WILLAMETTE
ENGINEERING AND EARTH SCIENCES

Hillary Banks/Brian Moore
Mountain West Investment
201 Ferry Street SE Suite 400
Salem, OR 97301

Re: Geotechnical Engineering Study, Lindbeck ALF, Salem, Oregon

At your request Willamette Engineering and Earth Sciences (Willamette) has completed a geotechnical engineering study for the above referenced site. As Willamette understands, the development will include a multi-family assisted living facility. The assumed foundation system is slab-on-grade with perimeter and column footings. An air photo of the site along with approximate project boundaries is presented in Figure 1.

SITE DESCRIPTION

Surface Conditions

The site is presently orchard and vacant farm land. The site surface is vegetated with grasses and fruit trees.

The parcel is bounded on the west by developed residential land, on the east by the unfinished extension to Lynnwod Drive, and on the south by Orchard Heights Road and on the east by farm land.

The site slopes gently to the north at approximately 15 percent inclination. There is a slight swale running south to north. The swale is heavily rutted by wheel traffic, indicating potential ground/surface water issues during winter months.

There appears to have been some utilities installed along the proposed Linwood Street alignment.

Subsurface Conditions

Willamette observed soil conditions in 9 test pit and 4 hollow stem auger explorations (GT 2 through GT 5) at the locations indicated on Figure 2, Exploration Locations. The maximum depth of explorations was 21 feet below ground surface.

In general, soil in the upper 2 to 3 feet of the site is stiff, dry, clayey silt. Soil below 3 feet is generally stiff, dry to moist silt and clay, grading to very stiff around 6 to7 feet. Weathered igneous rock was encountered at depths ranging from 3 feet in Test Pits 1 and 9 too on the order of 20 feet in boring GT 2. Auger refusal was encountered in Borings GT 4 and 5 at depths of approximately 12 feet and 17 feet respectively. Upper soil units are typically uniform across the parcel with the exception of the depth to rock. Test pit logs are presented after the report text and figures in Attachment A. Soil Borings are presented graphically in Attachment B.

Groundwater was encountered in the soil boring explorations at a depths ranging from 12 to 18 feet below ground surface. Groundwater appears to be perched atop the weathered and intact rock units. Groundwater in the vicinity is expected to be consistent along the rock contact or other soil units with relatively low hydraulic conductivity. Surficial evidence of seasonally high groundwater was noted in the swale area in the form of wheel rutting. The depth to groundwater in the area is also expected to vary considerably with seasonal fluctuations in rainfall.

Seismic Hazards

Based on a review of seismic hazard maps for the vicinity, the primary seismic risk at the site is earthquake induced lateral accelerations on structures. The site is located in a relatively flat area of West Salem Hills, and therefore is unlikely susceptible to major earthquake induced landslides. Based on the explorations, the soil profile does not indicate a significant potential for soil liquefaction. There are no known active faults at the site, although fault rupture always remains a remote possibility. Tsunami impacts at the site are unlikely.

FOUNDATION RECOMMENDATIONS

General

In general, the site appears to be acceptable for the proposed development. Based on the preliminary site plan, there will likely be substantial cutting and filling required to achieve desired building and parking lot grades, and over-excavation or other technologies may be required in some areas to increase soil bearing capacity and strength, and to remove unsuitable soil from the foundation areas. Rock excavation may also be required in the areas of GT 4 and GT5 to achieve finish parking lot and building grades. Slopes along the base of the south parking lot cuts may also be problematic due to the groundwater conditions observed in the field.

Shallow soil conditions are stiff to hard at the time of field exploration but will degrade rapidly to medium to medium stiff during wetter weather. All soil units encountered in the field exploration above the igneous rock are fine grained. Fine grained soil conditions indicate that some settlement of shallow foundations should be expected, although settlement should be limited. Soils appear to stiffen at depths greater than 6 feet.

Site soils are moisture sensitive, and will become difficult, if not impossible to work in wet weather.

Willamette believes that structures can be reasonably supported on a combination of spread footings and structural slab-on-grade with limited or no over-excavation. Settlements should not pose significant issues for a properly reinforced foundation.

Clearing and Stripping

All surficial materials contaminated with organic debris, rubble, or other deleterious material should be cleared from areas beneath footings, slabs, and paved areas, and disposed outside of building and pavement areas, or at an approved disposal site.

Once stripping is complete other disturbed soil exposed during stripping should be removed or re-compacted, and the finished surface should be graded to drain. Significant ponding of surface water on the stripped finish surface may cause soil conditions to deteriorate. Total depth of stripping is estimated at about 6 inches. Over-excavation may be required in some areas to remove the soft surficial fill.

Over-excavation

Site soils may be variable in the surface or at depth in excavations. Foundation areas should be over-excavated as required to develop adequate soil bearing. Over-excavation may be required in areas that appear soft or yield easily under equipment loads. Those areas should also be excavated and replaced with structural fill to the design structure footing subgrade.

Over-excavation and structural fill placement should be completed under the observation of the geotechnical engineer to ascertain that loose or unsuitable soils have been removed to sufficient depth to meet the design intent of the foundation bearing capacity recommendations.

General Fill Placement

General fill will be placed as backfill around the building perimeter, behind retaining walls, in landscape areas, and may support sidewalks around the building perimeter. In general, the fill should meet the following specifications:

Percent of Compaction:	90 percent:
Maximum Slope:	3:1 (Horizontal : Vertical)

Fill or backfill materials can consist of either suitable on-site fill or select fill. On-site fill is soil generated from excavation and grading which can, in the opinion of the geotechnical engineer, be satisfactorily moisture conditioned and placed and compacted as fill. Select fill is imported material consisting of aggregate or combinations of aggregate and soil that can be successfully compacted.

If grading is performed during the wet winter months, generally October through May, Willamette recommends that on-site fill only be used if it has been drained sufficiently well to achieve the required compaction.

Fill material should be placed in layers twelve inches or less in loose thickness, moisture conditioned if necessary, and compacted to 90-percent of the maximum Standard Proctor density, ASTM D698. Fill should not be placed against retaining walls until concrete has had sufficient curing time.

If field density tests indicate the required percentage of compaction has not been obtained, the fill material shall be re=compacted, or scarified and moisture conditioned as necessary and re-compacted to the required Percent Compaction before placing any additional material.

Structural Fill Placement

Structural fill will be placed beneath structure foundations and will support parking and roadway areas. In general, the structural fill should meet the following specifications:

Percent of Compaction:	95 percent:
Maximum Slope:	2:1 (Horizontal : Vertical)

Structural fill materials can consist of either select aggregate fill in wet or dry weather conditions, or approved on-site fill during dry weather conditions. On-site fill is soil generated from excavation and grading which can, in the opinion of the geotechnical engineer, be satisfactorily placed and compacted as fill.

If grading is performed during the wet winter months, generally October through May, Willamette recommends that on-site fill only be used if it has been drained sufficiently well to achieve the required compaction.

Fill material should be placed in layers twelve inches or less in loose thickness, moisture conditioned if necessary, and compacted to 95-percent of the maximum Modified Proctor density, ASTM D1557. Fill should not be placed against retaining walls until concrete has had sufficient curing time.

If field density tests indicate the required percentage of compaction has not been obtained, the fill material shall be re-compacted or scarified and moisture conditioned as necessary and re-compacted to the required Percent Compaction before placing any additional material.

Cut Slopes

Temporary cut slopes in the clays and silts should be limited 1-1/2 to 1 (horizontal to vertical). Temporary cut slopes in the weathered basalt should be limited to 1-1/2 to 1 (horizontal to vertical) unless groundwater is encountered. If groundwater is encountered the maximum temporary cut slope inclination should be 2 to 1. Steeper slopes may be stable for the short term however the interim stability should not be relied upon.

Permanent cut slopes in the clays and silts should be limited 2-1/2 to 1 (horizontal to vertical). Permanent cut slopes in the weathered basalt should be limited to 2 to 1 (horizontal to vertical) unless groundwater is encountered. If groundwater is encountered the maximum permanent cut slope inclination should be 2-1/2 to 1.

Fill Slopes

Permanent fill slopes comprised of on-site clays and silts should be limited 2-1/2 to 1 (horizontal to vertical). Permanent fill slopes comprised of select granular fill should be limited to 2 to 1 (horizontal to vertical).

Areas where fill slopes are anticipated should be properly prepared prior to placement of material. Preparation will include clearing and stripping of unsuitable materials as well as benching and keying the surface of existing slopes to provide adequate bonding and anchorage of the fill. A drainage zone at the base of the proposed fill may also be necessary in areas with evidence of significant surface water.

Utility Trench Excavation

Utility line excavations beneath paved or floor slab areas, should be properly backfilled with compacted aggregate fill, placed to the specified degree of compaction, or better. Figure 4 provides a pictorial representation of Willamette's recommended design. Utility lines that will be located in the vicinity of the buildings must be installed after site grading and fill placement. On-site soils should not be used as backfill for utility lines, except in landscape areas where some backfill settlement is tolerable. Shoring will be required in all excavations greater than 4-feet in depth, or as required by Oregon Occupational Health and Safety Construction standards.

Spread and Continuous Footings

Spread and continuous footings should be founded competent native soils or on structural fill placed in the over-excavation. Footings should not be constructed at locations and elevations such that the slope down from the edge of the footing is at an inclination greater than 2:1 (horizontal : vertical) without the approval of the engineer.

Bearing Material

Competent native soil or compacted structural fill.

Allowable Bearing Pressure

1,750-psf for all dead and live loads bearing on approved subgrade or compacted select fill placed in accordance with the structural fill recommendations. One-third increase allowable for temporary short-term wind and seismic loads.

Footing Lateral Load Resistance

Passive Resistance:	300 pounds per cubic foot (pcf) equivalent fluid density
Coefficient of Friction at Footing Base:	0.35

Note: These values do NOT include a load factor; the structural engineer should provide this factor. These values do, however, assume that all footing backfill has been placed and compacted to a maximum density equivalent to 95 percent of the maximum Modified Proctor density, ASTM D1557.

Seismic Design

The following parameters are provided to design for seismic forces in accordance with 2003 International Building Code.

Location (Lat, Long) Degrees	3
1.0 Second Period, S_1 -	0.347g
Short Period, S_s	0.802g
Soil Factors, Site Class	D
F_a -	1.179
F_V -	1.706
SD_1 - (0.667 x F_V x S_1)	0.395 g
SD_s - (0.667 x F_a x S_S)	0.630 g

Slab-on-Grade Floors

Subgrade

6-inches compacted structural fill

Capillary Break

Minimum of 2 inches of free-draining sand and gravel containing less than 3 percent fines (materials passing No. 200 mesh sieve) based on fraction passing the No. 4 mesh sieve. (Not necessary if Select Fill is used and meets this requirement)

Vapor Barrier

In areas where moisture would be detrimental to equipment, floor coverings or furnishings inside the building, a vapor barrier should be placed beneath the concrete floor slab. Reinforced plastic sheeting is satisfactory for this purpose.

Protection Measures

A layer of sand, approximately 2 inches thick, may be placed over the vapor barrier membrane to protect it from damage, to act as an aid in curing of the concrete slab, and also to help prevent cement paste bleeding down into the underlying capillary break.

Footing Drains

Install perimeter-footing drains adjacent to all continuous exterior footings and thickened slabs. Footing drains should not be connected to the downspout or roof drain system. A typical footing drain schematic is presented in Figure 5.

Settlement

Shallow soils on the site are fine grained and may be somewhat settlement sensitive. Settlement should be controlled however through over-excavation of unsuitable native soil. Over-excavation of soft or yielding areas should reduce post construction settlements for footings and structural slabs to reasonable levels.

Provided over-excavation recommendations are followed, foundation settlements should be within the following limits:

Total Settlement:	less than 1.0 inch
Differential Settlement:	less than 0.5 inch over 30 feet
Time Rate:	approximately 90 percent in first month after loads applied; remainder within one year of completion of construction.

Lateral Earth Pressures

Lateral earth pressures either apply active loads to retaining walls or buried structure walls such as basement walls, or provide passive resistance to lateral loads being carried in structure foundations. Active and passive lateral earth pressures are based on material friction angles estimated from the field testing program, and the proposed footing or wall backfill material. Compacted aggregate structural fill has been assumed for all footing and retaining wall backfill. Earth pressure diagrams are presented in Figure 6.

Design active lateral pressures

Wall free to rotate at top:	35-pcf equivalent fluid density
Wall fixed at top:	55-pcf equivalent fluid density
Floor surcharge:	40-psf uniformly distributed over entire height of wall where applicable
Traffic Surcharge:	80-psf uniformly distributed over entire height of wall where applicable
Hydrostatic Pressure Reduction:	Include footing drains to reduce hydrostatic pressures on basement or retaining walls.

Design passive lateral pressures

Wall:	300-pcf equivalent fluid density
Floor surcharge:	150-psf uniformly distributed over entire buried portion of the wall where applicable

Note: These values assume that all wall backfill has been placed and compacted to a maximum density equivalent to 92 percent of the maximum Standard Proctor density, ASTM D1557.

Pavement Sections

Pavement design and capacity recommendations for the parking areas have been developed based on site conditions and material properties developed from the field test program, and our experience with similar soils. Based on the soils in the shallow subsurface, all pavement areas should include a structural geotextile fabric as a base for the design pavement section (Mirafi 100X or equal).

The design pavement sections should consist of either a layer of Crushed Rock Base (CRB) or Asphalt Treated Base (ATB) material placed on the compacted subgrade and overlain at a later date by an Asphaltic Concrete Pavement (ACP). The design pavement section should consist of one of the following:

Parking and Light Traffic Areas

For areas that will support primarily automobile traffic. The upper 9-inches of aggregate fill will be compacted to not less than 95 Percent compaction verified by proof rolling as described above.

Minimum Base Layer Thickness: 9 inches of CRB or 3 inches of ATB

Minimum Surfacing Thickness: 2.5 inches of Class B ACP

Heavy Traffic Areas

For areas that will support primarily truck traffic. Upper 12-inches of aggregate fill compacted to not less than 95 Percent compaction verified by proof rolling as described above.

Minimum Base Layer Thickness: 12 inches of CRB or 8 inches of ATB

Minimum Surfacing: 3.5 inches of Class B ACP

SUMMARY

Willamette believes the site can be developed using standard construction practices. The fine grained soil conditions in the upper 8 will likely require carful construction practices if wet weather construction is anticipated.

Willamette appreciates the opportunity to be of service in this matter. Willamette should be requested to observe the foundation preparation prior to placement of foundations or structural fill, and to review the fill placement procedures to verify the execution of the design intent.

If you have any questions, please call me at (503) 623-0304 or (503) 871-4984.

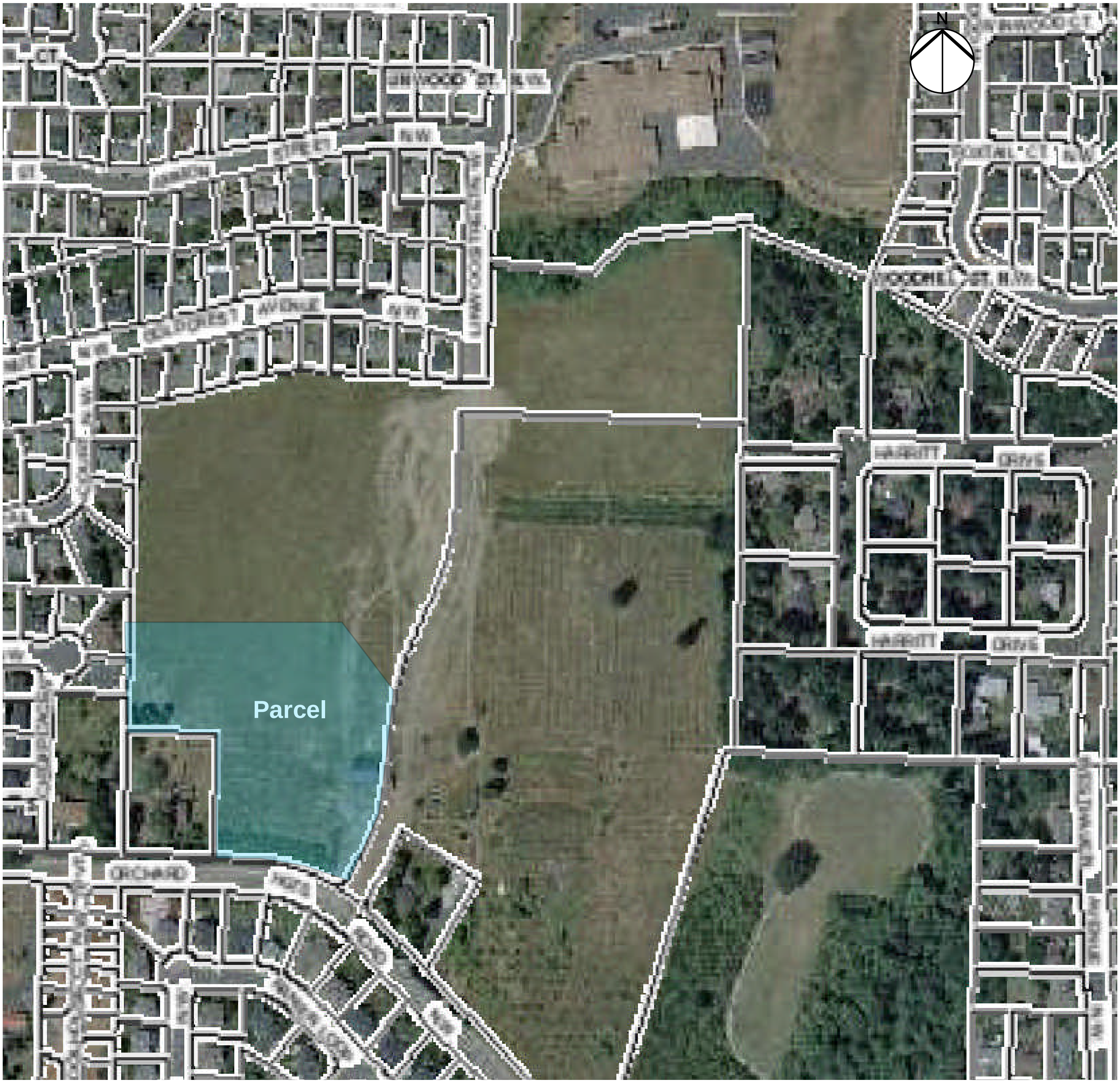
Sincerely,

Willamette
Engineering and Earth Sciences

REGISTERED PROFESSIONAL ENGINEER
17023
OREGON
JAN. 18, 1994
ROBERT J. SLYH
EXPIRES 06/30/12

Robert J. Slyh, P.E.
Principal

Attachments: Limitations
Figures 1 through 5
Attachments A and B



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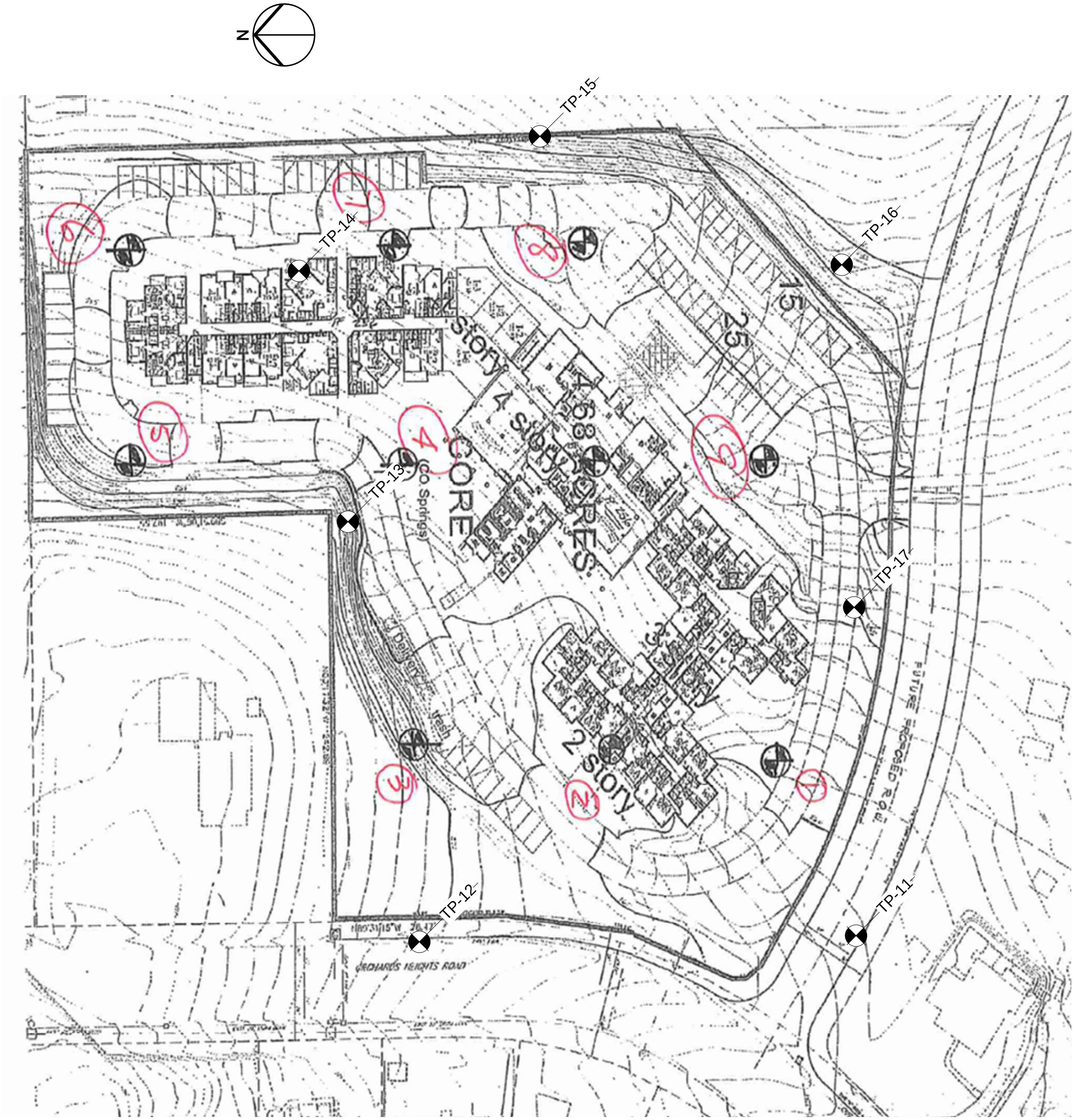
Lindbeck ALF Geotechnical Study
Mountain West Investments

ALF
Overall Site Map

SCALE	NTS.	Figure	1



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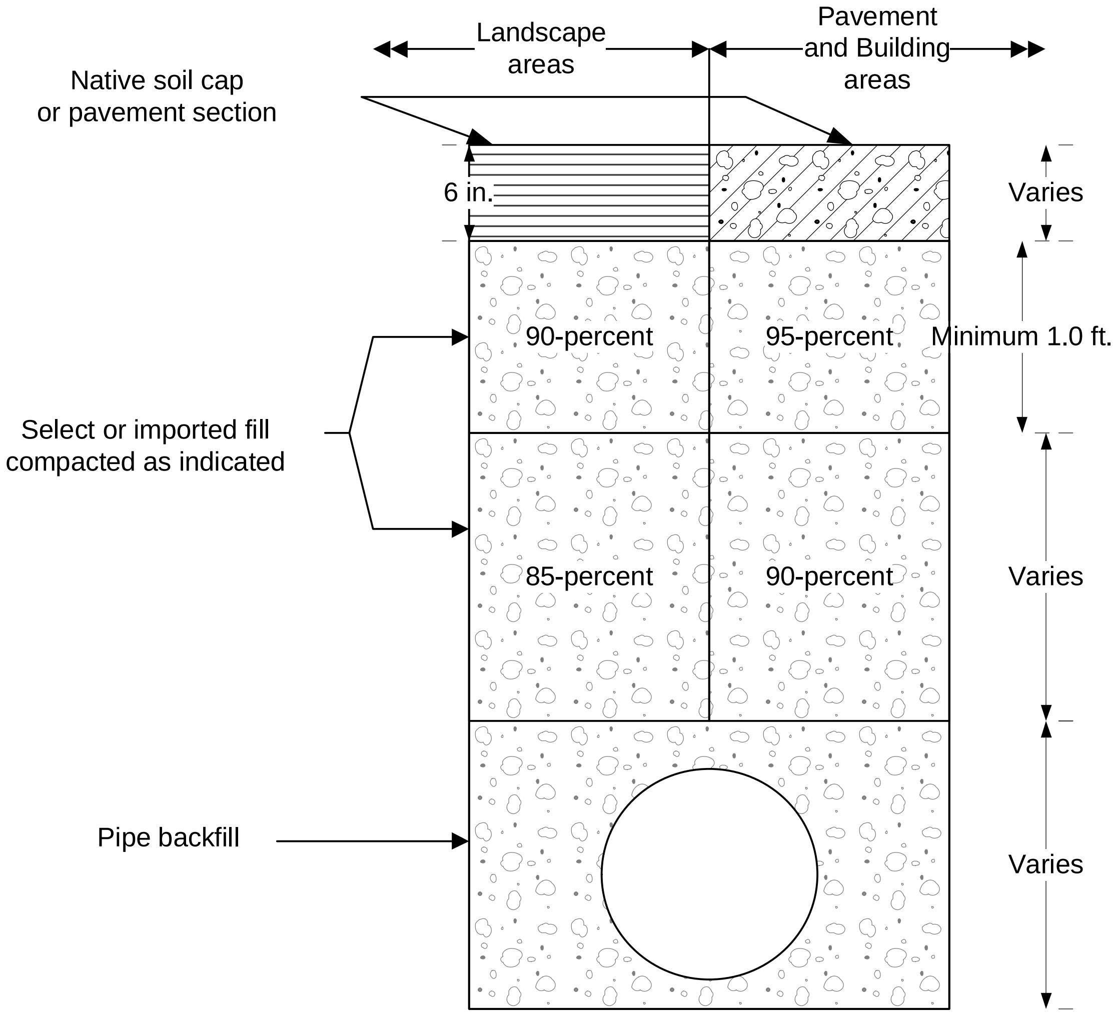
Mountain West Investments

Site Exploration
ALF

SCALE	NTS.		Figure	2



Note: percentage compaction refers to ASTM D-1557

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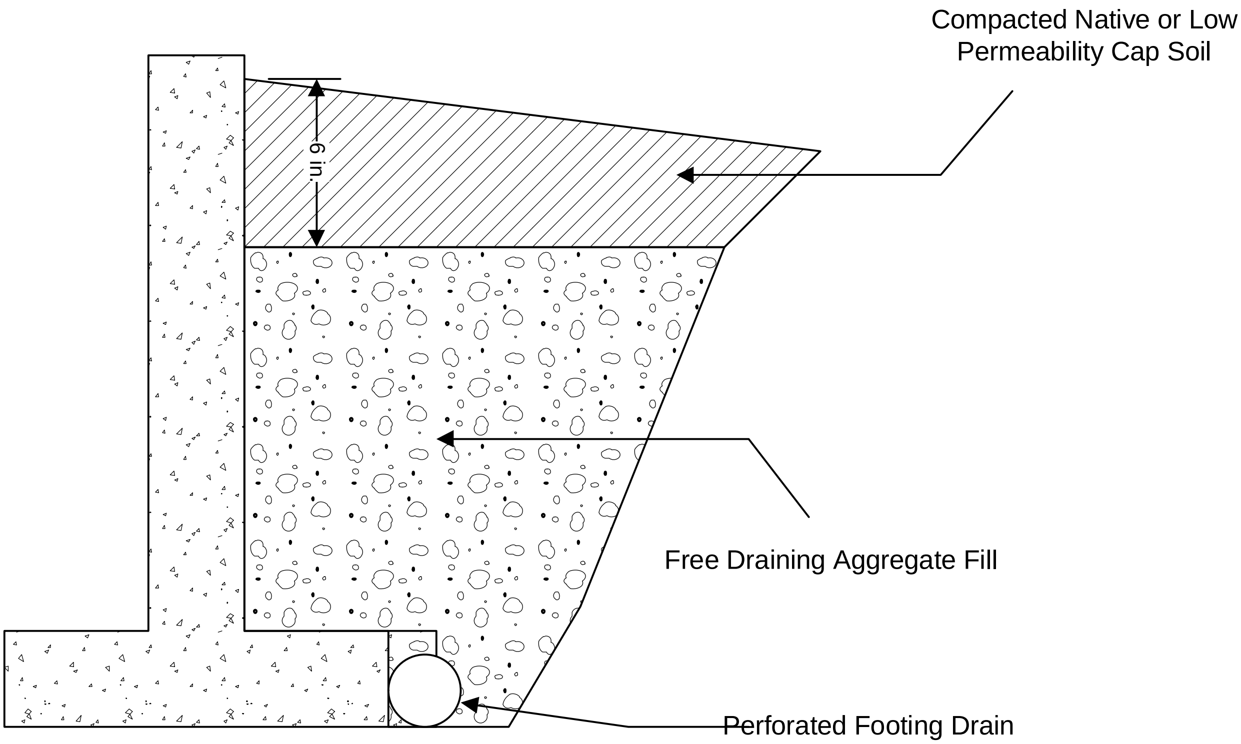
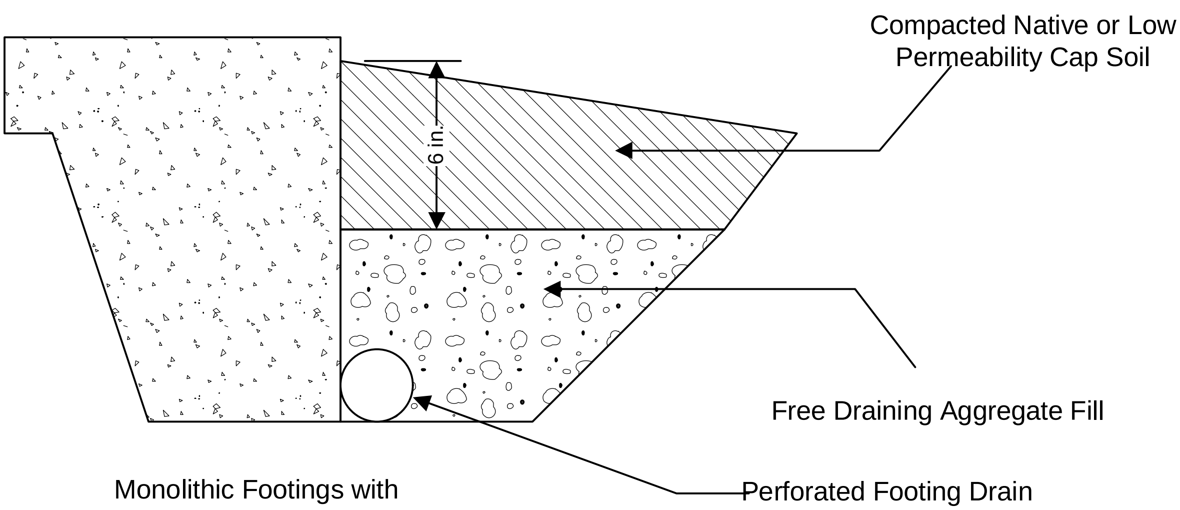
SCALE	NTS.		Figure	3



Spread and Continuous
Perimeter Footings



Monolithic Footings with
Slab-On-Grade Construction

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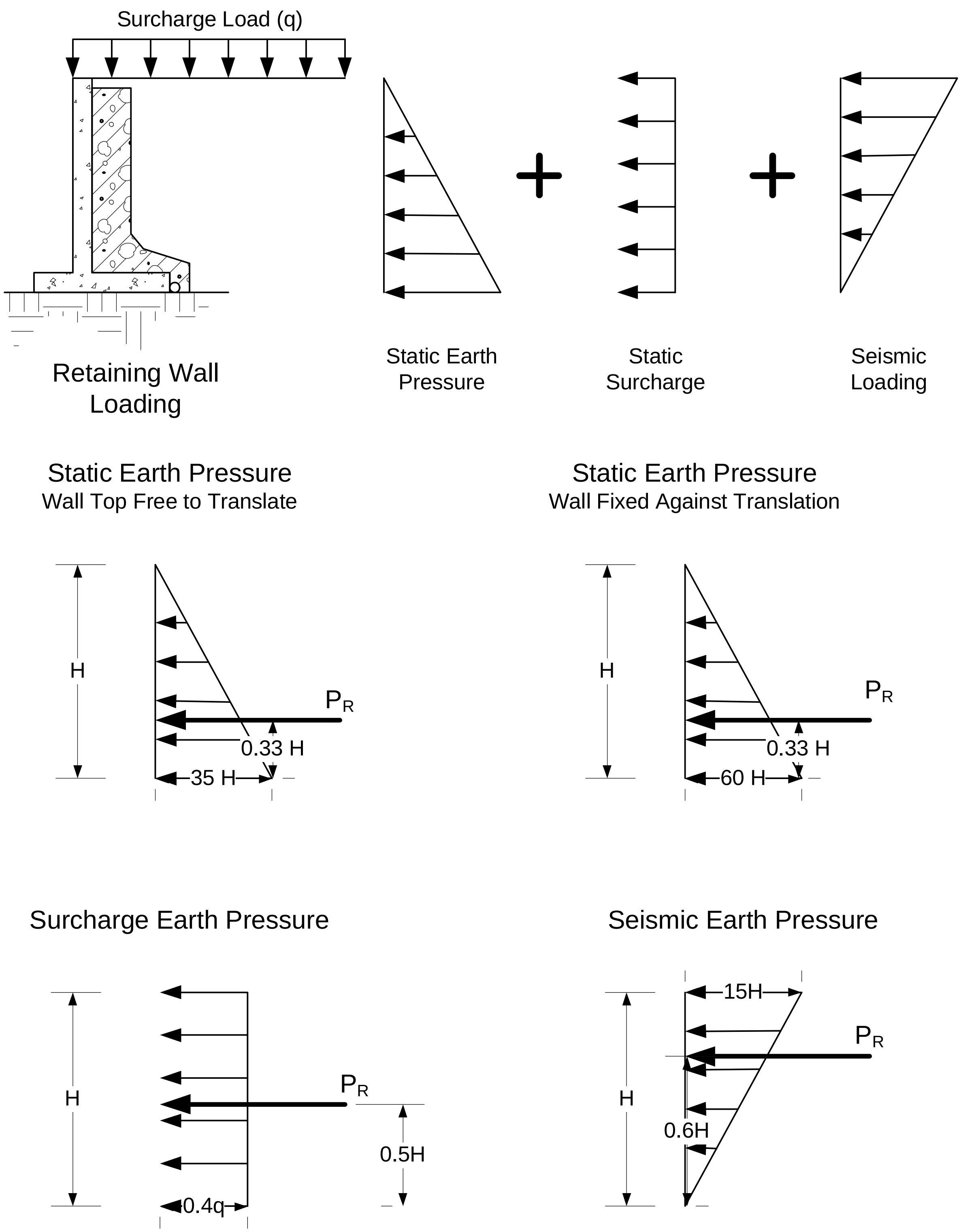
SCALE	NTS.	Figure	4

Lateral Earth Pressures



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Lindbeck ALF Geotechnical Study
Mountain West Investments

Horizontal Earth Pressures

SCALE	NTS.		Figure	5

Attachment A
Test Pit Logs

Test Pit 1

Depth Range	Soil Description
0.0 -2.0 feet	Tan Brown Clayey SILT (ML), dry to moist, very stiff, low plasticity
2.0 -3.0 feet	Brown Clayey SILT (ML), dry to moist, very stiff, rock fragments
3.0 -3.0 feet	Basalt

Ground Water not encountered

Test Pit 2

Depth Range	Soil Description
0.0 -1.5 feet	Tan Brown SILT (ML), dry, hard
1.5- 6.0 feet	Tan Brown Clayey SILT (ML), dry to moist, stiff, low plasticity
6.0 -9.0 feet	Brown SILT (ML), moist, stiff

Ground Water not encountered

Test Pit 3

Depth Range	Soil Description
0.0 -1.5 feet	Tan Brown SILT (ML), dry, hard
1.5- 7.0 feet	Tan Brown Clayey SILT (ML), dry to moist, stiff, low plasticity
7.0 -9.0 feet	Brown SILT (ML), moist, stiff

Ground Water not encountered

Test Pit 4

Depth Range	Soil Description
0.0 -3.5 feet	Tan Brown SILT (ML), dry, hard
3.5- 7.0 feet	Tan Brown Clayey SILT (ML), dry to moist, stiff, low plasticity

Ground Water not encountered

Test Pit 5

Depth Range	Soil Description
0.0 -5.5 feet	Tan Brown SILT (ML), dry to moist, hard
5.5- 7.0 feet	Tan Brown Clayey SILT (ML), dry to moist, stiff, low plasticity
7.0- 7.0 feet	Red Clayey SILT (ML), dry to moist, very hard, crumbly

Ground Water not encountered

Test Pit 6

Depth Range	Soil Description
0.0 -5.5 feet	Tan Brown SILT (ML), dry to moist, hard
5.5- 7.0 feet	Tan Brown Clayey SILT (ML), dry to moist, stiff, low plasticity
7.0- 7.0 feet	Red Clayey SILT (ML), dry to moist, very hard, crumbly

Ground Water not encountered

Test Pit 7

Depth Range	Soil Description
0.0 -5.5 feet	Tan Brown SILT (ML), dry to moist, hard
5.5- 7.0 feet	Tan Brown Clayey SILT (ML), dry to moist, stiff, low plasticity
7.0- 7.0 feet	Red Clayey SILT (ML), dry to moist, very hard, crumbly

Ground Water not encountered

Test Pit 8

Depth Range	Soil Description
0.0 -5.5 feet	Tan Brown SILT (ML), dry to moist, hard
5.5- 7.0 feet	Tan Brown Clayey SILT (ML), dry to moist, stiff, low plasticity
7.0- 7.0 feet	Red Clayey SILT (ML), dry to moist, very hard, crumbly

Ground Water not encountered

Test Pit 9

Depth Range	Soil Description
0.0 -5.5 feet	Tan Brown SILT (ML), dry to moist, hard
5.5- 7.0 feet	Tan Brown Clayey SILT (ML), dry to moist, stiff, low plasticity
7.0- 7.0 feet	Red Clayey SILT (ML), dry to moist, very hard, crumbly

Ground Water not encountered

Attachment B

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Geotechnical Soil Boring

Project Name:	Linbeck ALF	Soil Boring Number:	GT-2 (1 of 1)
Client:	Mountain West Investments	Date:	10-6-11
Job Number:	11-MWI-003	Reference Elevation:	100
Location:	Salem, Oregon	Total Depth:	21.5 ft
Excavation Method:	Hollow Stem Auger	Logged By:	Slyh

Sample Type	Blow Count	Ground Water Level	Sample	Depth in Feet	Graphic Log	USCS Soil Description
				0		**0.0 to 15.5 feet: Clayey SILT (ML)**, tan to brown, stiff to hard, dry, moderately plastic
SPT	1-8-9 17					
SPT	3-10-16 26			5		@ 5.0 grades to hard, dry
SPT	2-6-6 12			10		@ 10.0 becomes red-gray and moist
SPT	4-20-17 37			15		
						15.5 to 21.5 feet: Wx Basalt (), gray black, very hard, wet, plastic some free water
SPT	2-22-45 67			20		@20.0 wet, clayey matrix with intact rock, free water
				25		

Geotechnical
Soil Boring

Project Name:	Linbeck ALF	Soil Boring Number:	GT-3 (1 of 1)
Client:	Mountain West Investments	Date:	10-6-11
Job Number:	11-MWI-003	Reference Elevation:	100
Location:	Salem, Oregon	Total Depth:	21.5 ft
Excavation Method:	Hollow Stem Auger	Logged By:	Slyh

Sample Type	Blow Count	Ground Water Level	Sample	Depth in Feet	Graphic Log	USCS Soil Description
				0		**0.0 to 18.0 feet: Clayey SILT (ML)**, tan to brown, stiff to hard, dry, moderately plastic
SPT	2-4-5 9					
SPT	3-6-11 17			5		@ 5.0 grades to very stiff, dry
SPT	3-7-9 16			10		@ 10.0 becomes red-gray and moist
SPT	4-5-15 20	▼		15		@ 15.0 yellow black and moist to wet
						18.0 to 21.5 feet: Wx Basalt (), gray black, very hard, wet, plastic some free water
SPT	1-8-50 58			20		@20.0 wet, clayey matrix with intact rock, free water
				25		

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Geotechnical Soil Boring

Project Name:	Linbeck ALF	Soil Boring Number:	GT-4 (1 of 1)
Client:	Mountain West Investments	Date:	10-6-11
Job Number:	11-MWI-003	Reference Elevation:	100
Location:	Salem, Oregon	Total Depth:	13.0 ft
Excavation Method:	Hollow Stem Auger	Logged By:	McCann

Sample Type	Blow Count	Ground Water Level	Sample	Depth in Feet	Graphic Log	USCS Soil Description
				0		**0.0 to 9.0 feet: Clayey SILT (ML)**, tan to brown, stiff to hard, dry, moderately plastic
SPT	2-11-15 26					
SPT	2-7-9 16			5		@ 5.0 grades to stiff, dry
SPT	3-8-30 38			10		**9.0 to 12.0 feet: Wx Basalt ()**, gray black, very hard, wet, plastic some free water
SPT	10-50/6" 50	▼				@12.0 wet, intact rock
				15		
				20		
				25		

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Geotechnical Soil Boring

Project Name:	Linbeck ALF	Soil Boring Number:	GT-5 (1 of 1)
Client:	Mountain West Investments	Date:	10-6-11
Job Number:	11-MWI-003	Reference Elevation:	100
Location:	Salem, Oregon	Total Depth:	18.0 ft
Excavation Method:	Hollow Stem Auger	Logged By:	McCann

Sample Type	Blow Count	Ground Water Level	Sample	Depth in Feet	Graphic Log	USCS Soil Description
				0		**0.0 to 15.0 feet: Clayey SILT (ML)**, tan to brown, stiff to hard, dry, moderately plastic
SPT	3-5-5 10					
SPT	3-7-14 21			5		@ 5.0 grades to stiff, dry
SPT	3-11-21 33			10		@ 10.0 becomes red-gray and moist
SPT	2-5-17 22			15		**15.0 to 18.5 feet: Wx Basalt ()**, gray black, very hard, wet, plastic some free water
SPT	29-50/2" 50	▼				@18.0 wet, intact rock
				20		
				25		