

**GEOTECHNICAL ENGINEERING REPORT  
PROPOSED CAMAS RIVERFRONT TOWNHOMES  
3210 SW 6TH AVENUE  
CAMAS, WASHINGTON**

**Terrie Cox Revocable Living Trust,  
Terrie Cox Trustee  
16408 SE Mill Plain Blvd.  
Vancouver, WA 98684**

**October 8, 2018  
Project No. 839-001**

**TERRA DOLCE CONSULTANTS, INC.**

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**Terrie Cox Revocable Living Trust,  
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16408 SE Mill Plain Blvd.  
Vancouver, WA 98684**

**GEOTECHNICAL REPORT  
PROPOSED CAMAS RIVERFRONT TOWNHOMES  
3210 SE 6<sup>TH</sup> AVENUE  
CAMAS, WASHINGTON**

Dear Terry:

Terra Dolce Consultants, Inc. (TDC) is pleased to present our report summarizing the results of our geotechnical evaluation for the referenced project. Our project work included site visit, engineering analyses, and preparation of our report. Our work was completed in general accordance with our proposal dated June 29, 2018.

**SITE DESCRIPTION**

The referenced site is located in Camas, Washington (see Figure 1). The 0.78-acre property is developed in 1936 with a 1,443-square-foot single-story house, with an unfinished basement. Adjacent to the house is a single-story detached garage. and a shed (see Figure 2). The existing buildings will be demolished and the property will be divided into six townhomes.

A gravel driveway, off of Evergreen Highway, provides access to the referenced property and to the property to the west. The house and driveway is downslope of the driveway (see Figure 2).

The property slopes towards the southeast, with elevations ranging from on the property range between 86 feet along the northern property line to 58 feet at the southeast property corner.

It appears that there are two areas of Fill on the property (see Figure 2). The first area is around the house footprint and is most likely from when they excavated the basement for the house. The second area of Fill is located close to the entrance to the properties, downslope of the access road (see Figure 2). The fill is most likely from when they graded the road.

**PROJECT DESCRIPTION**

TDC understands that you are planning to build six (6) townhomes on the property (see Figure 3). The proposed lots for the townhomes will range from 4,036 square feet (sf) to 5,073 sf. The buildings be supported on shallow foundations and isolated footings.

## **GEOLOGIC CONDITIONS**

Geologic maps of the area indicate that the site is underlain with volcanic rocks (Oligocene). The volcanic rocks are typically olive-brown, mafic tuff breccia, lapilli tuff, and minor tuff; and have distinct decimeter-scale stratification defined by gradational variations in grain size; moderately well sorted to poorly sorted; composed largely of angular fragments as large as 60 cm across of texturally variable, basalt and basaltic andesite. Unit locally contains rounded lithic clasts and blackened wood fragments; one exposure displays matrix-poor, talus-like deposit of angular blocks to 2 meters across; cemented by clay, zeolites, and calcite.

## **GEOLOGIC HAZARDS CONDITIONS**

Review of the Clark County Online Environmental maps indicate that the referenced property is located within a Potential Area of Slope Instability. The property is underlain with volcanic rock and appears to be stable. There were no signs of slope instability on the property during our field investigation.

## **FIELD INVESTIGATION**

On August 28, 2018, TDC conducted a site investigation for the reference project. The borings were drilled with a solid-stem auger drill rig. The borings were drilled to 5 feet below ground surface (bgs) (see Figures 2 and 3, and Attached Borings). The shallow boring depths were due to the shallow bedrock.

Soil samples were taken in 2.5-foot intervals to the bottom of the borings. Samples were collected using Standard Penetration Test method (ASTM D 1586). The method includes driving an 18-inch-long split-spoon sampler with a 140-pound hammer. The number of blows required to drive the sampler 18 inches were recorded in three (3) 6-inch intervals. The number of blows for the last two intervals were added together to determine the blow count (N) or blows per foot (bpf), which are used to estimate the in-place consistency of the soil. The soil types and blow counts were documented on boring logs (see Attached Boring Logs).

### **Surface Conditions.**

The site is developed with a one-story house with a basement and attic and a detached garage. The house and garage sit downslope of the gravel driveway that provides access for both the referenced site and the adjacent property to the west (see Figure 2). Downslope of the structures, the property slopes towards the southeast, where it abuts the railroad tracks.

There are two areas of Fill on the property (see Figures 2 and 3). The Fill is most likely from the excavation of the basement and of the graveled driveway. The Fill appears to be isolated and was not encountered in the borings.

There are large trees in the area of the proposed lots. These trees would either be worked around or removed as the site is developed.

### **Subsurface Conditions**

The following subsurface conditions were encountered at the site:

**Silty Topsoil (ML).** Up to 4 inches of Silty Topsoil was encountered across the site. The Topsoil is not appropriate for bearing surface and will need to be stripped from the site. It can be, however, stored onsite and used for non-structural general fill in landscape areas.

**Silt (ML).** Silt, up to 1 to 2 feet deep, was encountered across the site. The Silt was brown, moist, and medium stiff.

**Volcanic Bedrock.** Volcanic Bedrock was encountered directly under the Silt. The bedrock was hard to very hard, and will provide a good bearing surface.

**Groundwater**

No groundwater was observed on the property.

**GEOLOGIC HAZARDS**

**The Clark County Geo**

**SEISMIC CONSIDERATION**

The site is located in southwest of Camas, Washington. The site is at latitude 45.5779 and longitude -122.4439, respectively. The seismically induced acceleration values at the rock interface, and the coefficients used to estimate ground surface response adjusted for Site Class B (rock), for the MCE at the site are presented below:

<b>Seismic Parameters</b>	<b>Value</b>
Mapped Peak Ground Acceleration, ASCE7-10, Fig. 22-7, PGA	0.405g
Peak Ground Acceleration adjusted for site effects, $PGA_M$	0.405g
MCE Bedrock Spectral Acceleration, 0.2 second period, $S_s$	0.938g
MCE Bedrock Spectral Acceleration, 1.0 second period, $S_1$	0.386g
Short-Period Site Factor, $F_a$	1.0
Long-Period Site Factor, $F_v$	1.0
Soil MCE Spectral Acceleration, 0.2 second period, Site Class D, $S_{MS}$	0.938g
Soil Design Spectral Acceleration, 1.0 second period, Site Class D, $S_{M1}$	0.386g
Soil Design Spectral Acceleration, 0.2 second period, Site Class D, $S_{DS}$	0.625g
Soil Design Spectral Acceleration, 1.0 second period, Site Class D, $S_{D1}$	0.257g

**CONCLUSIONS AND RECOMMENDATIONS**

The conclusions and recommendations in this report are based on the information provided to us, results of the site investigation, and professional judgment. We have observed only a small portion of the pertinent soil and groundwater conditions. The recommendations are based on the assumptions that the soil conditions do not deviate appreciably for those encountered during our site visit.

**Conclusions**

It is our opinion that the property is geotechnically sound for the project. Our opinion assumes that the recommendations provided below are followed.

## **Recommendations**

### **Site Preparation.**

TDC recommends that once the house and the garage are demolished, the foundation, and other construction debris be overexcavated and removed from the site. The basement walls and floors shall be removed and the area backfilled with Structural Fill, as described below. If underground storage tanks or cisterns are encountered, then they should be removed and appropriately backfilled.

### **Wet Weather or Wet Soil Construction**

During wet weather or soil conditions, the exposed soils may be disturbed with construction traffic. Such disturbance will structurally weaken the soil and render it unsuitable for uses in foundation bearing.

If construction occurs during wet weather, the exposed soils should be protected with at least non-woven geofabric and 12 inches of rock with less than 6 percent fines. In addition, care should be taken to minimize disturbance of native Silty soil, which may become “pumped” and weakened by repeated loading and vibratory compaction and wheeled equipment. Should soils become disturbed, the soils should be removed to firm native subgrade and replaced with compacted  $\frac{3}{4}$ -inch-minus gravel structural fill placed in accordance with the above recommendations.

### **Excavation**

No deep excavations are anticipated for the project. Within 3 feet of the surface is volcanic bedrock. Excavation into the bedrock may require additional effort.

Several large trees are located within the area of the proposed townhomes. If the trees are within 5 feet of the foundation, then the trees and rootballs shall be removed. The rootball and roots over 4 inches shall be overexcavated and replaced with Structural Fill.

### **Fill Areas.**

As noted above, there are two area of Fill that will need to be removed. The first area surrounds the footprint of the existing house and the second is just downslope of the gravel driveway near the entrance to the property (see Figures 2 and 3). These areas will need to be overexcavated and removed from the site. The Fill is not appropriate as Structural Fill. If require, this material shall be replaced with Structural Fill, as described below.

### **Structural Fill**

Structural Fill may be required in the areas that the Undocumented Fill has been removed. The Structural Fill shall consist of 1  $\frac{1}{2}$  inch to  $\frac{3}{4}$ -inch crushed rock with 10 percent passing No 200 sieve. The Structural Fill shall have little to no organics or other deleterious materials. The Structural Fill shall be placed in 12-inch-thick lifts and compacted to 95 percent of the maximum dry density as determined by standard Proctor (ASTM D698). At the time of placement, moisture content of the Structural Fill shall be within 5 percent of the Optimum Moisture Content. The subgrade of the Structural Fill shall be firm, non-yielding, native soil that is neat cut.

All Structural Fills over 2 feet thick shall be tested by a Materials Testing company, such as ACS Testing or Carlson.

### **Shallow Foundation Recommendations**

TDC recommends that continuous footings and individual spread footings should be embedded at least 18 inches into the native Volcanic Rock. Subgrades for the shallow foundations should be firm and free of organics and deleterious debris as determined by the geotechnical engineer. Soft soils or undocumented fills encountered during excavation of the footings should be removed to firm soils and backfilled with imported granular structural fill, as described above.

Lateral loads on the building foundations may be resisted using an allowable frictional coefficient of 0.35. In addition, passive resistance may be considered using an allowable equivalent fluid weight of 300 pound per cubic foot (pcf). For consideration of passive resistance, the upper 1 foot of embedment should be disregarded.

### **Allowable Bearing Capacity**

TDC recommends an allowable bearing capacity of 3,500 psf for the native, non-yielding Volcanic Rock subgrade, as recommended below. The allowable bearing capacity can be increased by one-third to account for seismic and other transitory live loads.

### **Estimated Total and Differential Settlements**

With the foundation bearing on rock, the total and differential settlements are not applicable.

### **Slab-on-Grade Recommendations**

The slab-on-grade should be designed for an allowable subgrade reaction modulus of approximately 150 pounds per cubic inch (pci). The subgrade soil shall be firm, non-yielding condition at the time of slab construction. Soft areas encountered during the preparation of the slab subgrade should be overexcavated and replaced with structural fill.

For wet weather conditions, care must be taken to reduce the potential of rainwater ponding on the slab-on-grade rock section. In the areas where covered with moisture-sensitive flooring, an additional 4-inch thick lift of ¼-inch to ¾-inch, open graded, angular drain rock placed below the capillary break.

It is our experience that concrete slab-on-grade commonly exhibit shrinkage cracks despite the presence of steel reinforcing or fiber strands. This cracking can be reduced by using a low-slump concrete, properly designed and constructed joints and by properly curing the concrete.

### **Surface Water Management.**

The referenced property is underlain volcanic rock and cannot percolate surface water. Therefore, TDC recommends that the stormwater be managed with onsite facilities, such as Flow-Through” planters and allowed to discharge offsite.

## **REVIEW AND CONSTRUCTION MONITORING**

TDC shall review final plans and specifications for the new tasting room and, if required, the access road. This review will allow us to examine the documents to determine whether the intent of our recommendations presented in this report was incorporated into the report.

TDC should provide construction monitoring during the foundation construction activities. The purpose of our field monitoring services is to confirm that the site conditions are as anticipated and to provide field recommendations as required based on the conditions encountered. TDC should observe the following:

- Foundation Subgrade Conditions;
- If required, a material testing firm, such as ACS Testing shall be hired for laboratory and field density testing of the Structural Fill.

## **LIMITATIONS**

Geotechnical review is of paramount importance in engineering practice. The poor performance of many foundations has been attributed to inadequate construction review. On-site grading and earthwork should be observed and, where necessary, tested by a qualified engineering firm to verify the compliance with the recommendations contained in this report. Foundation excavation should also be observed to compare the generalized site conditions assumed in this report with those found on the site at the time of construction. If the plans for site development are changed, or if various or undesirable geotechnical conditions are encountered during construction, the geotechnical engineer should be consulted for further recommendations.

This report is issued with the understanding that it is the responsibility of the Client to ensure that the recommendations are incorporated in the plans and the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field. Geotechnical engineering is characterized by a certain degree of uncertainty. Professional judgments presented are based partly on our understanding of the proposed construction and partly on our general experience. Our engineering work and judgments rendered meet current professional standards; no other warranties, either expressed or implied are made. This report is subject to review and should not be relied upon after a period of 3 years.

It has been a pleasure providing you the geotechnical services for this project. If you have any questions, please call at 503.502.5114.

Sincerely,  
Terra Dolce Consultants, Inc.



Cynthia L. Hovind, P.E., G.E.  
Professional Geotechnical Engineer, OR-17857PE

**Attachments**

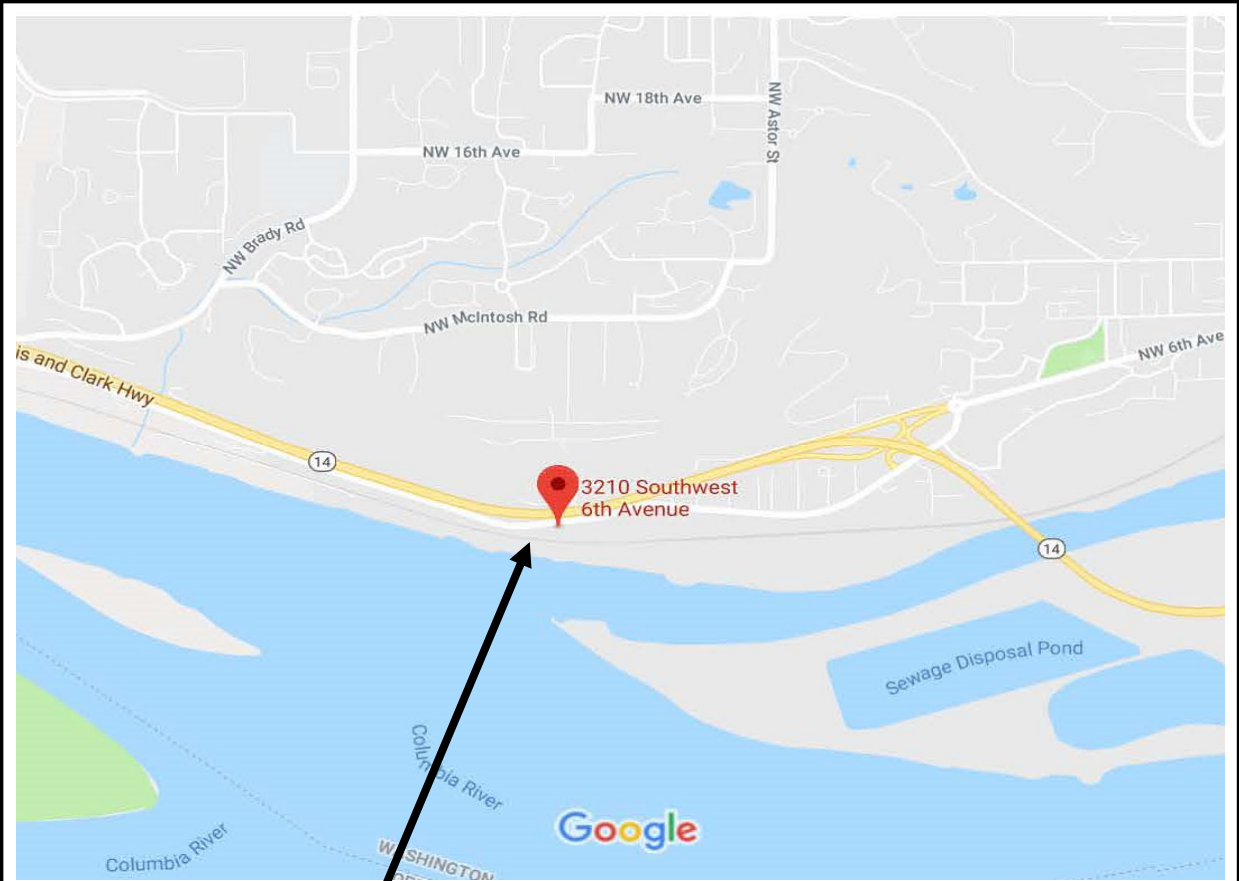
**Figure 1 – Vicinity Map**

**Figure 2 – Site Plan**

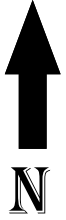
**Figure 3 – Proposed Development**

**Boring Logs**



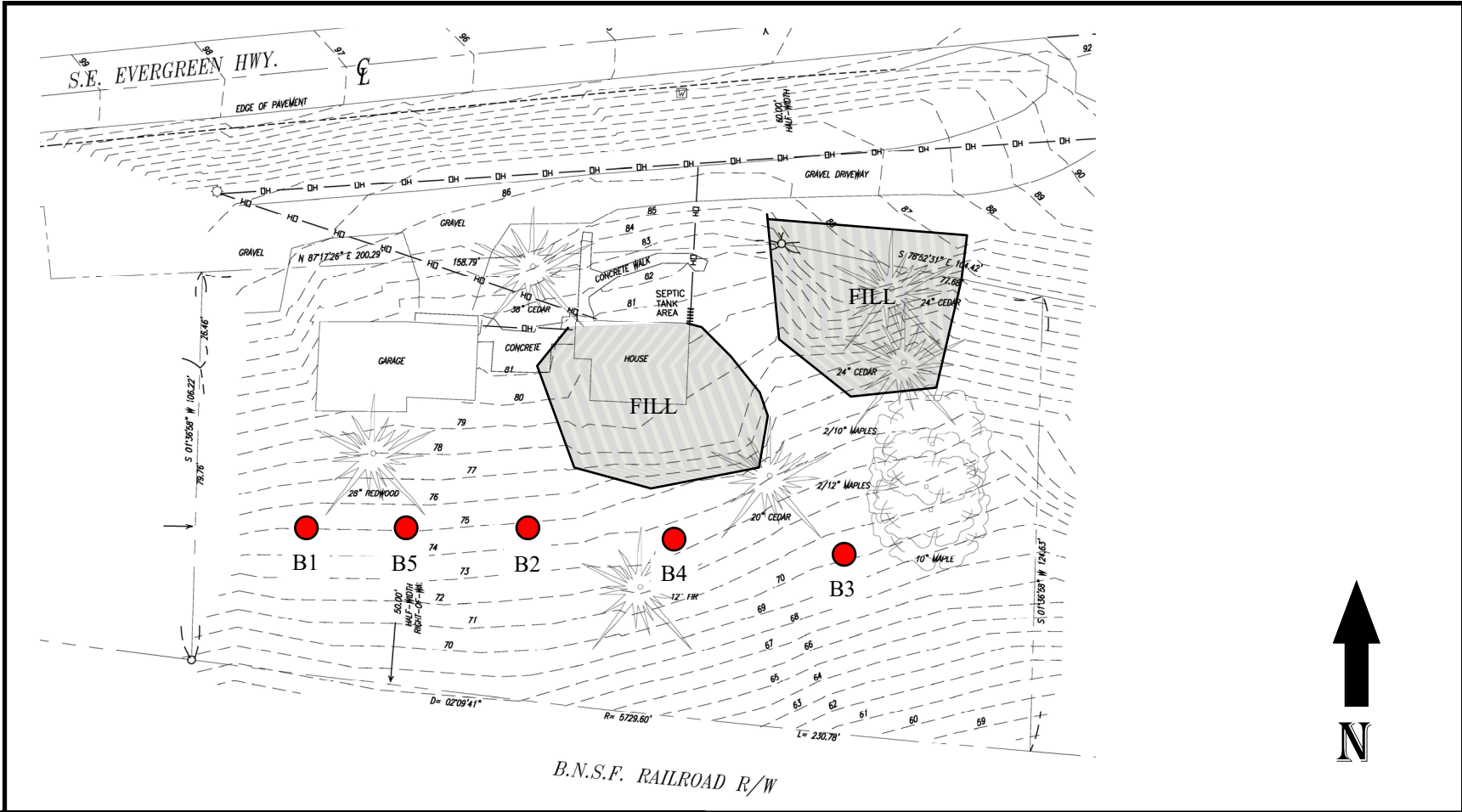


Site



GOOGLE MAP, 2018

<p><b>Terra Dolce Consultants, Inc.</b>          4706 NE 75th Ave          Portland, Oregon 97218          Phone 503.502.5114          Fax 503.206-5114</p>		<p>Terrie Cox Living Trust          3210 SW 6th Ave.          Camas, WA</p>	
<p>Project No. 839-001</p>	<p>October 8, 2018</p>	<p>Vicinity Map</p>	<p>Figure 1</p>



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 Phone 503.502.5114  
 Fax 503.206-5114

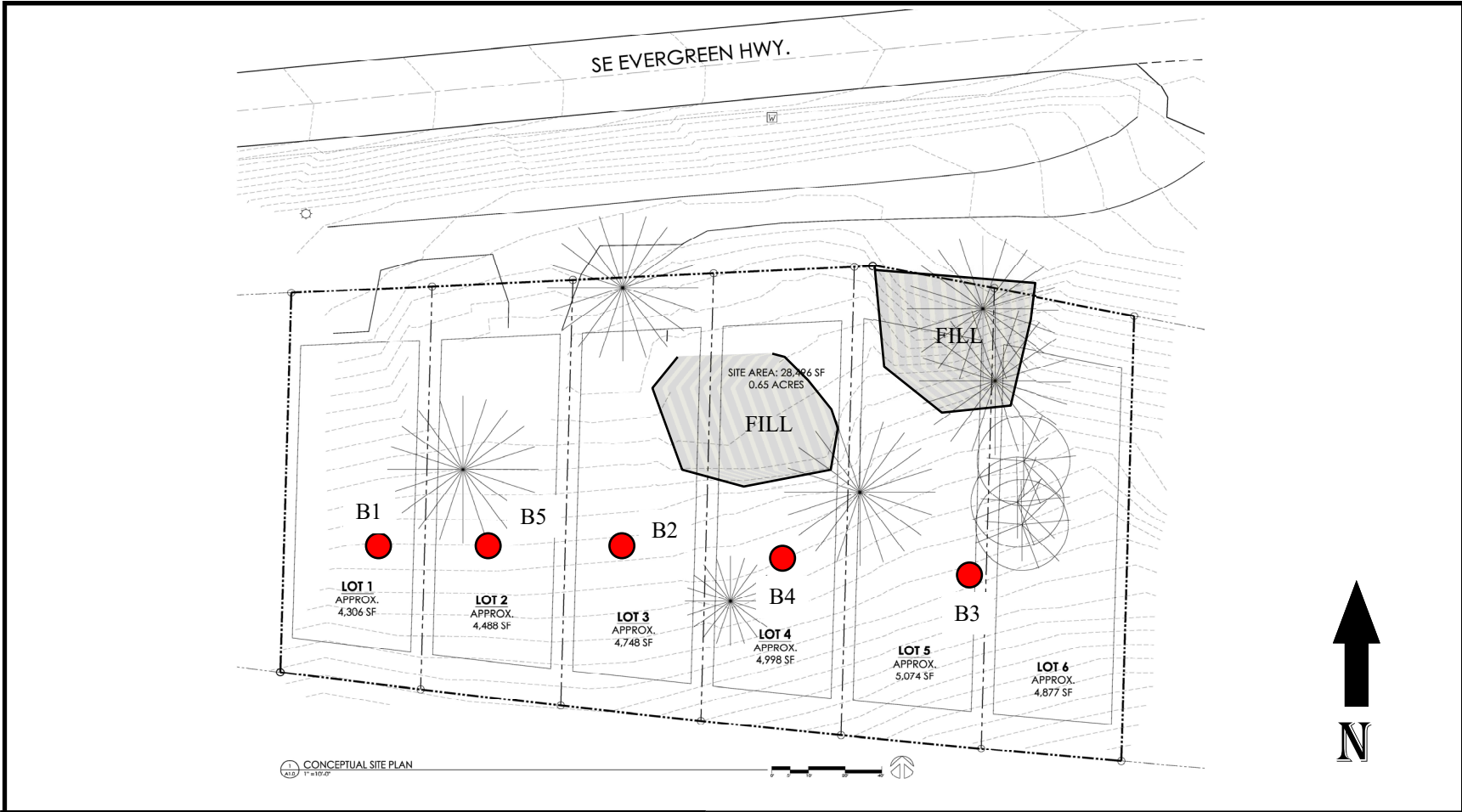
Terrie Cox Living Trust  
 Proposed Camas Riverfront Townhomes  
 3210 SW 6th Ave.  
 Camas, WA

Project No. 839-001

October 8, 2018

Site Map

Figure 2



**Terra Dolce Consultants, Inc.**  
 4706 NE 75th Ave  
 Portland, Oregon 97218  
 Phone 503.502.5114  
 Fax 503.206-5114

Terrie Cox Living Trust  
 Proposed Camas Riverfront Townhomes  
 3210 SW 6th Ave.  
 Camas, WA

Project No. 839-001

October 5, 2018

Proposed Development

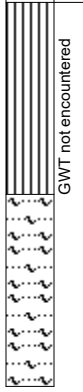
Figure 3

## **BORING LOGS**

File: L:\Users\Cindy\Documents\TDC Projects\839 Camas Riverfront Townhomes\TDC\TDC Camas Riverfront Townhomes\Boring logs.log Date: 10/5/2018  
 SuperLog CivilTech Software, USA www.civiltech.com

<b>Terra Dolce Consultants, Inc</b>	<b>Boring Log No. B-1</b> <b>Camas Riverfront Townhomes</b>
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Location: 3210 SW 6th Ave. Camas, WA		WO#: 839-001
Method: Solid Stem Auger 4"		Ground EL: N/A
Hammer: Safety Hammer	Hammer weight (lb): 140	Hole depth (ft): 2
Sampler: Split Spoon 2"	Drop (in): 30	G.W.T. @ Drilling (ft): N/A
Driller: Dan J. Fischer Excavating		Logged by: AS
		Drill Date: 8/28/18

Depth	Strata	GWT	No.	Type	Blows Per 6"	USCS	Soil Description	SPT. blow/ft				Notes	
								0	20	40	60		
0	 GWT not encountered					ML	Silt (ML), brown, moist, medium stiff (Silt)						0
1							Basalt Bedrock, light grey-brown, dry, hard (Basalt Bedrock)				■		1
2							Boring completed at depth of 2 feet						2
3			1		10-10-43								3
4													4
5													5
6													6
7													7

Remarks:

SuperLog CivilTech Software, USA www.civiltech.com File: L:\Users\Cindy\Documents\TDC Projects\839 Camas Riverfront Townhomes\TDC Data\camas riverfront townhomes boring logs.log Date: 10/5/2018

**Terra Dolce Consultants, Inc**

## Boring Log No. B-2 Camas Riverfront Townhomes

**Location:** 3210 SW 6th Ave. Camas, WA

**WO#:** 839-001

**Method:** Solid Stem Auger 4"

**Ground EL:** N/A

**Hammer:** Safety Hammer

**Hammer weight (lb):** 140

**Hole depth (ft):** 5

**Sampler:** Split Spoon 2"

**Drop (in):** 30

**G.W.T. @ Drilling (ft):** N/A

**Sampled by:** AS

**Driller:** Dan J. Fischer Excavating

**Drill Date:** 8/28/18

**Logged by:** AS

Depth	Strata	GWT	No.	Type	Blows Per 6"	USCS	Soil Description	SPT. blow/ft				Moisture %	Notes
								0	20	40	60		
0	GWT not encountered					ML	Silt (ML), brown, moist, medium stiff (Silt)						
1													
2							Basalt Bedrock, red-brown, dry, hard (Basalt Bedrock)						
3			1	22-50/4"						■			Refusal in basalt bedrock
4													
5							Boring completed at depth of 5 feet			■			
6			2	50/1.5"									Refusal in basalt bedrock
7													

Remarks:

File: L:\Users\Cindy\Documents\TDC Projects\839 Camas Riverfront Townhomes\TDC\TDC Projects\839 Camas Riverfront Townhomes\Boring logs.log Date: 10/5/2018  
 SuperLog CivilTech Software, USA www.civiltech.com

**Terra Dolce Consultants, Inc**

**Boring Log No. B-3  
Camas Riverfront Townhomes**

**Location: 3210 SW 6th Ave. Camas, WA**

**WO#: 839-001**

**Method: Solid Stem Auger 4"**

**Ground EL: N/A**

**Hammer: Safety Hammer**

**Hammer weight (lb): 140**

**Hole depth (ft): 1.5**

**Sampler: Split Spoon 2"**

**Drop (in): 30**


**G.W.T. @ Drilling (ft): N/A**

**Sampled by: AS**

**Driller: Dan J. Fischer Excavating**

**Drill Date: 8/28/18**

**Logged by: AS**

Depth	Strata	GWT	No.	Type	Blows Per 6"	USCS	Soil Description	SPT. blow/ft				Notes		
								0	20	40	60			
0	 GWT not encountered					ML	Silt (ML), brown, moist, medium stiff (Silt)						0	
1							Basalt Bedrock, light grey-brown, dry, hard (Basalt Bedrock)							1
2			1		50/3.5"		Boring completed at depth of 1.5					■		2
3														3
4														4
5														5
6														6
7														7

Remarks:

File: L:\Users\Cindy\Documents\TDC Projects\839 Camas Riverfront Townhomes\TDC Data\camas riverfront townhomes boring logs.log Date: 10/5/2018  
 SuperLog CivilTech Software, USA www.civiltech.com

**Terra Dolce Consultants, Inc**

## Boring Log No. B-4 Camas Riverfront Townhomes

**Location: 3210 SW 6th Ave. Camas, WA**

**WO#: 839-001**

**Method: Solid Stem Auger 4"**

**Ground EL: N/A**

**Hammer: Safety Hammer**

**Hammer weight (lb): 140**

**Hole depth (ft): 4**

**Sampler: Split Spoon 2"**

**Drop (in): 30**

**G.W.T. @ Drilling (ft): N/A**

**Sampled by: AS**

**Driller: Dan J. Fischer Excavating**

**Drill Date: 8/28/18**

**Logged by: AS**

Depth	Strata	GWT	No.	Type	Blows Per 6"	USCS	Soil Description	SPT. blow/ft				Moisture %	Notes
								0	20	40	60		
0	GWT not encountered					ML	Silt (ML), brown, moist, medium stiff (Silt)						
1							Basalt Bedrock, purple-grey, dry, hard (Basalt Bedrock)						
2													
3			1		50/1.5"						■		Refusal in basalt bedrock
4							Boring completed at depth of 4 feet				■		
5			2		36-50/4"								Refusal in basalt bedrock
6													
7													

Remarks:



Terra Dolce Consultants, Inc

## Boring Log No. B-5 Camas Riverfront Townhomes

**Location:** 3210 SW 6th Ave. Camas, WA

**WO#:** 839-001

**Method:** Solid Stem Auger 4"

**Ground EL:** N/A

**Hammer:** Safety Hammer

**Hammer weight (lb):** 140

**Hole depth (ft):** 2

**Sampler:** Split Spoon 2"

**Drop (in):** 30

**G.W.T. @ Drilling (ft):** N/A

**Sampled by:** AS

**Driller:** Dan J. Fischer Excavating

**Drill Date:** 8/28/18

**Logged by:** AS

Depth	Strata	GWT	No.	Type	Blows Per 6"	USCS	Soil Description	SPT. blow/ft Moisture %				Notes	
								0	20	40	60		
0	GWT not encountered					ML	Silt (ML), brown, moist, medium stiff (Silt)						0
1							Basalt Bedrock, light grey-brown, dry, hard (Basalt Bedrock)						1
2							Boring completed at depth of 2 feet					■	2
3			1		50/4"								3
4													4
5													5
6													6
7													7

Refusal in basalt bedrock

Remarks: