oregon Cascade flows north, towards the McKenzie River. As shown in Figure 1, the aquifer width, which is equivalent to the width of the drainfield perpendicular to the groundwater flow direction, was estimated to be 220 feet based on the site plan provided in Attachment B.

2.8 Aquifer Hydraulic Conductivity (K)

Hydraulic conductivity is a property of porous materials that describes how easily fluid moves through the pore space, and is correlated with soil type in the aquifer (e.g., clay, silt, sand, or gravel). According to well log LANE 70704, located at the Upper McKenzie Rural Fire Protection District Facility adjacent to the Oregon Cascade property (Attachment A), the aquifer consists of gravels and coarse sand. A well test at this well indicated that the aquifer is characterized by a high hydraulic conductivity (i.e., the well produces groundwater at a rate of 200 gallons per minute).

A hydraulic conductivity of 1,000 feet per day was used in the LOSS model, which is the median hydraulic conductivity for a gravel in Table 3.3 of Anderson and Woessner (1992).

2.9 Hydraulic Gradient (i)

The hydraulic gradient (i) is the slope of the water table. The default value of 0.01 for hydraulic gradient from DOH (2021) was used because no groundwater elevation contour maps or groundwater elevation measurements were available to determine a site-specific hydraulic gradient.

2.10 Recharge (R)

Recharge is the amount of precipitation that infiltrates into the aquifer. USGS (2005) indicates that recharge in the study area is in the range of 26 to 30 inches per year. A value of 28 inches per year (the midrange value) was used in the LOSS model.

2.11 Nitrate Concentration of Upgradient Ground Water (N_B)

Groundwater at Oregon Cascade flows north, towards the McKenzie River. The area upgradient (i.e., south) of Oregon Cascade is undeveloped. No nitrate concentration data are available upgradient of Oregon Cascade. Therefore, we conservatively assumed that the upgradient concentration of nitrate in groundwater was equal to the nitrate concentration in rainwater recharging the aquifer (i.e., 0.24 mg/L).

2.12 Wastewater Volume (V_w)

Civil West developed a wastewater volume estimate for Oregon Cascade (Civil West, 2023b), and staff from the Oregon Department of Environmental Quality provided feedback about the volume estimate (DEQ, 2023). The wastewater volume estimate is 7,000 gallons per day.

3. Model Output ($N_{GW\,ALT}$)

Output from the LOSS model is provided in Attachment C. The output of the LOSS model is the nitrate concentration in groundwater at the downgradient property boundary (called "$N_{GW\,ALT}$" in Attachment C). The

nitrate concentration in groundwater at the downgradient property boundary calculated by the LOSS model is 0.67 mg/L.

4. Conclusions

While the 0.67mg/L potentially represents an increase above background nitrate concentrations (recall that the upgradient nitrate concentration is *assumed* to be 0.24 mg/L), it should be noted that the increase is minimal. The existing septic system at Oregon Cascade RV is a standard system that offers little nitrate reduction. The new system should significantly reduce current impacts to groundwater.

5. References

Anderson, M. P. and W. W. Woessner. 1992. Applied Groundwater Modeling: Simulaton of Flow and Advective Transport. Academic Press, San Diego, California, 381 pp.

Civil West. 2023a. RE: Oregon Cascade Coop – 56640 McKenzie Hwy Drainfield Replacement. Email from Tim Gross (Civil West) to Matt Kohlbecker (GSI Water Solutions) and Shawn McFadden (Oregon Cascade). May 30.

Civil West. 2023b. RE: Oregon Cascade Coop – 56640 McKenzie Hwy Drainfield Replacement. Email from Tim Gross (Civil West) to Daniel Wiltse (Oregon Department of Environmental Quality). January 11.

DEQ. 2023. RE: Oregon Cascade Coop – 56640 McKenzie Hwy Drainfield Replacement. Email from Dan Wiltse (Oregon Department of Environmental Quality) to Tim Gross (Civil West). January 18.

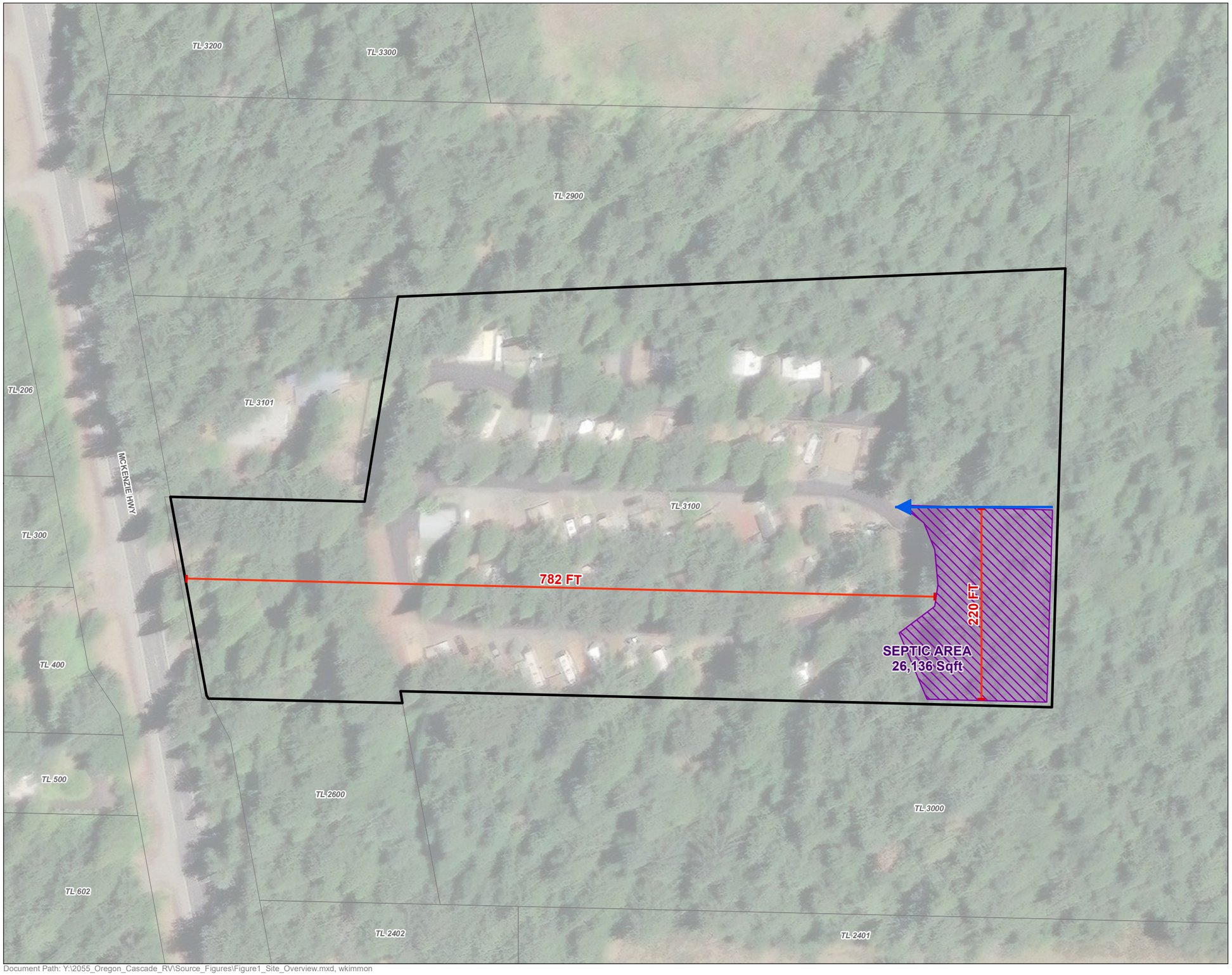
DOH. 2021. Level 1 Nitrate Balance Instructions for Large On-Site Sewage Systems.

USGS. 2005. Groundwater Hydrology of the Willamette Basin, Oregon. Scientific Investigations Report 2005-5168. 95 pp.

FIGURE 1

Site Overview

Oregon Cascade RV



LEGEND

- Property Boundary
- Groundwater Flow Direction
- Septic Area (Drainfield)
- Tax Lot

N

0 50 100 150

Feet

Date: July 26, 2023
Data Sources: BLM, ESRI, ODOT, USGS, Aerial Photo 2020

GSI Water Solutions, Inc.

Document Path: Y:\2055_Oregon_Cascade_RV\Source_Figures\Figure1_Site_Overview.mxd, wkimmon

ATTACHMENT A

Upper McKenzie Rural Fire Protection District
Well Log (LANE 70704)

LANE 70704

Lane 70704

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)

WELL I.D. # L 100545

START CARD # 206451

Instructions for completing this report are on the last page of this form.

(1) LAND OWNER Well Number 2
Name Upper McKenzie Rural Fire District
Address ~~55402 Delta Road~~ 56578 McKenzie Hwy. POB 199
City Blue River State OR Zip 97413

(2) TYPE OF WORK ☑ New Well
☐ Deepening ☐ Alteration (repair/recondition) ☐ Abandonment ☐ Conversion

(3) DRILL METHOD
☑ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger ☐ Cable Mud
☐ Other

(4) PROPOSED USE
☐ Domestic ☑ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION Special Construction: ☐ Yes ☑ No
Depth of Completed Well 105 ft.
Explosives used: ☐ Yes ☑ No Type Amount

BORE HOLE Diameter	From	To	SEAL Material	From	To	Sacks or Pounds
12"	0'	18'	bentonite	0'	18'	19 sacks
8"	18'	105'	chips			

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☑ Other as per OAR 690-210-340
Backfill placed from ft. to ft. Material
Gravel placed from ft. to ft. Size of gravel

(6) CASING/LINER

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	8"	+2'	105'	.250	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Drive Shoe used ☑ Inside ☐ Outside ☐ None
Final location of shoe(s) 105'

(7) PERFORATIONS/SCREENS
☑ Perforations Method tool
☐ Screens Type star Material

From	To	Slot Size	Number	Diameter	Tele/pipe size	Casing	Liner
65'	72'		35	8"	pipesize	☑	☐
72'	98'		130	8"	pipesize	☑	☐
98'	102'		20	8"	pipesize	☑	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☑ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
200	50.3		1 hour
well output	may fluctuate		

RECEIVED
OCT 13 2010
WATER RESOURCES DEPT
SALEM, OREGON

Temperature of water 50 Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

(9) LOCATION OF WELL (legal description)
County Lane
Tax Lot ~~2400~~ 2402 Lot
Township 16 S Range 5 E WM
Section 13 SE 1/4 SE 1/4
Lat ° ' " or (degrees or decimal)
Long ° ' " or (degrees or decimal)
Street Address of Well (or nearest address) ~~across from Jenny B. Harris Wa Blue River, OR 97413~~ 56578 McKenzie Hwy - Blue River - OR

(10) STATIC WATER LEVEL
25' ft. below land surface. Date 08-31-10
ft. below land surface. Date
Artesian pressure lb. per square inch Date

(11) WATER BEARING ZONES
Depth at which water was first found 50'

From	To	Estimated Flow Rate	SWL
50'	54'	100 gpm	25'
78'	82'	100 gpm	25'
88'	95'	100 gpm	25'

(12) WELL LOG Ground Elevation

Material	From	To	SWL
gravel,fill with loam	0	2	
topsoil	2	4	
gravels, grey/brown	4	5	
boulders, gravels	5	20	
gravels, blue grey	20	39	25
gravels, black sand	39	50	25
gravels, blue grey w/coarse sand	50	56	25
gravels with sand	56	105	25

RECEIVED
OCT 12 2010
WATER RESOURCES DEPT
SALEM, OREGON

Date Started 8-17-10 Completed 8-31-10

(unbonded) Water Well Constructor Certification
I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

WWC Number Date

Signed

(bonded) Water Well Constructor Certification
I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 636 Date

Signed Paul Christensen V-Pres
Christensen Well Drilling Co.

ORIGINAL – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER 06/16/2004

LANE 70704

STATE OF OREGON
WATER SUPPLY WELL REPORT
(as required by ORS 537.765)

WELL I.D. # L 100545

START CARD # 206451

Instructions for completing this report are on the last page of this form.

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City **Blue River** State **OR** Zip **97413**

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☑ Rotary Air ☐ Rotary Mud ☐ Cable ☐ Auger ☐ Cable Mud
☐ Other

(4) PROPOSED USE
☐ Domestic ☑ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Livestock ☐ Other

(5) BORE HOLE CONSTRUCTION Special Construction: ☐ Yes ☑ No
Depth of Completed Well 105 ft.
Explosives used: ☐ Yes ☑ No Type Amount

BORE HOLE Diameter	From	To	SEAL Material	From	To	Sacks or Pounds
12"	0'	18'	bentonite	0'	18'	19 sacks
8"	18'	105'	chips			

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
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Backfill placed from ft. to ft. Material
Gravel placed from ft. to ft. Size of gravel

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	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
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					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Drive Shoe used ☑ Inside ☐ Outside ☐ None
Final location of shoe(s) 105'

(7) PERFORATIONS/SCREENS
☑ Perforations Method tool
☐ Screens Type star Material

From	To	Slot Size	Number	Diameter	Tele/pipe size	Casing	Liner
65'	72'		35	8"	pipesize	☑	☐
72'	98'		130	8"	pipesize	☑	☐
98'	102'		20	8"	pipesize	☑	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☑ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
200	50.3		1 hour
well output	may fluctuate		

Temperature of water 50 Depth Artesian Flow Found
Was a water analysis done? ☐ Yes By whom
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other
Depth of strata:

RECEIVED
SEP 13 2010
WATER RESOURCES DEPT
SALEM, OREGON

(9) LOCATION OF WELL (legal description)
County Lane
Tax Lot 2400 Lot
Township 16 S Range 5 E WM
Section 13 SE 1/4 SE 1/4
Lat ° ' " or (degrees or decimal)
Long ° ' " or (degrees or decimal)
Street Address of Well (or nearest address) across from Jenny B. Harris Wa
Blue River, OR 97413

(10) STATIC WATER LEVEL
25' ft. below land surface. Date 08-31-10
ft. below land surface. Date
Artesian pressure lb. per square inch Date

(11) WATER BEARING ZONES
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(12) WELL LOG Ground Elevation

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gravels, blue grey w/coarse sand	50	56	25
gravels with sand	56	105	25

Date Started 8-17-10 Completed 8-31-10

(unbonded) Water Well Constructor Certification
I certify that the work I performed on the construction, deepening, alteration, or abandonment of this well is in compliance with Oregon water supply well construction standards. Materials used and information reported above are true to the best of my knowledge and belief.

WWC Number Date

Signed

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I accept responsibility for the construction, deepening, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon water supply well construction standards. This report is true to the best of my knowledge and belief.

WWC Number 636 Date

Signed Paul Christensen V-Pres
Christensen Well Drilling Co.

ORIGINAL – WATER RESOURCES DEPARTMENT FIRST COPY – CONSTRUCTOR SECOND COPY – CUSTOMER 06/16/2004

ATTACHMENT B

Oregon Cascade RV LOSS Site Plan

OREGON CASCADE RV CO-OP

56640 McKENZIE HIGHWAY
McKENZIE BRIDGE, OR. 97413
SW 1/4 OF SEC. 13, T 16 S, R 5 E, W.M.

TYPICAL PLOT PLAN
SCALE 1" = 20'

769.41'
215.43'
456.35'
208.16'
208.76'
676.35'

SCALE : 1" = 30'

9- SEPTIC TANKS
1- TANK BEHIND LAUNDRY ROOM

OLSON & THOMPSON, INC.
207 'Q' STREET
SPRINGFIELD, OREGON
97477

SEPTIC AREA
26,136 SF

- (P) POWER POLE
- (T) TELEPHONE SERVICE BOX
- (E) ELECTRICAL SERVICE
- (S) SANITARY SEWER HOOK-UP
- (W) WATER SERVICE HOOK-UP
- CONCRETE SLAB
- POWER POLE ANCHOR
- WATER VALVE
- SEWER CLEAN-OUT
- SEWER STAND PIPE
- (V) CABLE TV BOX

NOTES:

Civil West Engineering Services, Inc.

OREGON CASCADE RV CO-OP
LANE COUNTY, OR

SEPTIC SYSTEM ANALYSIS

SITE MAP

1" = 60'

DRAWN BY: TEG
DATE: DECEMBER 2022

FIGURE 1

DATE:12/8/22 FILE:O:\CW_Projects\2204 Misc Private Engineering Work\2204-236 Oregon Cascades RV Coop\03 Design\Drawings\Dwg\Oregon Cascade RV Park WORKING 12-8-22.dwg

ATTACHMENT C

LOSS Model Results

Washington State Department of Health

Large On-Site Sewage System (LOSS)
LEVEL 1 NITRATE BALANCE

Project name:	**Cascade RV**
Address, city and county:	**McKenzie Bridge, Lane County, Oregon**
Completed by (name and title):	**M. Kohlbecker (Principal Hydrogeologist)**
Date:	**5/26/2023**

Input Values	**Factor**	**Units**	**Values**	Instructions	**Information Source**
Nitrate concentration in precipitation	**N_R**	**mg/l as N**	**0.24**	**Default**	Default from DOH (2021)
Total nitrogen concentration in wastewater	**N_W**	**mg/l**	**24.0**	**Default - residential strength**	Default from DOH (2021) (60 mg/L) reduced by 60% by Orenco AdvanTex
Soil denitrification	**d**	**unitless**	**0.1**	**Default**	Default used
Aquifer thickness	**b**	**ft**	**20**	**Default or aquifer thickness if known**	Default used, max allowable is 20 feet per guidance. Saturated thickness of aquifer is over 75 feet (see Attachment A)
Drainfield area	**A_D**	**ft^2**	**20,000**	**Primary drainfield area**	From site plan (see Attachment B), 10 foot spacing between laterals, and lateral length of 45 feet per 150 gpd
Distance from drainfield to property boundary	**D_{pb}**	**ft**	**782**	**Measure in direction of GW flow**	From Google Earth/site plan
Aquifer width	**W_A**	**ft**	**220**	**Perpendicular to GW flow**	From site plan
Aquifer hydraulic conductivity	**K**	**ft/day**	**1,000**	**Measured or literature value**	Slightly less than the median for a gravel (Anderson and Woessner, pg. 40, Table 3.3, 1992)
Hydraulic gradient	**i**	**ft/ft**	**0.010**	**If unknown, use 0.01**	Default from DOH (2021)
Recharge	**R**	**in/yr**	**28.00**	**Recharge will be a % of ppt**	From USGS groundwater hydrology report (Figure 12, https://pubs.usgs.gov/sir/2005/5168/pdf/sir2005-5168.pdf, midrange of the 26 to 30 inches per year range)
Nitrate concentration of upgradient ground water	**N_B**	**mg/l**	**0.24**	**Prefer sampling data**	No development to south of site. 0.24 used (nitrate concentration in precip)
Wastewater volume	**V_W**	**gpd**	**7,000**	**Design flows or measured volume**	System Design

Output Values				
Groundwater nitrate value	**N_{GW}**	**mg/l as N**	**0.68**	**Point of Compliance (POC)**
Groundwater nitrate value	**$N_{GW\ ALT}$**	**mg/l as N**	**0.67**	**Alternative POC**