Associated Earth Sciences, Inc.

May 7, 2004
Project No. KE04216A

Quilceda Land Group
8115 Broadway, Suite 204
Everett, Washington 98203

Attention: Mr. John Lakhani

Subject: Subsurface Exploration, Geologic Hazard, and Geotechnical Engineering Report
Magnolia Meadows
Arlington, Washington

Dear Mr. Lakhani:

We are pleased to present copies of the above-referenced report. This report summarizes the results of our subsurface exploration, geologic hazard, and geotechnical engineering study, and offers recommendations for design and development of the proposed project.

We have enjoyed working with you on this study and are confident that the recommendations presented in this report will aid in the successful completion of your project. Should you have any questions, or if we can be of additional help to you, please do not hesitate to call.

Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington

Bruce L. Blyton, P.E.
Principal Engineer

cc: Higa-Burkholder Associates, LLC
1721 Hewitt Avenue, Suite 401
Everett, Washington 98201

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Subsurface Exploration, Geologic Hazard,
and Geotechnical Engineering Report

MAGNOLIA MEADOWS

Arlington, Washington

Prepared for

Quilceda Land Group

Project No. KE04216A
May 7, 2004

SUBSURFACE EXPLORATION, GEOLOGIC HAZARD, AND GEOTECHNICAL ENGINEERING REPORT

MAGNOLIA MEADOWS

Arlington, Washington

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I. PROJECT AND SITE CONDITIONS

1.0 INTRODUCTION

This report presents the results of our subsurface exploration, geologic hazard assessment, and geotechnical engineering study for the proposed Magnolia Meadows development in Arlington, Washington (Figure 1, Vicinity Map). The site plan and the approximate locations of the subsurface explorations referenced in this study are presented on the Site and Exploration Plan (Figure 2). In the event that any changes in the nature, design, or layout of the project are planned, the conclusions and recommendations contained in this report should be reviewed and modified, or verified, as necessary.

1.1 Purpose and Scope

The purpose of this study was to provide subsurface soil and ground water data to be utilized in the design and development of the proposed residential plat. Our study included a review of available geologic literature, excavation of exploration pits, and performing a geologic study to assess the type, thickness, distribution, and physical properties of the subsurface sediments and shallow ground water conditions. A geologic hazard assessment and geotechnical engineering study were also completed to determine suitable geologic hazard mitigation techniques, the type of suitable foundations, allowable foundation soil bearing pressures, anticipated foundation settlements, erosion considerations, and drainage considerations. This report summarizes our current fieldwork and offers geologic hazard mitigation and development recommendations based on our present understanding of the project.

1.2 Authorization

Written authorization to proceed with this study was granted by Mr. John Lakhani of Quilceda Land Group. Our study was accomplished in general accordance with our scope of work letter dated April 7, 2004. This report has been prepared for the exclusive use of Quilceda Land Group and their agents, for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted geotechnical engineering and engineering geology practices in effect in this area at the time our report was prepared. No other warranty, express or implied, is made.

2.0 PROJECT AND SITE DESCRIPTION

This report was completed with an understanding of the project based on discussions with Mr. John Lakhani of Quilceda Land Group, construction plans by Higa-Burkholder, dated February

27, 2004, and familiarity with our geotechnical work performed in the site area. Present plans call for the construction of 114 lots, new streets, detention ponds, and associated development improvements. Access to the new development will be from the Magnolia Estates development to the south and the Glen Eagle Heights development to the east.

The site was primarily forested or grass covered, undeveloped land with one abandoned house and the remains of several outbuildings near the south central portion of the site along with a wetland, pond, and associated small unnamed creek flowing to the north through the middle of the site. A large area of wood waste was observed spread across the surface near the west central portion of the site. The site was level to slightly rolling with an overall elevation drop of approximately 35 feet based on the supplied construction plans.

3.0 SITE EXPLORATION

Our field study included advancing 13 exploration pits on April 12, 2004 and performing a geologic reconnaissance to gain information about the site. The various types of sediments, as well as the depths where characteristics of the sediments changed, are indicated on the exploration logs presented in the Appendix. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types. Our explorations were approximately located in the field by measuring from known site features shown on the attached Site and Exploration Plan, and their locations and elevations should be considered approximate.

The conclusions and recommendations presented in this report are based on the exploration pits completed for this study. The number, location, and depth of the explorations were completed within site and budgetary constraints. Because of the nature of exploratory work below ground, extrapolation of subsurface conditions between field explorations is necessary. It should be noted that differing subsurface conditions may sometimes be present due to the random nature of deposition and the alteration of topography by past grading and/or filling. The nature and extent of any variations between the field explorations may not become fully evident until construction. If variations are observed at that time, it may be necessary to re-evaluate specific recommendations in this report and make appropriate changes.

3.1 Exploration Pits

The exploration pits were excavated with a trackhoe made under contract to Quilceda Land Group. The pits permitted direct, visual observation of subsurface conditions. Materials encountered in the exploration pits were studied and classified in the field by an engineering geologist from our firm. All exploration pits were backfilled immediately after examination and logging. Selected samples were then transported to our laboratory for further visual

classification and testing, as necessary. One modified Proctor test and three moisture content tests were performed on selected samples from across the site. The test results are included in the attached Appendix.

4.0 SUBSURFACE CONDITIONS

Subsurface conditions at the project site were inferred from the field explorations accomplished for this study and visual reconnaissance of the site. As shown on the field logs, the exploration pits generally encountered lodgement till throughout the site. Minor amounts of fill were encountered in exploration pit EP-1 located south of the abandoned house and in exploration pit EP-9, excavated near an area of wood waste, wood chips, and sawdust. Review of the United States Geological Survey (USGS) publication *Distribution and Description of the Geologic Units in the Arlington East Quadrangle, Washington* by Minard (1980) indicates that the area of the subject site is underlain by Vashon lodgement till. Our interpretations of the sediments encountered during our study are in agreement with this regional geologic map. The following section presents more detailed subsurface information organized from the shallowest (youngest) to the deepest (oldest) sediment types.

4.1 Stratigraphy

Sod/Forest Duff/Topsoil

A layer of organic-rich soil classified as sod, forest duff, and/or topsoil was encountered at the surface in all of the exploration pits except EP-9 where wood waste was present at the surface. The organic-rich soil was generally 1 foot thick across those areas of the site that were explored. It is expected that there is a greater thickness of organic-rich soils along the stream channel and in the wetlands adjacent to the stream, though no exploration was accomplished in these areas. This soil is not considered suitable for building or pavement support due to its compressive nature.

Fill

Approximately 2 feet of fill consisting of loose, moist to wet sand containing few amounts of gravel and trace amounts of plastic pipe fragments was encountered below the sod and topsoil in exploration pit EP-1. There was a slight petroleum odor associated with this fill. No environmental screening, analysis, or testing was accomplished in these soils as this was outside of the present scope of work. Approximately 3 feet of wood waste fill (chips, sawdust, and small wood chunks) was encountered in exploration pit EP-9. The fill is not considered suitable for building foundation or pavement support.

Weathered Vashon Lodgement Till

Weathered Vashon lodgement till, consisting generally of dense, silty fine to coarse sand, containing few amounts of gravel, was encountered below the fill, the sod, the forest duff, and/or the topsoil in all of the exploration pits excavated for the site. The lodgement till was deposited at the base of the Vashon age glacial ice sheet and was subsequently overridden by several thousand feet of ice. Consequently, these materials are generally dense to very dense, possess high shear strength, low compressibility characteristics, and have relatively low permeability. The upper portions of the till are generally weathered and less dense, oxidized brown, and siltier than the lower unweathered portions of the deposit. The weathered till is suitable for direct foundation support and support of pavement sections. These sediments are considered moisture-sensitive and are anticipated to have a relatively low permeability rate.

Vashon Lodgement Till

Unweathered till was encountered below the weathered till in all of the exploration pits excavated for the site. The unweathered till consisted of dense to very dense, fine to coarse silty sand containing few fine to coarse gravel and trace amounts of cobbles. Though not encountered in any of the exploration pits, boulders are commonly present scattered in both the weathered and unweathered till. The unweathered till is also suitable for structural support, is considered moisture-sensitive, and is anticipated to have a very low relative permeability rate.

4.2 Hydrology

Ground water seepage was only encountered in exploration pit EP-1 excavated near the south central portion of the site. This ground water is interpreted to be perched ground water. Perched ground water occurs when surface water infiltrates down through relatively permeable soils such as the fill or the weathered portions of the till and becomes trapped or "perched" atop a comparatively impermeable barrier such as the unweathered portions of the till. This infiltration can occur at great distances from the area where the ground water is encountered. It should be noted that fluctuations in the level of the ground water may occur due to the time of the year, stream flow, and variations in the amount of precipitation. The quantity and duration of flow from excavations made into the perched zone will vary depending on season, topography, and soil grain size. Generally there will be more abundant perched ground water in the winter, spring, and early summer and in the proximity of the wetlands and stream in the central portion of the site. The site soils nearest the wetlands and stream exhibited elevated moisture contents. It is anticipated that ground water will be encountered during construction of streets, structures, and underground utilities that cross or come close to the existing wetlands and stream.

4.3 Laboratory Results

Moisture contents were determined at several locations around the project on both the weathered and unweathered till units. The results of the moisture determinations revealed the underlying soils to contain approximately 15 percent water by weight. A Proctor sample was also obtained from EP-2 to determine maximum density and optimum moisture content of the soil. Depending on the gravel content the maximum density was between 135 and 137 pounds per cubic foot (pcf) with optimum moisture between 7.5 and 8.0 percent. The Proctor and moisture content results are presented in the Appendix.

II. GEOLOGIC HAZARDS AND MITIGATIONS

The following discussion of potential geologic hazards is based on the geologic conditions as observed and discussed herein.

5.0 SLOPE STABILITY ASSESSMENT

There are no steep slopes on the site and medium dense to dense lodgement till is located at a relatively shallow depth beneath the ground surface across the site. Therefore, it is our opinion that the risk of failures in naturally occurring slopes is low for static conditions and no mitigation measures are required.

6.0 SEISMIC HAZARDS AND RECOMMENDED MITIGATION

Earthquakes occur in the Puget Lowland with great regularity. The vast majority of these events are small and are usually not felt. However, large earthquakes do occur as evidenced by the 1949, 7.2-magnitude event; the 1965, 6.5-magnitude event; and the 2001, 6.8-magnitude event. The 1949 earthquake appears to have been the largest in this area during recorded history. Evaluation of return rates indicates that an earthquake of the magnitude between 6.0 and 7.0 is likely within a given 25- to 40-year time period in the Puget Sound Basin.

Generally, there are four types of potential geologic hazards associated with large seismic events: 1) surficial ground rupture; 2) seismically induced landslides; 3) liquefaction; and 4) ground motion. The potential for each of these hazards to adversely impact the proposed project is discussed below.

6.1 Surficial Ground Rupture

The nearest known fault trace to the project is the South Whidbey Island-Lake Alice Fault, located approximately 19 miles to the south. Little is known about the South Whidbey Island-Lake Alice Fault but no evidence of surficial ground rupture has been noted.

The recurrence intervals for movement along this fault system is still unknown, although it is hypothesized to be in excess of several thousand years. Due to the suspected long recurrence interval and the distance to this fault zone, the potential for surficial ground rupture is considered to be low during the expected life of the structures and no mitigation efforts beyond

complying with the current (1997) *Uniform Building Code* (UBC) or current (2003) *International Building Code* (IBC) are recommended.

6.2 Seismically Induced Landslides

There are no steep slopes on the site and medium dense to dense lodgement till is located at a relatively shallow depth beneath the ground surface across the site. Therefore, it is our opinion that the risk of landslides is low for seismic conditions and no mitigation measures are required.

6.3 Liquefaction

The encountered stratigraphy has a low potential for liquefaction due to the high strength of the glacially consolidated near-surface site soils. No liquefaction mitigation efforts are recommended.

6.4 Ground Motion

The project site is located within a Zone 3 rating for seismic activity on a scale of 1 (lowest) to 4 (highest) based on the *Seismic Zone Map of the United States*, Figure No. 16-2 in the 1997 edition of the UBC. This is based on past earthquake activity in the Puget Sound region. As such, structural design for the project should accommodate the possible effect of seismic activity in areas with a Zone 3 rating, corresponding to a peak ground acceleration of 0.3g (a Richter magnitude 7.5 earthquake occurring directly beneath the site), in accordance with UBC guidelines, using soil type Sc. No additional mitigation efforts beyond the UBC guidelines are recommended.

Alternatively, guidelines presented in the 2003 *International Building Code* (IBC) Section 1615 may be used. Information presented in Figure 1615(1) of the IBC indicates a mapped spectral acceleration for short periods of $S_s = 1.12$. Information presented in Figure 1615(2) of the IBC indicates a mapped spectral acceleration for a 1 second period of $S_1 = 0.35$. Based on the results of subsurface exploration and on an estimation of soil properties at depth utilizing available geologic data, Site Class "C" in conformance with Table 1615.1.1 of the IBC may be used. These values correspond to site coefficients $F_a = 1.0$ and $F_v = 1.5$ in conformance with IBC Tables 1615.1.2(1) and 1615.1.2(2), respectively.

7.0 EROSION HAZARDS AND MITIGATION

Under existing conditions, there is a low to moderate potential for erosion to occur in sloping areas during and after construction. The potential for increased erosion during and after

construction can be mitigated by following the recommendations listed below and in previous sections of this report.

1. All storm water from impermeable surfaces should be tightlined into an approved storm water drainage system or temporary storage facilities.

2. If possible, construction should proceed during the drier periods of the year and disturbed areas should be revegetated as soon as possible.

3. Clearing beyond the areas to be developed should be avoided. Disturbed areas should be revegetated as soon as possible.

4. Temporary silt fences should be provided along the lower margins of cleared/disturbed areas.

5. Check dams should be provided along any swales or temporary ditches.

6. Temporary sediment catchment facilities should be cleaned out and maintained periodically as necessary to maintain their capacity and function.

7. Soils, which are to be reused around the site, should be stored in such a manner as to reduce erosion from the stockpile. Protective measures may include, but are not necessarily limited to, covering with plastic sheeting, or the use of straw bales/silt fences around pile perimeters.

8. Temporary construction entrances should be constructed with quarry spalls or equivalent according to the City of Arlington regulations.

III. DESIGN RECOMMENDATIONS

8.0 INTRODUCTION

It is our opinion that from a geotechnical standpoint, the parcel is suitable for the proposed development provided that the recommendations contained herein are properly followed. Medium dense to dense lodgement till was encountered at relatively shallow depths in our explorations and conventional spread footings may be used for support of the proposed residences. There was a slight amount of perched ground water encountered in one of the explorations near the south end of the site. Ground water and elevated soil moisture contents are expected to increase near the wetlands and the existing stream. The lodgement till was generally above its optimum moisture content (wet) at the time of our site exploration. The soils are also quite silty and during the wet winter and spring months the contractor and developer should be prepared to manage over-optimum moisture content (wet) soil and subgrade conditions. Construction should be timed to take advantage of dry weather.

9.0 SITE PREPARATION

Site preparation of areas to be graded should include removal of all trees, brush, old utilities, demolition debris from the existing house and outbuildings, and any other deleterious material. Additionally, the upper organic topsoil should be removed and the remaining roots grubbed. Areas where loose soils exist due to previous grading, filling, or grubbing operations should be considered as uncontrolled fill to the depth of disturbance and treated as subsequently recommended for structural fill placement. Where existing loose fill or natural sediments are relatively free of organics and near their optimum moisture content for compaction, they can be segregated for reuse as structural fill.

Soft, wet, and/or organic soils encountered at proposed subgrade elevations near the wetlands and stream should be excavated down to firm and unyielding soils as determined by the geotechnical engineer or their representative.

Since the density of the soil is variable, random soft pockets may exist and the depth and extent of stripping can best be determined in the field by the geotechnical engineer or their representative.

9.1 Permanent Cut and Fill Slopes

Permanent cut and structural fill slopes should be graded no steeper than 2H:1V (Horizontal:Vertical). Slopes should be hydroseeded as soon as possible after grading.

9.2 Temporary Slopes

In our opinion, stable construction slopes should be the responsibility of the contractor and should be determined during construction. For estimating purposes, we anticipate that temporary unsupported cut slopes in the unsaturated weathered and unweathered till can be made at a maximum slope of 1H:1V. As is typical with earthwork operations, some sloughing and raveling may occur and cut slopes may have to be adjusted in the field. In addition, WISHA/OSHA regulations should be followed at all times.

9.3 Site Disturbance

The on-site soils contain a high percentage of fine-grained material, which makes them moisture-sensitive and subject to disturbance when wet. Most of the soils encountered in our explorations were judged to be near or above their optimum moisture content for compaction at the time of our study. The contractor must use care during site preparation and excavation operations so that the underlying soils are not softened, particularly during wet weather conditions. If disturbance occurs, the softened soils should be removed and the area brought to grade with structural fill. Because of the moisture-sensitive nature of the soils, we anticipate that wet weather construction would significantly increase the earthwork costs over dry weather construction. Moisture conditioning (watering) of the upper weathered portions of the lodgement till may be needed if construction proceeds in the drier summer and early fall.

10.0 STRUCTURAL FILL

Structural fill will be necessary to establish desired grades, and for utility trench backfill. All references to structural fill in this report refer to subgrade preparation, fill type, placement, and compaction of materials as discussed in this section. In those areas where existing uncontrolled fill is present, we recommend that it be removed and replaced with new structural fill. Where suitable, the removed old fill can be set aside for reuse. Our recommendations for the placement of structural fill are presented in the following sections.

10.1 Fill Placement

After stripping, planned excavation, and any required overexcavation has been performed to the satisfaction of the geotechnical engineer or their representative, the upper 12 inches of exposed ground should be recompacted to 90 percent of the modified Proctor maximum density using ASTM:D-1557 as the standard. If the subgrade contains too much moisture, adequate recompaction may be difficult or impossible to obtain and should probably not be attempted. In lieu of recompaction, the area to receive fill should be blanketed with quarry spalls or similar to act as a capillary break between the new upper fill and the lower wet subgrade. This

procedure will likely be necessary in the vicinity of EP-9 where the proposed roadway will cross between the existing pond and wetland. In the wetland and stream crossing areas, the quarry spalls will also allow for the lateral migration of ground water through the area. Where the exposed ground remains soft and further overexcavation is impractical, placement of an engineering stabilization fabric such as Mirafi 500X or equivalent may be necessary to prevent contamination of the free-draining layer by silt migration from below.

After compaction of the exposed ground is tested and approved, or a free-draining rock course is laid, possibly in conjunction with engineering stabilization fabric, structural fill may be placed to attain desired grades. Structural fill is defined as non-organic soil, acceptable to the geotechnical engineer, placed in maximum 8-inch loose lifts with each lift being compacted to at least 95 percent of the modified Proctor maximum density using ASTM:D-1557 as the standard or in accordance with compaction standards for Snohomish County and the City of Arlington.

The contractor should note that any proposed fill soils should be evaluated by Associated Earth Sciences, Inc. (AESI) prior to their use in fills. This would require that we have a sample of the material 72 hours in advance of filling activities to perform a Proctor test and determine its field compaction standard. Soils in which the amount of fine-grained material (smaller than the U.S. No. 200 sieve) is greater than approximately 5 percent (measured on the minus U.S. No. 4 sieve size) should be considered moisture-sensitive. Use of moisture-sensitive soils in structural fills should be limited to favorable dry weather and near-optimum subgrade moisture conditions.

At the time of our study, the soil moisture content of the collected samples was on the order of 15 percent, which is approximately twice the optimum moisture content necessary to achieve compaction requirements. In our opinion, soil conditions may improve during the drier summer months or in different locations and depths around the site. In that case, the likelihood to achieve at least 90 percent compaction may improve. However, preparations should be made to mitigate wet soils for re-use as backfill through aeration, replacement, or amendment methods.

All of the on-site soils except the sod, forest duff, and topsoil are suitable for use as structural fill but generally contained significant amounts of silt and are considered moisture-sensitive. Construction equipment traversing the site when the soils are wet can cause considerable disturbance. If fill is placed during wet weather or if proper compaction cannot be obtained due to wet subgrade or soil conditions, a select material consisting of a clean, free-draining gravel and/or sand should be used. Free-draining fill consists of non-organic soil with the amount of fine-grained material limited to 5 percent by weight when measured on the minus U.S. No. 4 sieve fraction and at least 25 percent greater than the No. 4 sieve. The use of

powdered cement or kiln dust may also be needed to modify over-optimum moisture content soils.

10.2 Construction Monitoring

A representative from our firm should inspect the stripped subgrade and be present during placement of structural fill to observe the work and perform a representative number of in-place density tests. In this way, the adequacy of the earthwork may be evaluated as filling progresses and problem areas may be corrected at that time. It is important to understand that taking random compaction tests on a part-time basis will not ensure uniformity or acceptable performance of a fill. As such, we are available to aid you in developing a suitable monitoring and testing frequency.

11.0 FOUNDATIONS

Spread footings may be used for building support when founded on the medium dense to dense weathered lodgement till, lower unweathered lodgement till, or on structural fill placed as previously discussed. We recommend that an allowable bearing pressure of 2,500 pounds per square foot (psf) (including both dead and live loads) be utilized for the houses and other near-surface foundation design purposes if placed on weathered lodgement till or structural fill placed on the weathered lodgement till.

An increase of one-third may be used for short-term wind or seismic loading. Perimeter footings should be buried at least 18 inches into the surrounding soil for frost protection. All footings must penetrate to the prescribed bearing stratum and no footing should be founded in or above loose, organic, or existing uncontrolled fill soils. All footings should have a minimum width of 14 inches for one-story structures, 16 inches for two-story structures, and 18 inches for three-story structures.

It should be noted that the area bounded by lines extending downward at 1H:1V from any footing must not intersect another footing or intersect a filled area that has not been compacted to at least 95 percent of ASTM:D-1557. In addition, a 1.5H:1V line extending down from any footing must not daylight because sloughing or raveling may eventually undermine the footing. Thus, footings should not be placed near the edge of steps or cuts in the bearing soils.

Anticipated settlement of footings founded on the medium dense to dense weathered lodgement till, lower unweathered lodgement till, or approved structural fill placed over these soils should be on the order of ¾ inch. However, disturbed soil not removed from footing excavations prior to footing placement could result in increased settlements. All footing areas should be inspected by AESI prior to placing concrete to verify that the design bearing capacity of the soils has been attained and that construction conforms to the recommendations contained in this

report. The City of Arlington may require such inspections. Perimeter footing drains should be provided as discussed under Section 13.0, *Drainage Considerations*.

The depth to bearing soils (medium dense to dense weathered till) was approximately 1 foot below existing grades in the locations of most of our exploration pits across the site. The depth to bearing soils was approximately 3 feet in the location of exploration EP-1, located near the south end of the site. Based on the surrounding topography, it appeared that approximately 5 feet of wood waste fill and pre-existing topsoil is located in a large area near the west central portion of the site. The depth to bearing soils in the area of the wood waste is anticipated to be approximately 5 feet below the existing surface. The depth to bearing soils in the wetlands and near the stream was not explored.

12.0 FLOOR SUPPORT CONSIDERATIONS

Slab-on-grade floors may be used over structural fill or pre-rolled and compacted medium dense to dense lodgement till soils. Where moisture migration through slabs is to be controlled, the floor should be cast atop a minimum of 4 inches of washed rock or pea gravel to act as a capillary break. The floor should also be protected from dampness by an impervious moisture barrier (plastic sheeting).

13.0 DRAINAGE CONSIDERATIONS

Traffic across the on-site soils when they are damp or wet will result in disturbance of the otherwise firm stratum. Therefore, during site work and construction, the contractor should provide surface drainage and subgrade protection, as necessary.

Any retaining walls and all perimeter footing walls should be provided with a drain at the footing elevation. Drains should consist of rigid, perforated, polyvinyl chloride (PVC) pipe surrounded by washed pea gravel. The level of the perforations in the pipe should be set at the bottom of the footing and the drains should be constructed with sufficient gradient to allow gravity discharge away from the buildings. The perforations should be located on the lower portion of the pipe. In addition, any retaining or basement walls should be lined with a minimum 12-inch-thick washed gravel blanket, backfilled completely with free-draining material, or lined with a drainage mat such as Mira-Drain 6000 over the full height of the wall (excluding the first 2 feet below the surface). This drainage material should tie into the footing drains. Roof and surface runoff should not discharge into the footing drain system but should be handled by a separate, rigid, tightline drain. Discharge from drains upslope should not be allowed to pass water through lower wall and footing drains. Drain lines leading from upper systems should bypass lower drain systems.

In planning, exterior grades adjacent to walls and buildings should be sloped downward away from the structures to achieve surface drainage. Runoff water from impervious surfaces should be collected by a storm drain system that discharges into the site storm water system.

14.0 LATERAL WALL PRESSURES

All backfill behind walls or around foundation units should be placed as per our recommendations for structural fill and as described in this section of the report. Horizontally backfilled walls, which are free to yield laterally at least 0.1 percent of their height, may be designed using an equivalent fluid equal to 35 pcf. Fully restrained, horizontally backfilled rigid walls, which cannot yield, should be designed for an equivalent fluid of 50 pcf. If parking areas are adjacent to walls, a surcharge equivalent to 2 feet of soil should be added to the wall height in determining lateral design forces.

The lateral pressures presented above are based on the conditions of a uniform backfill consisting of on-site glacial soils compacted to 90 percent of ASTM:D-1557. A higher degree of compaction is not recommended, as this will increase the pressure acting on the wall. A lower compaction may result in settlement. Thus, the compaction level is critical and must be tested by our firm during placement. Surcharges from adjacent footings, heavy construction equipment, or sloping ground must be added to the above values. Footing and wall drains should be provided for all retaining walls as discussed under the section on *Drainage Considerations*.

14.1 Passive Resistance and Friction Factors

Lateral loads can be resisted by friction between the foundation and native till or supporting structural fill soils, or by passive earth pressure acting on the buried portions of the foundations. We recommend the following design parameters:

- Passive equivalent fluid = 300 pcf
- Coefficient of friction = 0.35

The above values include a safety factor of 1.5.

15.0 DETENTION PONDS

Two detention ponds are planned for the site. One is planned for the northwest site corner and one is planned for the north central portion of the site, east of the wetlands and stream.

It is anticipated that the ponds will be founded in weathered lodgement till over unweathered lodgement till based on the soils encountered in exploration pits EP-8 and EP-12. The till was over its optimum moisture content for compaction. No ground water was encountered in either pit. The till soils are anticipated to have low permeability rates and no pond liners are anticipated. The interior pond sidewalls should be sloped no steeper than 3H:1V. Exterior sides of the pond embankments may be graded as steep as 2H:1V. Fill used in the pond embankments should contain at least 20 percent fines or soil particles smaller than the U.S. No. 200 sieve. The fill should also contain a maximum of 60 percent sand. Pond embankment fill should be keyed at least 1 foot into the medium dense weathered lodgement till and the key width should be equal to one-half the base width of the berm. The embankment fill should be placed at a moisture content approximately 2 to 3 percent over its optimum moisture content and be compacted to at least 95 percent of ASTM:D-1557 to reduce in-place permeability and the potential for wetting-induced soil collapse. The on-site till soils may be suitable for pond embankments with some drying first. Samples of the soils, slated for use as pond embankment fill, should be tested by AESI to determine if they have sufficient fines prior to construction.

16.0 EXISTING WATER WELL

According to the plans supplied by Higa-Burkholder Associates, LLC, a domestic water well is located on the property. If the well will not be used in the future, it should be properly abandoned. Specific standards for abandonment of wells depend on the type of well in question. The State of Washington Department of Ecology outlines this information in a publication entitled "Minimum Standards for Construction and Maintenance of Water Wells". Local regulations may also apply.

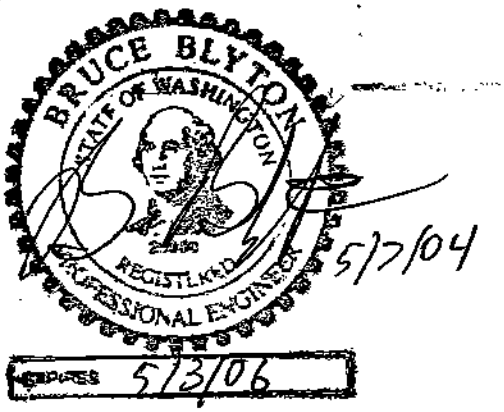
17.0 PROJECT DESIGN AND CONSTRUCTION MONITORING

We recommend that AESI perform a geotechnical review of the plans prior to final design completion. In this way, our recommendations may be properly interpreted and implemented in the design. This plan review is not included in the current scope of work and budget.

We are also available to provide geotechnical engineering and monitoring services during construction. The integrity of the earthwork and foundations depends on proper site preparation and construction procedures. In addition, engineering decisions may have to be made in the field in the event that variations in subsurface conditions become apparent. Construction monitoring services are not part of this current scope of work.

We have enjoyed working with you on this study and are confident that these recommendations will aid in the successful completion of your project. If you should have any questions, or require further assistance, please do not hesitate to call.

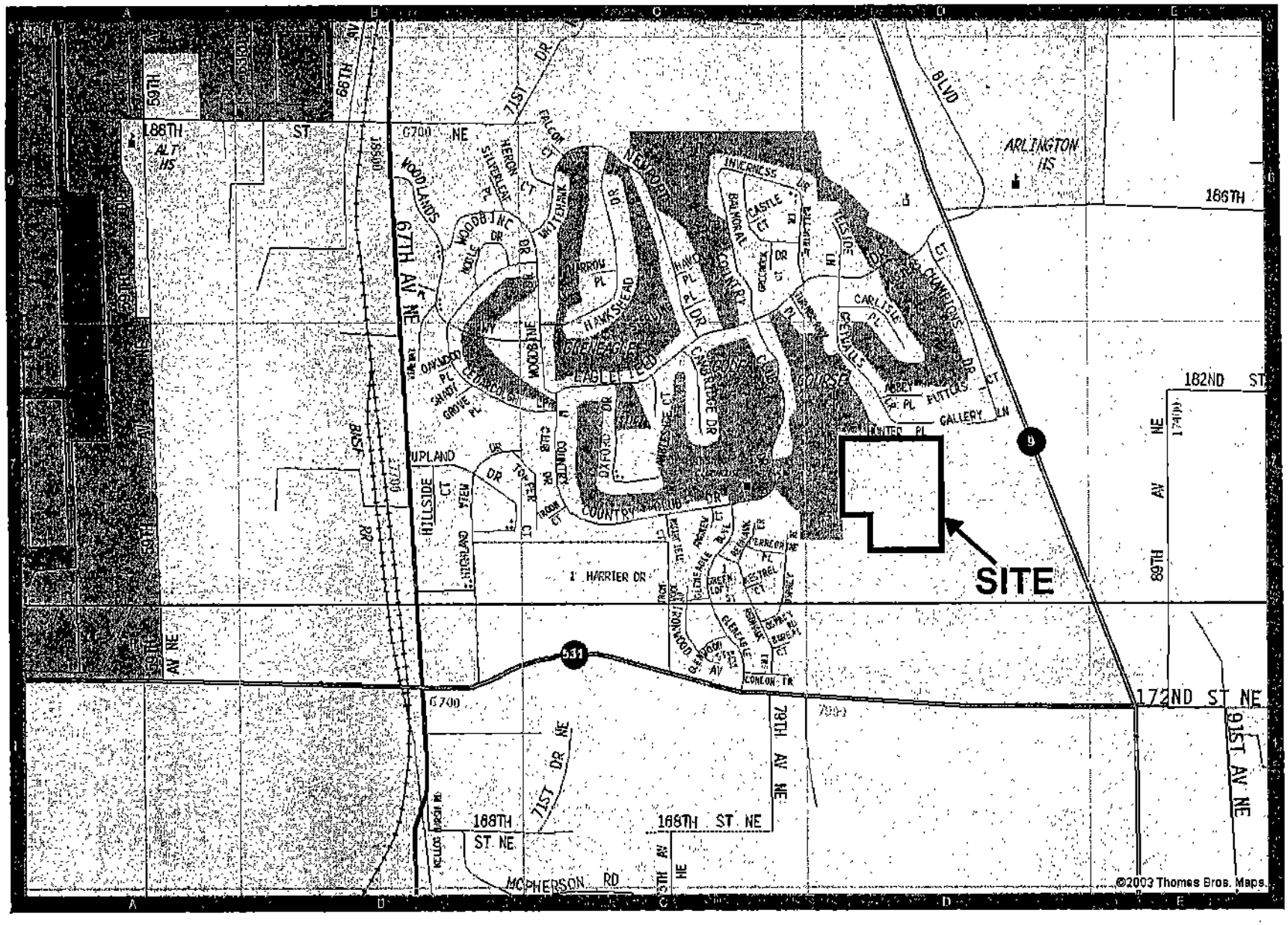
Sincerely,
ASSOCIATED EARTH SCIENCES, INC.
Kirkland, Washington



Scott R Hannah - FOR
John D. Coleman, P.E.G.
Project Geologist

Bruce L. Blyton, P.E.
Principal Engineer

Attachments: Figure 1: Vicinity Map
Figure 2: Site and Exploration Plan
Appendix: Exploration Logs
Laboratory Testing Results



N

NOT TO SCALE

Associated Earth Sciences, Inc.

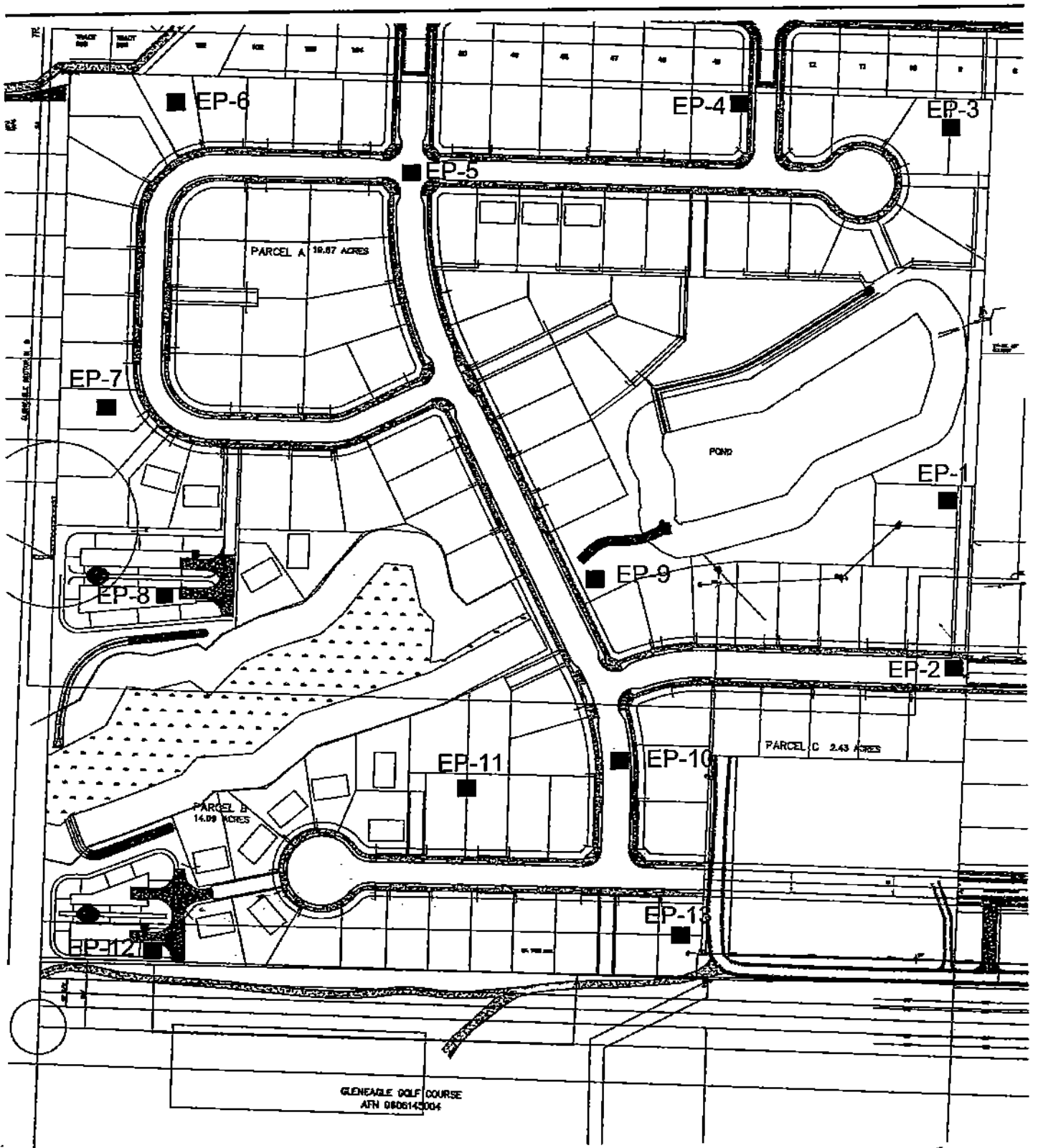
VICINITY MAP
MAGNOLIA MEADOWS
ARLINGTON, WASHINGTON

FIGURE 1

DATE 4/04

PROJ. NO. KE04216A

04216 magnolia meadows\04216-vicinity.cdr page1



LEGEND

EP-1 ■ Approximate location of exploration pit

N

0 100 200
FEET

REFERENCE: HIGA BURKHOLDER ASSOCIATES, LLC, 4/23/04 ELECTRONIC.

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SITE AND EXPLORATION PLAN

MAGNOLIA MEADOWS
ARLINGTON, WASHINGTON

FIGURE 2
DATE 4/04
PROJECT NO. KE04216A

04216 magnolia meadows\04216-site.dwg layout1

APPENDIX

LOG OF EXPLORATION PIT NO. EP-1

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Sod and Topsoil
1	**Fill**
2	Loose, moist to wet, mottled light olive-brown, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel, trace plastic pipe fragments, possible petroleum odor (SM).
3	**Weathered Lodgement Till**
4	Medium dense, moist to wet, mottled light olive-brown, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
5	
6	
7	**Lodgement Till**
8	Medium dense to dense, wet to moist, mottled light-olive gray, nonstratified, fine to coarse SILTY SAND, few fine to coarse, subrounded gravel (SM).
9	
10	
11	Bottom of exploration pit at depth 10 feet Slight (~1 gpm) ground water seepage between 3' and 5'. Moderate caving throughout.
12	
13	
14	
15	
16	
17	
18	
19	
20	

Magnolia Meadows
Arlington, WA

Associated Earth Sciences, Inc.

Logged by: JDC
Approved by:

Project No. KE04216A
April 2004

KCTP3 04216A-1.GPJ April 28, 2004

LOG OF EXPLORATION PIT NO. EP-2

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Forest Duff
1	**Weathered Lodgement Till**
2	Medium dense to dense, moist, light olive-brown, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
3	
4	**Lodgement Till**
5	Dense, moist, light olive-gray, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel, trace subrounded cobbles (SM).
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No caving. No ground water seepage.
12	
13	
14	
15	
16	
17	
18	
19	
20	

Magnolia Meadows
Arlington, WA

Associated Earth Sciences, Inc.

Logged by: JDC

Approved by:

Project No. KE04216A

April 2004

KCTP3 04216A-1.GPJ April 28, 2004

LOG OF EXPLORATION PIT NO. EP-3

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Forest Duff
1	**Weathered Lodgement Till**
2	Medium dense to dense, moist, light olive-brown, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
3	
4	**Lodgement Till**
5	Dense, moist, light olive-gray, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel, trace subrounded cobbles (SM).
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No caving. No ground water seepage.
12	
13	
14	
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16	
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20	

Magnolia Meadows
Arlington, WA

Associated Earth Sciences, Inc.

Logged by: JDC
Approved by:

Project No. KE04216A
April 2004

KCTP3 04216A-1.GPJ April 28, 2004

LOG OF EXPLORATION PIT NO. EP-4

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Forest Duff
1	**Weathered Lodgement Till**
2	Medium dense to dense, moist, light olive-brown, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
3	
4	**Lodgement Till**
5	Dense, moist, light olive-gray, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel, trace subrounded cobbles, trace small boulders (SM).
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No caving. No ground water seepage.
12	
13	
14	
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Magnolia Meadows
Arlington, WA

Associated Earth Sciences, Inc.

Logged by: JDC

Approved by:

Project No. KE04216A

April 2004

KCTP3 04216A-1.GPJ April 28, 2004

LOG OF EXPLORATION PIT NO. EP-5

Depth (ft)	DESCRIPTION
	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
	Forest Duff
1	**Weathered Lodgement Till**
2	Medium dense to dense, moist, light olive-brown, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
3	
4	**Lodgement Till**
5	Dense, moist, light olive-gray, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel, trace subrounded cobbles (SM).
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No caving. No ground water seepage.
12	
13	
14	
15	
16	
17	
18	
19	
20	

Magnolia Meadows
Arlington, WA

Associated Earth Sciences, Inc.

Logged by: JDC
Approved by:

Project No. KE04216A
April 2004

KCTP3 04216A-1.GPJ April 28, 2004

LOG OF EXPLORATION PIT NO. EP-6

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Forest Duff
1	**Weathered Lodgement Till**
2	Medium dense to dense, moist, light olive-brown, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
3	
4	**Lodgement Till**
5	Dense, moist, light olive-gray, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel, trace subrounded cobbles (SM).
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No caving. No ground water seepage.
12	
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18	
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KCTP3 04216A-1.GPJ April 28, 2004

Magnolia Meadows
Arlington, WA

Associated Earth Sciences, Inc.

Logged by: JDC

Approved by:

Project No. KE04216A

April 2004

LOG OF EXPLORATION PIT NO. EP-7

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Forest Duff
1	**Weathered Lodgement Till**
2	Medium dense to dense, moist, light olive-brown, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
3	
4	**Lodgement Till**
5	Dense, moist, light olive-gray, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel, trace subrounded cobbles (SM).
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No caving. No ground water seepage.
12	
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Magnolia Meadows
Arlington, WA

Associated Earth Sciences, Inc.

Logged by: JDC

Approved by:

Project No. KE04216A

April 2004

KCTP3 04216A-1.GPJ April 28, 2004

LOG OF EXPLORATION PIT NO. EP-8

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Forest Duff
1	**Weathered Lodgement Till**
2	Medium dense to dense, moist, light olive-brown, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
3	
4	**Lodgement Till**
5	Dense, moist, light olive-gray, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel, trace subrounded cobbles (SM).
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No caving. No ground water seepage.
12	
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Magnolia Meadows
Arlington, WA

Associated Earth Sciences, Inc.

Logged by: JDC

Approved by:

Project No. KE04216A

April 2004

KCTP3 04216A-1.GPJ April 28, 2004

LOG OF EXPLORATION PIT NO. EP-9

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Wood Chips, Wood Waste, and Sawdust
1	
2	
3	**Weathered Lodgement Till**
4	Medium dense, moist to wet, mottled light olive-brown, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
5	
6	
7	**Lodgment Till**
8	Medium dense to dense, wet to moist, mottled light-olive gray, nonstratified, fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
9	
10	
11	Bottom of exploration pit at depth 10 feet No caving. No ground water seepage.
12	
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Magnolia Meadows
Arlington, WA

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Project No. KE04216A

April 2004

KCTP3 04216A-1.GPJ April 26, 2004

LOG OF EXPLORATION PIT NO. EP-10

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.

Depth (ft)	DESCRIPTION
	Forest Duff
1	**Weathered Lodgement Till**
2	Medium dense to dense, moist, light olive-brown, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
3	
4	**Lodgement Till**
5	Dense, moist, light olive-gray, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel, trace subrounded cobbles (SM).
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No caving. No ground water seepage.
12	
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Magnolia Meadows
Arlington, WA

Associated Earth Sciences, Inc.

Logged by: JDC

Approved by:

Project No. KE04216A

April 2004

KCTP3 04216A-1.GPJ April 28, 2004

LOG OF EXPLORATION PIT NO. EP-11

Depth (ft)

This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.

DESCRIPTION

Forest Duff

Weathered Lodgement Till

Medium dense to dense, moist, light olive-brown, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).

Lodgement Till

Dense, moist, light olive-gray, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel, trace subrounded cobbles (SM).

Bottom of exploration pit at depth 10 feet
No caving. No ground water seepage.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Magnolia Meadows
Arlington, WA

Associated Earth Sciences, Inc.

Logged by: JDC
Approved by:

Project No. KE04216A

April 2004

KCTP3 04216A-1.GPJ April 28, 2004

LOG OF EXPLORATION PIT NO. EP-12

Depth (ft)	DESCRIPTION
	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered.
	Forest Duff
1	**Weathered Lodgement Till**
2	Medium dense to dense, moist, light olive-brown, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
3	
4	**Lodgement Till**
5	Dense, moist, light olive-gray, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel, trace subrounded cobbles (SM).
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No caving. No ground water seepage.
12	
13	
14	
15	
16	
17	
18	
19	
20	

Magnolia Meadows
Arlington, WA

Associated Earth Sciences, Inc.

Logged by: JDC

Approved by:

Project No. KE04216A

April 2004

KCTP3 04216A-1.GPJ April 28, 2004

LOG OF EXPLORATION PIT NO. EP-13

Depth (ft)	This log is part of the report prepared by Associated Earth Sciences, Inc. (AESI) for the named project and should be read together with that report for complete interpretation. This summary applies only to the location of this trench at the time of excavation. Subsurface conditions may change at this location with the passage of time. The data presented are a simplification of actual conditions encountered. **DESCRIPTION**
	Forest Duff
1	**Weathered Lodgement Till**
2	Medium dense to dense, moist, light olive-brown, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel (SM).
3	
4	**Lodgement Till**
5	Dense, moist, light olive-gray, nonstratified, SILTY fine to coarse SAND, few fine to coarse, subrounded gravel, trace subrounded cobbles (SM).
6	
7	
8	
9	
10	
11	Bottom of exploration pit at depth 10 feet No caving. No ground water seepage.
12	
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Magnolia Meadows
Arlington, WA

Associated Earth Sciences, Inc.

Logged by: JDC

Approved by:

Project No. KE04216A

April 2004

KCTP3 04216A-1.GPJ April 28, 2004

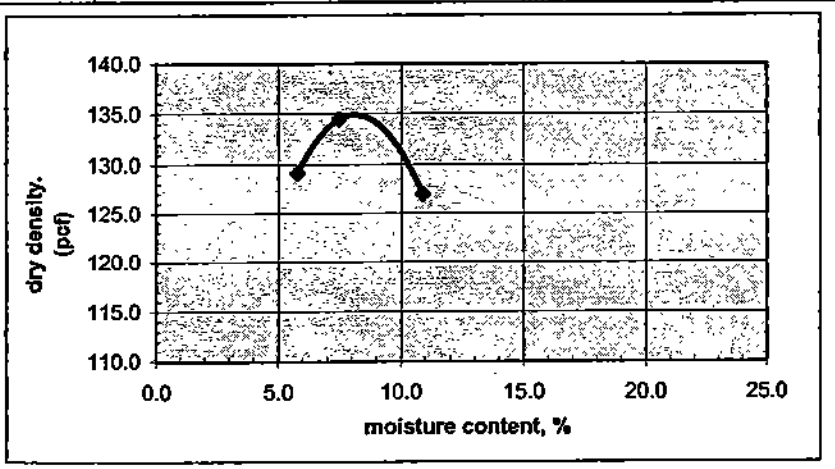
Associated Earth Sciences, Inc.

Proctor Analysis
ASTM D1557, D698

Date Sampled	Project	Project No.		Soil Description
21-Apr-04	Magnolia Meadows	KE04216A		
Tested By	**Location**	**EB/EP No.**	**Depth**	Silty SAND, little gravel
RDT	South side of site		5'	

Percent passing 3/4" sieve:	93%	ASTM D1557 Method C	Automatic Tamper

A	Mold Number	1	2	3		Remarks
B	Water Added	dry	dry	dry		
C	Wt. of Wet Soil + Mold (lb)	24.090	24.370	23.782		
D	Wt. of Mold (lb)	13.530	13.530	13.530		
E	Wt. of Wet Soil (lb)	10.560	10.840	10.252		
F	Wet Density, (pcf)	140.800	144.533	136.694		
G	Wt. of Pan (lb)	1.160	1.025	1.025		
H	Wt. of Wet Soil + Pan (lb)	11.690	10.210	10.415		
J	Wt. of Dry Soil + Pan (lb)	10.655	9.570	9.900		
K	Wt. of Water (lb)	1.035	0.640	0.515		
M	Wt. of Dry Soil (lb)	9.495	8.545	8.875		
N	Moisture Content (%)	10.9	7.5	5.8		
O	Dry Density (pcf)	127.0	134.5	129.2		
Z	For a 6 inch mold: Z = 0.075			For a 4" mold: Z = 0.0333		



Test Results:	
Optimum Moisture Percentage:	8.0
Maximum Dry Density:	135.0

Correction for oversize: ASTM D4718	
Corrected Moisture Percentage:	7.4
Corrected Maximum Dry Density	136.9

Assumed Specific Gravity: 2.7

ASSOCIATED EARTH SCIENCES, INC.

911 Fifth Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

Associated Earth Sciences, Inc.

Moisture Content
ASTM D 2216

Date Sampled	Project	Project No.		Soil Description
4/21/04	Magnolia Meadows	KE04216A		
Tested By	**Location**	**EB/EP No.**	**Depth**	
RDT				

Sample ID	EP-1,3'-6'	EP-3,4'-6'	EP-8,5'-8'
Wet Weight + Pan	1010	1069	866
Dry Weight + Pan	915	967	791
Weight of Pan	295	313	298
Weight of Moisture	95	102	75
Dry Weight of Soil	620	654	493
% Moisture	15.3	15.6	15.2

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MAINTENANCE REQUIREMENTS

4.6 Maintenance Standards for Drainage Facilities

The facility-specific maintenance standards contained in this section are intended to be conditions for determining if maintenance actions are required as identified through inspection. They are not intended to be measures of the facility's required condition at all times between inspections. In other words, exceedence of these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these standards. However, based upon inspection observations, the inspection and maintenance schedules shall be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard Trees
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth: pond reseeded if necessary to control erosion.
	Liner (If Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.

No. 1 – Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway and Berms over 4 feet in height.	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway	Emergency Overflow/ Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See "Side Slopes of Pond"	

No. 4 – Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).
Catch Basin	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab. i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

No. 6 – Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars.	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

No. 7 – Energy Dissipaters

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged.	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
	Water Flows Out Top of "Distributor" Catch Basin.	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
	Other Defects	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).