GEOTECHNICAL SITE EVALUATION
50 ACRE SITE MASTER PLAN
KLAMATH COMMUNITY COLLEGE
KLAMATH FALLS, OREGON

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1.0 INTRODUCTION

This report presents results of our geotechnical subsurface evaluation of the site located near the intersection of Highway 140 and Highway No. 39 in east Klamath Falls, Oregon. The purpose of this investigation was to evaluate the site surface and subsurface conditions with a series of exploratory test pits in order to evaluate the site soils for their suitability to support new structures within an expanded Klamath Community College Campus.

2.0 SITE AND PROJECT DESCRIPTION

The subject property is located to the west of the intersection of Highway 140 and the Klamath Falls-Lakeview Highway No. 39, in east Klamath Falls, Oregon. The site is bordered on the north by the Klamath Falls-Lakeview Highway, along much of the east side by the Enterprise Irrigation Canal and private property on the west and south. This 50 acre parcel is contiguous to approximately seven (7) acres which now houses buildings of the Community College. Please see Figure 1, Vicinity Map and Figure 2, Site Plan, for a more detailed site location and site details.

The site slopes mildly downwards toward the southwest. The site is generally covered with grass and some scattered brush.

We understand the project to consist of developing this 50 acre site into a larger Community College Campus. Initially there will be a preliminary review and development of a Master Plan for development of the site. To formulate such a Master Plan, this preliminary Site Investigation and Geotechnical Report was accomplished. The purpose of this investigation and report was to investigate the subsurface soil conditions, provide general recommendations for placement of structures, areas to be avoided, potential problematic conditions, review of potential geotechnical and geologic hazards and other items which would affect development of the site.

3.0 FIELD EXPLORATION

On December 29, 2000, our Project Geologist, Mr. Ed Busby, C.E.G., visited the site to conduct the subsurface investigation. Site soils were investigated by excavating ten (10) test pits spread generally across the site. Test pits were excavated using a 580K Case rubber-tired backhoe supplied by Jefferson State Rock Products of Klamath Falls, Oregon. The backhoe used was outfitted with an 24" bucket and 4 rock teeth. Approximate locations of the exploratory test pits are presented on Figure 2, Site Plan, at the end of this report. All test pits were backfilled with soil spoils from the excavation operations.

Our representative located the test pits spread generally across the site, logged subsurface soil and groundwater conditions, and collected representative samples for transport to our office and testing laboratory. Visual classification of the soils were made in the field and are represented in the Test Pit Logs in Appendix A, at the end of this report. Please note that in the logs soil changes are depicted as distinct layers, while in nature they may be more gradual.

4.0 LABORATORY TESTING

The surficial zones of soil encountered in the investigation ranged from a surficial layer of dark brown to yellow-brown, silty, clayey Sand or silty Clay. Based on previous experience in the area, these soils are generally expansive in nature. Due to the possibility that these soils are expansive (changes in volume with changes in moisture content), one sample from the silty Clay layer was tested for expansive potential. The brown, silty Clay was found to have a Expansion Index (EI) of 36. This test result indicates the silty Clay is mildly to moderately expansive. See Appendix B, Laboratory Testing, at the end of this report for test results.

5.0 SUBSURFACE CONDITIONS

5.1 SOIL

Subsurface conditions encountered on the site were reasonably similar between test pits. The surficial layer generally consisted of clayey, silty Sand topsoil. This was generally underlain by silty Clay and clayey Sand. In some test pits the clayey Sand became cemented and hard to excavate in the lower portion of the pits.

<u>Topsoil / Rootzone</u>

In all of the test pits, a thin layer of topsoil was encountered. The topsoil and/or rootzone layer ranged in thickness from 0.0 to 1.0 feet. The topsoil and/or root zone layer generally consists of a loose to medium dense, dark brown, silty, clayey fine Sand with numerous roots. The topsoil unit should not be used for structural fill or trench backfill and should only be used for landscape areas.

Expansive, Silty Clay

Test pits TP-3 and TP-4 encountered a layer of mildly to moderately expansive, soft to medium stiff, brown to light brown, silty Clay. This unit varies in depth from 1.0 feet in TP-3 to 10.0 feet in TP-3 and TP-4. This unit should not be used as trench backfill or structural fill since the material is expansive in nature and also very difficult to recompact well. This material is also highly susceptible to disturbance during the wet winter months. If construction is accomplished during the wet winter months, the silty Clay unit will likely become severely disturbed and unworkable. This material is easily excavated and generally stands reasonably well for short periods of time in utility trench excavations (some sloughing when wet).

Silty, Clayey Sand

Many of the test pits encountered a medium dense to very dense, brown or yellow-brown, silty, clayey Sand beneath the topsoil layer. After encountering a medium dense clayey sand near the surface, this layer becomes cemented and was very difficult to excavate. Most test pits terminated within this unit and in some cases the backhoe was near "refusal". The silty, clayey Sand layer varied in depth from 0.5 feet in test pit TP-10 to 8.5 feet in TP-9.

The trench walls should stand reasonably well for short periods of time in shallow trenches in this native unit as long as seepage is not present. Seepage or groundwater will tend to cause the upper zones of this unit to cave into the trench. These materials should make reasonable trench backfill if compacted in thin lifts during dry weather. This material will be extremely difficult to attain proper compaction in during wet weather or where seepage is present in the trench.

Please note, that while we have commented on the anticipated stability of the soil and rock units in trenches, we are not responsible for job site safety. The contractor is at all times responsible for job site safety, including excavation safety. We recommend all local, state and federal safety regulations be adhered to.

Please note that soil descriptions and layer interfaces are interpreted from observations at the site. While the layers are shown as having distinct boundaries in the test pit logs, in nature they may grade slowly from one soil type to another. Soil conditions may also vary between the test pit locations. For additional detail of the soils conditions encountered at the site, please see the Test Pit Logs in Appendix A at the end of this report.

5.2 GROUNDWATER

Numerous groundwater seepages were encountered in the test pits across the site (TP-3, TP-4, TP-5, TP-6, TP-9 and TP-10). It appears that when the test pits were excavated to depth, the groundwater "seeped" in through the "cleaner" zones of sand. This groundwater seepage appears to "run" through the clean zones of the clayey sand, "perched" on top of the denser (cemented) or more clayey zones. In the majority of the test pits, the surface soils tended to be moist. Static groundwater levels were encountered in test pits TP-3, TP-4 and TP-5 during the investigation. Depths to seepage zones ranged from 4.8 feet in TP-4 to 8 feet in TP-10. We found the depth to groundwater seepage to become shallower as you moved closer to the canal.

It appears that much of the groundwater seepage and water levels will fluctuate with the water levels in the Enterprise Irrigation Canal which "runs" along the east and northeast sides of the site.

Areas with looser fine-grained and sandy soils will tend to exhibit moderate seepage and instability if excavated during very wet weather or late in the winter after some areas have become saturated due to irrigation. Our test pits were excavated after a very dry fall and early winter. Excavations below the groundwater table will also tend to be unstable and the trench will tend to cave into the excavation. Pumping from open sumps may not be feasible if the groundwater levels must be lowered below 7 to 8 feet. However, to help decrease sloughing and caving of trench soils, construction in the drier months and getting adjacent parcels to limit irrigation just prior to and during excavation and backfill is recommended.

6.0 CONCLUSIONS

Based on the test pit excavations and our site observations, in our professional opinion, the site is suitable for the proposed college campus development. However, the site is underlain by expansive soils and easily disturbed soils which will require special care to be taken during construction in order to minimize disturbance to the surficial soils. The onsite clayey Sand is suitable for use as structural fill beneath landscape and paved areas such as parking lots and roadways. We do not recommend using the onsite soils as structural fill beneath proposed buildings. We recommend the use of crushed rock for structural fill beneath any structural elements of the structures.

7.0 DEVELOPMENT ISSUES

7.1 EXPANSIVE CLAY SOILS

Expansive clay soils were encountered during the investigation. The brown, silty Clay was tested and exhibited mild to moderate expansive potential. These expansive clays will require special attention during design and construction of this project. Foundation and pavement issues regarding the expansive clay are addressed in the following sections.

During construction, the base of all excavations and all exposed subgrade areas must be kept wet prior to covering them with other soils or rock. Any areas which have the surface dry out must have these soils rewetted to a "fully swelled" condition prior to covering. Areas which become severely dried out with shrinkage cracks on the surface may be very difficult to moisture condition to the proper moisture content. Covered dried out expansive soils will rewet during the wet months of the year and could create a swell problem beneath structures or asphalt areas.

7.2 FOUNDATIONS

7.2.1 Expansive Clay Soils

It appears that the site contains mild to moderately expansive clays. Foundations will require special care and attention during construction. We recommend that the geotechnical engineer observe all excavations to determine the presence of expansive clay soils and to verify they have been removed from beneath footings (or to the depth required).

Footings on this project will generally require overexcavation and structural fill to a depth at least three (3) feet or more below the final grade (expansive clay soils beneath this depth typically undergo only minimal volume change). Therefore, even though there is a small increase in risk, (compared to over-excavating to an even deeper depth), footings or structural fill embedded a minimum of three feet or more generally works well for foundation support. This must be verified in the final design report for specific structures.

It should be noted, that structures such as decks, walkways, or pavements placed on or in the expansive clay could undergo distress due to shrink and swell of the clay soils. The potential excessive cracking of decks and walkways by the movements could be mitigated by placing 6 to 8 inches of crushed rock, shale or decomposed granite beneath the walkways and/or decks. These should also be adequately reinforced to decrease movements.

Where expansive clay soils are left beneath footings or structural fill, the clay must be kept moist (in fully swelled condition) prior to being covered. If dry "shrunken clays" are covered, they will rewet in later wet months causing potential swell-related problems.

7.2.2 Foundation Support

Over most of the site, medium dense to dense soils were encountered within the upper 1 to 1.5 feet. In many areas the soils became dense to very dense from 2 feet to 4 or 5 feet below the surface. Therefore, moderate to moderately high bearing capacity values would be anticipated for design of foundations for structures (anticipated 2,500 psf to 3,500 psf).

Areas around TP-3 and TP-4 apparently have looser or soft soil conditions and would require consideration of alternate methods of support should the footing and/or column loads be large. These softer soils tended to be silty Clay. In this area these soils can exhibit unsatisfactory amounts of consolidation (resulting in building settlement) when subjected to heavy loads. Therefore, care must be taken in placing heavy structures across this area of the site.

Wetter soil zones located closer to the irrigation canal may also have lower allowable bearing values and may consolidate more under load. However, some of these soils appear to have the seepage confined above the denser layers and therefore deeper foundations (below 4 or 5 feet) may not be affected.

7.3 PAVEMENTS

Our subsurface investigation of the project indicates that the site is underlain by medium dense, silty, clayey Sands. The clayey soil is mildly to moderately expansive, which could cause shrinkage and swelling of the subgrade material under varying moisture conditions. Therefore, we recommend roadways not be placed over these soils unless woven support fabric and adequate thickness of subbase be placed over the expansive soil subgrade.

In general, our past experience with expansive clays has led us to believe that expansive soils can have an effect on the asphaltic concrete unless the overall section thickness is close to 24 inches. In general, our recommended pavement section for an entrance roadway over properly prepared expansive clay subgrade soils has been the following:

3” to 4”	Asphaltic Concrete
8”	Aggregate Base Rock (¾” or 1” minus crushed Rock)
18”	Aggregate Subbase (4” minus crushed Rock)

Woven Geotextile Support Fabric (6 oz./sq. yard minimum)

Lesser A.C. thicknesses could be used in smaller access lanes and parking lots. However, the woven support fabric and thick subbase section would most likely be required over much of the site (except perhaps in light auto parking areas). These pavement sections have not been specifically verified for the site subgrade which will be exposed after grading operations or for site specific traffic loading, and will need to be verified before construction begins.

7.4 GROUNDWATER CONSIDERATIONS

Groundwater or seepage was encountered in six of the ten test pits. In all cases the seepage was below 4.8 feet, and standing water levels in test pits were below seven feet. However, it is likely that if some of the pits were left open for an additional time period (1 to 2 days) the groundwater level in these pits would have risen up to the seepage level.

A few of the pits exhibited sloughing and caving when the test pits encountered the cleaner sand zones below the seepage zone. However, we did not encounter any large areas of saturated flowing sand or soils which could exhibit "quick" conditions during construction. It would be prudent in these areas to verify liquefaction.

As can be seen by the groundwater and higher seepage zone levels, the water levels tend to rise closer to the surface as you move towards the irrigation canal. Based on this, it would be prudent to utilize areas close to the irrigation canal for open spaces and "greenway" areas. This would decrease water related problems during design and construction of the project.

It is likely that any embedded structures or embedded open areas located downslope and close to the canal would require comprehensive dewater systems to maintain dry conditions. Therefore structures with basement levels should not be placed in this area (unless the cost for extensive permanent dewatering systems is offset by the need for such basements.

Based on information gathered during our test pit exploration, if structures are kept near the surface (embedment for frost depth) groundwater related problems should be small. The exception would be site utilities that must penetrate below the seepage levels encountered. It is also likely that during a very wet year, the seepage levels encountered would be higher than those encountered during our site investigation.

8.0 GENERAL GEOTECHNICAL RECOMMENDATIONS

The following recommendations are general items that apply to site preparation and structural fill placement. Please note that this is to be used for planning and budgeting purposes and for general formation of a grading plan. This study and report were not intended to be a final design study and report for the subject development. We have not reviewed proposed site layouts and have little knowledge of the actual magnitude of grading or size and location of structures that will be constructed. Therefore, we recommend that the geotechnical recommendations in this report not be used for final design of the facility. These should be provided for on a structure by structure basis in building specific Geotechnical Design Reports. In that way the various load levels, cuts and fills, elevation of footings, type of structure and other related items could be considered when the design recommendations are formulated.

8.1 GENERAL

The subject site has relatively uniform soil conditions across the site. Some materials should make reasonable structural fill beneath pavements and landscape areas, while the use of others should be avoided.

The site is underlain by mildly expansive silty Clays and clayey Sands. These expansive soils will require special consideration in the design and construction of structures and pavements. The expansive clay soils must be kept moist (in fully swelled condition) prior to being covered by crushed rock or pavements. If dry shrunken clays are covered, they will rewet in later wet months causing potential swell-related problems beneath structures or pavements.

The following sections provide general materials specification, placement and compaction specifications and observation and testing requirements for structural fills at this site. These could be used for planning purposes. However, a site and development specific geotechnical report should be accomplished for the project which should contain a section on structural fill for the design phase of the project.

8.2 SITE PREPARATION

All areas proposed for structures, parking, and walkways, as well as areas designated for structural fill placement should be cleared of all grass, brush, trees and other debris and/or deleterious materials. The site should be stripped and cleared of sod and organic topsoil. It appears that a stripping depth of 6 to 12 inches would be required in most areas due to the farming practices which have occurred on site. The stripped materials should be hauled from the site or stockpiled for use in landscape areas only. This material should not be used in structural fill, trench backfill or retaining wall backfill on this project.

Holes or depressions resulting from the removal of underground obstructions and old ditches or excavations that extend below the finish subgrade and are situated beneath proposed structures, roadways or parking should be cleared of all loose material and dished to provide access for compaction equipment. These areas should then be filled with lean concrete or be backfilled and compacted to grade with structural fill, as described later in this report.

Prior to placement of structural fill the subgrade should be redensified and proofrolled. All soft or unstable areas should be removed and replaced with structural fill. We recommend the subgrade be redensified to 95% of ASTM D-698 (Standard Proctor). When all areas of overexcavation and backfill have been completed the site subgrade should be proofrolled with a loaded dump truck. All soft and/or unstable areas should be overexcavated and backfilled with granular structural fill.

It is recommended that the finished stripping of the site, backfill and compaction of depressions below finish subgrade and subgrade redensification, watering and proofrolling be observed by our representative prior to construction at the site.

8.3 FILL AND COMPACTION RECOMMENDATIONS

8.3.1 Beneath Structural Components

Structural fill is defined as any fill placed and compacted in areas that will be under structures, pavements, roadway embankments, parking areas, sidewalks and other load-bearing areas. It appears that footings and floor slabs will require structural fill below them when the expansive clay soils are removed and replaced with structural fill as generally described in the Foundation section earlier in this report.

Structural Fill Materials. Ideally, and particularly for wet weather construction, structural fill should consist of a free-draining granular material with a maximum particle size of six to eight inches. The material should be reasonably well-graded with less than 5 percent fines (silt and clay passing the No. 200 mesh sieve). During dry weather, any organic-free, non-expansive, compactible granular material meeting the maximum size criteria is acceptable for this purpose. However, under heavy loads, fill materials other than crushed, weathered or hard rock will cause more settlement. All import materials proposed for structural fill should be sampled and approved by our representative prior to placement at the site. The locally available crushed rock and crushed jaw run "shale" are typically acceptable for this purpose. The on site "sands" would most likely be acceptable in dry weather for areas not beneath foundations.

Structural Fill Placement. Structural fill should be placed in horizontal lifts not exceeding 10 inches loose thickness (less, if necessary to obtain proper compaction) for heavy compaction equipment and four inches or less for light and hand-operated equipment (deeper lifts would be acceptable for larger rock and heavier compaction equipment). Each lift should be compacted to a minimum of 98 percent of the maximum dry density, as determined by ASTM Test Method D-698 (Standard Proctor).

Structural fill placed beneath footings or other structural elements must extend beyond all sides of such elements a distance equal to at least ½ the total depth of the structural fill beneath the structural element in question.

To facilitate the earthwork and compaction process, the earthwork contractor should place and compact fill materials at or slightly above their optimum moisture content. If fill soils are on the wet side of optimum, they can be dried by continuous windrowing and aeration or by intermixing lime or Portland cement to absorb excess moisture and improve soil properties. Alternatively, if soils become very dry during the summer months, a water truck should be available to help keep the moisture content at or near optimum during compaction operations.

Care must be taken when placing the clayey soils as fill (landscape areas). The soil must be moisture-conditioned to at least 3 percent above optimum moisture content and compacted to between 92 % and 95% of D-698. The earthwork contractors must understand the difference between "hardness" caused by the clays drying out (which can lead to heave related problems) and increased density due to proper placement and compaction.

Water trucks, scrapers and ample numbers of sheepsfoot rollers will be required to properly place and compact these clayey soils. When placed properly they will form a relatively homogenous unit of soil that exhibits reasonable strength and should perform reasonably well as specified.

Fill Placement Observation and Testing Methods. The required construction monitoring of the structural fill utilizing standard nuclear density gage testing and standard laboratory compaction curves (ASTM D-698 specified) is not applicable to larger sizes (2" or greater) of jaw run shale or crushed rock. The high percentage of rock particles greater than ¾" in these materials causes laboratory and field density test results to be erratic and does not provide an adequate representation of the density achieved. Therefore, construction specifications for this type of material typically specify method of placement and compaction coupled with visual observation during the placement and compaction operations.

For these larger rock materials a "method" specification works well. We recommend the 8-inch lift be compacted by a minimum of 3 passes with a heavy vibratory roller (varies with material). One "pass" is defined as the roller moving across an area once in both directions. For clay soils compaction with sheepsfoot rollers and/or scrapers or other heavy rubber-tired equipment is recommended (smooth drum rollers should not be allowed). The moisture content should be such that after several passes on each "lift" the sheepsfoot pads will "walk out" of the fill layer. This means it has become densified enough to support the load of the roller on only the sheepsfoot pads. Good earthwork contractors understand this process and are able to build a well compacted fill mass, free of voids or soft spots.

Placement and densification of the larger rock will have to be verified by visual observation. The larger rock material must not be allowed to create "open work" rock zones where voids could fill up over time, creating a potential surface subsidence problem.

The placement and compaction should be observed by our representative. After compaction (as specified above) is completed, the entire area should be proofrolled with a loaded dump truck to verify density has been achieved. All areas which exhibit movement or compression of the rock material under proofrolling should be removed and replaced as specified above. If imported material is to be used as structural fill, we should be notified so that we may observe and sample the borrow source prior to hauling to the site.

Field density testing by "nuclear" methods would be adequate for verifying compaction of 2½-inch to ¾-inch minus crushed base rock as well as the fractured siltstone or other rock. Therefore, typical specifications provided herein for compaction requirements would suffice.

We recommend all structural fill placement and compaction be tested for density compliance or be observed during placement (as for coarser material such as 3" or greater rock) by our representative prior to covering individual lifts.

8.3.2 Non-Structural Fill

Any waste soil, organic strippings or other deleterious soil would be considered non-structural fill. These materials many times make excellent landscape soils and lawn topsoil material. This material may be placed in landscape areas and waste soil areas. It should not be placed as part of a structural fill slope. It is recommended that when these soils are used they be given a moderate level of compaction (at least 90 percent) to help seal them from surface water. These materials should also be placed with fill slopes flatter than 3.0H:1.0V.

8.4 SOIL PROFILE TYPE

The Soil Profile Type of medium stiff silty Clay and medium dense clayey Sand is S_D due to the medium stiff nature of the soils in the upper 4 feet. It is unlikely that a value of S_C could be used on this site. However, some of the soft zones could fall within the S_E category. The designation used for each building will have to be determined once foundation elevations are known.

8.5 CONCRETE SLABS-ON-GRADE

It is generally best to remove all expansive Clay soils from beneath floor slab areas. However, this presents a large cost-related obstacle where these clay soils are deep. Alternately, the floor slab could be supported on the drain rock layer over a layer of compacted non-expansive structural fill. We recommend the non-expansive structural fill layer be at least 12-inches thick due to expansive clay soils being left in place. There is a risk of future shrink-swell related movements due to the clay being left in place (if the clay is completely removed the full 12 inches is not required). However, our experience has been that if the soils are kept moist during construction and 12-inches of structural fill is used beneath the drain rock layer (for these soils), these movements are small and do not significantly adversely affect the structure.

Prior to placing the structural fill layer the expansive clay subgrade soils must be moisture-conditioned to from 3 to 4% above optimum moisture content and compacted to between 90% to 92% of the maximum dry density determined in accordance with ASTM D-1557 (Modified Proctor). Where the clay subgrade is firm it should be kept wet but not scarified and recompacted. The subgrade soils must be kept moist by watering (through the rock fill after placement) until the entire area is sealed in with the vapor barrier. In no case shall these subgrade soils be allowed to dry out prior to sealing up the area. If dried back expansive clay soils are left beneath the slab area, they can cause "heave" related problems during future months as they swell in the presence of moisture. This is a critical issue which must be properly handled when expansive soils are left beneath slab areas.

The following general recommendations are provided for structural slabs constructed on 12-inches of structural fill over properly prepared subgrade soils:

1. A six-inch layer of clean (less than 2% passing the No. 200 sieve) crushed rock (½" to ¾" clean crushed rock works well) should be placed over the structural fill to provide a positive capillary moisture break and uniform slab support. The capillary break is especially helpful in office and display areas with floors that will not "breathe" (such as tile or linoleum).
2. An impermeable membrane, such as 6-mil (10-mil is better) plastic sheeting, should be placed over the crushed rock layer to further prevent upward migration of moisture vapor into and through the concrete slab.
3. In order to protect the membrane and provide more uniform curing of the slab, it is generally advisable to place one to two inches of clean sand on top of the membrane. The sand should be moistened slightly prior to placing concrete.

Note: In some cases others have felt the sand layer and/or vapor barrier could trap moisture causing dampness in the floor. They many times use concrete additives to decrease moisture transmission through the slab. We leave the decision to the building designer to use or not use the sand layer, concrete additives and vapor barrier.

We recommend that the contractor use deformed reinforcing steel for slab reinforcement rather than welded wire fabric. A minimum reinforcement scheme would be #3 or #4 bars, 18 inches on center, both ways. Fibermesh may be used to help decrease drying shrinkage cracks, however it is not a replacement for structural reinforcing. All slabs will crack, therefore jointing at approximately 8 to 10 foot intervals, both ways, will significantly decrease random cracking in the open areas. Refer to your structural designer for detailed slab reinforcement and jointing that will provide the desired performance over the life of the project.

8.6 FOUNDATION, WALL AND FLOOR DRAINS

All exterior foundations, retaining walls and embedded floors should have proper drainage. This will be especially needed close to the canal. Cross section details of the following items would be provided in Design Reports for specific structures.

Footing Drains. Foundation and base of wall drainage should consist of a rigid smooth wall perforated pipe surrounded by at least 8 inches of drain rock on all sides, all wrapped in a nonwoven geotextile designed as a filter fabric. We recommend the fabric be covered with a two to three-inch layer of sand to protect it against damage during backfilling operations and potential plugging from soil fines. The perforated pipe should be located on the footing next to the stem wall (or beside the footing), provided this is at least 12 inches below the underslab drain rock (for footing drains) or below the elevation of crawl spaces for buildings with suspended floors.

Wall Drains. Wall Drains should have at least a 12-inch wide drainage zone of clean sand or sand and gravel immediately behind the wall extending up from the drainage section to within 12 inches of the surface. In the case of loading dock walls the drainage section should extend up to the underslab rock section. Exterior wall drains, which will not be sealed on top by asphalt or concrete, should have the upper 12 inches backfilled with compacted on-site silt soils to minimize intrusion of surface waters into the wall drain system.

Floor Subdrains. Slab-on-grade floors that will be embedded such that the underslab drain rock layer is below exterior grades should be provided with floor subdrains. These usually consist of at least a 3-inch diameter hard wall perforated pipe located at 20 to 25 foot intervals across the structure. The perforated pipe should be embedded slightly into the subgrade and sloped to drain to a tightline collector which empties into the storm drain. The perforated pipe should not be raised high into the drain rock in order to attain the desired "slope". We recommend that our design engineer be allowed to review the proposed floor subdrain design prior to construction bidding.

All drains should be tightlined to an approved storm water disposal location. We strongly recommend against connecting roof drains or surface area drains to foundation drain systems.

All drains should consist of rigid smooth-wall perforated pipe. The rigid smooth-wall pipe can be cleaned out by means of a "roto-rooter" type system should it become plugged with sediment or fine roots. We recommend cleanouts be placed periodically by the designer to facilitate cleaning and maintenance of the drains.

8.7 LATERAL LOAD RESISTANCE

Lateral loads can be resisted by passive pressure acting on buried portions of the foundation and other buried structures and by friction between the bottom of concrete elements of the foundations and slabs and the underlying soil. We recommend the use of passive equivalent fluid pressures of the following values for portions of the structure and foundations embedded into the native soils.

- Medium Stiff Clay 200 pcf
- Medium Dense Clayey Sand 500 pcf
- Dense Sands 400 pct

We also recommend that the first one foot below the ground surface be ignored when computing the passive resistance. A coefficient of friction of 0.30 can be used for elements poured neat against native soil and 0.40 can be used for elements poured against crushed rock fill. These should be reduced to 0.2 for areas over a plastic vapor barrier.

8.8 LATERAL EARTH PRESSURES

Lateral earth pressures will be imposed on all below ground and backfilled structures or walls, including foundations which do not have uniform heights of fill on both sides. The following recommendations are provided for design and construction of retaining walls:

- We recommend walls which are free to rotate at the top (unrestrained) be designed for an equivalent fluid pressure of at least 45 pcf.
- Walls that are fixed at the top (restrained) should be designed for an equivalent fluid pressure of at least 60 pcf.
- These values are for properly compacted, non-expansive, free-draining granular soils (such as crushed rock, sandy decomposed granite, drain rock or jaw run shale), free of organics and other debris or for imported granular backfill. The on-site organic topsoil and clayey soils should not be used for wall backfill materials.
- These design values assume the wall or structure is fully drained, has a flat backfill and has no surcharge loads from traffic or other structures. The structural designer should include surcharge loading from traffic and building loads.
- We recommend designing retaining walls to resist seismic loading. A peak horizontal acceleration of at least 0.15g should be applied to the mass of an enlarged active wedge of soil behind the walls and utilized in a pseudo-static analysis. The wedge length back from the wall along the ground surface may be taken as from 0.7H to 1.0H, where H is the height of the wall. This relates to approximately a uniform load on the back of the wall equal to approximately 12 psf for each foot of backfill behind the wall, for walls up to 10 feet in height. This load is in addition to the static active or at-rest loads given above.
- The backfill should be placed in lifts at near the optimum moisture content and compacted to between 93 and 95 percent of the maximum dry density as determined by laboratory procedure ASTM D-698 (Standard Proctor).
- Backfill and compaction against walls or embedded structures should be accomplished with lighter hand-operated equipment within a distance of 1/2h to 1/3h (h being the vertical distance from the level being compacted down to the surface on the opposite side of the wall). Outside this distance normal compaction equipment may be used.

While proper compaction of wall backfill is critical to the proper performance of the walls, care should be taken to not overcompact the backfill materials. Overcompaction can induce greater lateral loads on the wall or structure than the design pressures given above.

8.9 PAVEMENT DESIGN

We understand that the project could include new city streets, access drive lanes and parking. Individual lots or projects may include a paved entrance road and parking areas and some could have truck access and turn-arounds. Below we have provided recommendations for preparation of pavement areas and generally recommended pavement sections for heavy traffic areas such as entrance ways, and delivery areas and areas such as parking and storage. Due to the expansive nature of the clay soils and our laboratory testing of similar soils, we have used a subgrade CBR of ≤ 2.0 (R-value of 3) for design. Also, it should be noted that expansive soils can have some effect on the asphaltic concrete unless the overall section thickness is upwards of 24 inches.

General Recommendations

In areas with the expansive clay subgrade we recommend the following for all areas intended for pavement.

1. The exposed subgrade should be wetted to maintain a moisture content at least 3% above optimum (fully "swelled" condition).
2. The subgrade should demonstrate a firm unyielding condition when proofrolled by a loaded dump truck prior to placing any imported granular fill. Soft areas should be overexcavated and replaced with compacted structural fill.
3. The contractor shall adopt measures to prevent the exposed subgrade from drying out. Possible measures include sprinkling, covering with plastic sheeting, or prompt backfill of the subgrade once it has been exposed and proofrolled.
4. We recommend that the subgrade be covered with a woven geotextile support fabric and a minimum of 12 inches of imported granular fill (such as shale). This should provide an adequate working surface and help protect the subgrade from damage from construction traffic in dry weather. In dry weather the subgrade should be moisture conditioned prior to placing the imported granular fill to rewet any areas which have dried out on the surface.

If wet weather renders the subgrade unworkable for construction traffic, a layer of geotextile fabric covered with a minimum of 18 inches of imported granular fill may be required. Compaction of the fill should not begin until a minimum of 12 inches of rock is placed above the fabric. However, preparation of subgrade and rock placement during dry weather typically yields a better asphaltic concrete section than construction during wet periods of the year.

Asphaltic Concrete Design Recommendations

The following sections were designed utilizing the California Design Method. The three proposed sections will have varying traffic loads due to their location and likelihood of being used by heavy trucks. These are generalized asphalt sections, which must be reviewed once the project development plan has been completed.

We have assumed the traffic loading and percent trucks for these areas. The Traffic Indices (TI) for design were 7.5 for the heavy truck areas, 6.0 for access roads and 5.0 for parking.

Traffic into individual projects will usually be much less than that on the surrounding streets. The following section designs are typical for various commercial project applications we have been involved with.

Entrance Roadways and Delivery Areas (Heavy Truck Traffic)

4 inches Asphaltic Concrete
8 inches Crushed Aggregate Base (¾" Minus Crushed Rock)
16 inches Aggregate Subbase (4" Minus Crushed Rock or Crushed Shale)
Woven Geotextile Support Fabric (AMOCO 2002 or Greater)

Access Roadways and Delivery Areas (No Heavy Trucks)

3 inches Asphaltic Concrete
6 inches Base Rock (¾" Minus Crushed Rock)
14 inches Subbase (4" Minus Crushed Rock or Crushed Shale)
Woven Geotextile Support Fabric (AMOCO 2000 or Greater)

Parking Areas

2 inches Asphaltic Concrete
4 inches Crushed Aggregate Base (¾" Minus Crushed Rock)
12 inches Aggregate Subbase (4" Minus Crushed Rock or Crushed Shale)
Woven Geotextile Support Fabric (may be omitted if not used for construction)

Many times irregularities in the base rock surface result in an asphalt thickness less than designed. Areas with less than 2.0 inches of asphalt may show signs of distress early in the life of the pavement. Therefore, the owner may wish to require a minimum design thickness of 2.5 inches of asphaltic concrete to allow for these inconsistencies. Aggregate base and subbase quality and compaction requirements are the same for both section designs.

Aggregate base rock should consist of angular, hard crushed rock with a minimum CBR of 90 to 100 and having less than seven percent passing the No. 200 sieve. We recommend against using subrounded sandy gravel materials for the aggregate base. The aggregate subbase or shale should consist of any subangular crushed rock or crushed shale, having a minimum CBR of 50, with less then 12 percent passing the No. 200 sieve and a maximum size of six inches. All aggregate subbase and base should be placed in loose lifts less than 10 inches in thickness and compacted to at least 98 percent of the Standard Proctor maximum dry density (ASTM D-698).

8.10 SITE DRAINAGE AND EROSION CONTROL

8.10.1 Site Drainage

Site soils perform better when they are not saturated. Therefore, we recommend all areas be graded to drain. Water should not be allowed to pond on building roadway or parking lot subgrades during construction.

Permanent grades should be such that surface water flows rapidly away from the structures for at least eight feet. It should then be collected in shallow swales which are intercepted by periodic area drains. Collected surface runoff should be discharged into the street gutters or other acceptable stormwater discharge locations.

We recommend that site and finish floor elevations be established that will not place slab drain rock layers below the exterior ground surface. This will help get the best performance from the drain rock/capillary break rock layer beneath the slab. Where this drain rock layer may be located beneath the exterior ground surface we recommend some form of drainage or subdrain system be installed to drain away water which could collect in this low area. Refer to the earlier section on floor subdrains.

8.10.2 Erosion Control

The site surface soils are at least moderately susceptible to erosion. The site grades are reasonably mild. Therefore, we do not anticipate significant erosion-related problems during construction. However care must be taken to keep mud off city streets and to keep "suspended solids" levels of site runoff low.

All storm water runoff during construction should be channeled to a collection point(s). This should consist of a settling basin surrounded by silt fencing and hay bales. These and other media should be used to help filter and settle out much of the silt and sand prior to this runoff leaving the site. We also recommend that a shale or crushed rock pad be created at the entrance of the site to limit "tracking" of mud onto the existing streets. This shale area should be from 50 to 100 feet in length unless otherwise specified by the City.

When the project is completed all exposed soils should be vegetated or covered with some form of hard surface or landscape materials that will minimize future erosion. On-site catch basins and area drains must be protected from siltation by hay bales or other means until the permanent erosion control measures are in place.

9.0 ADDITIONAL SERVICES AND LIMITATIONS

9.1 ADDITIONAL SERVICES

Additional services by the geotechnical engineer are recommended to help complete design of the project, verify that design recommendations are correctly interpreted in final project design and to help monitor compliance with project specifications during the construction process. For this project, we anticipate additional services could include the following:

1) Geotechnical Design reports for final design of the specific buildings.
2) Review of final construction plans and specifications for compliance with geotechnical recommendations.
3) Possible project team meetings and/or phone discussions to clarify issues and proceed smoothly into and through the construction process.
4) Preconstruction meeting with City Building Department to help formulate inspection and testing program for the project and to establish lines of communication and reporting.
5) Observation and testing of various aspects of the earthwork, drainage, foundations and other construction at the site.
6) Periodic reports, as requested by the client and/or required by the building department.
7) Other geotechnically related items requested by the client.

We would provide these additional services on a time-and-expense basis in accordance with our current Fee Schedule at the time the project is designed and constructed and the terms and conditions already in place for this project. Alternatively, we could provide a cost proposal for the Geotechnical Design Report and an estimate of scope and costs for construction services.

9.2 LIMITATIONS

The analyses, conclusions and recommendations contained in this report are based on site conditions and development plans as they existed and that were provided to us at the time of the study, and assume soils, rock and groundwater conditions exposed and observed in the test pits are representative of soils, rock and groundwater conditions throughout the site. If during construction, subsurface conditions or assumed design information is found to be different, we should be advised at once so that we can review this report and reconsider our recommendations in light of the changed conditions. If there is a significant lapse of time between submission of this report and the start of work at the site, or if conditions have changed due to acts of God or construction at or adjacent to the site, it is recommended that this report be reviewed in light of the changed conditions and/or time lapse.

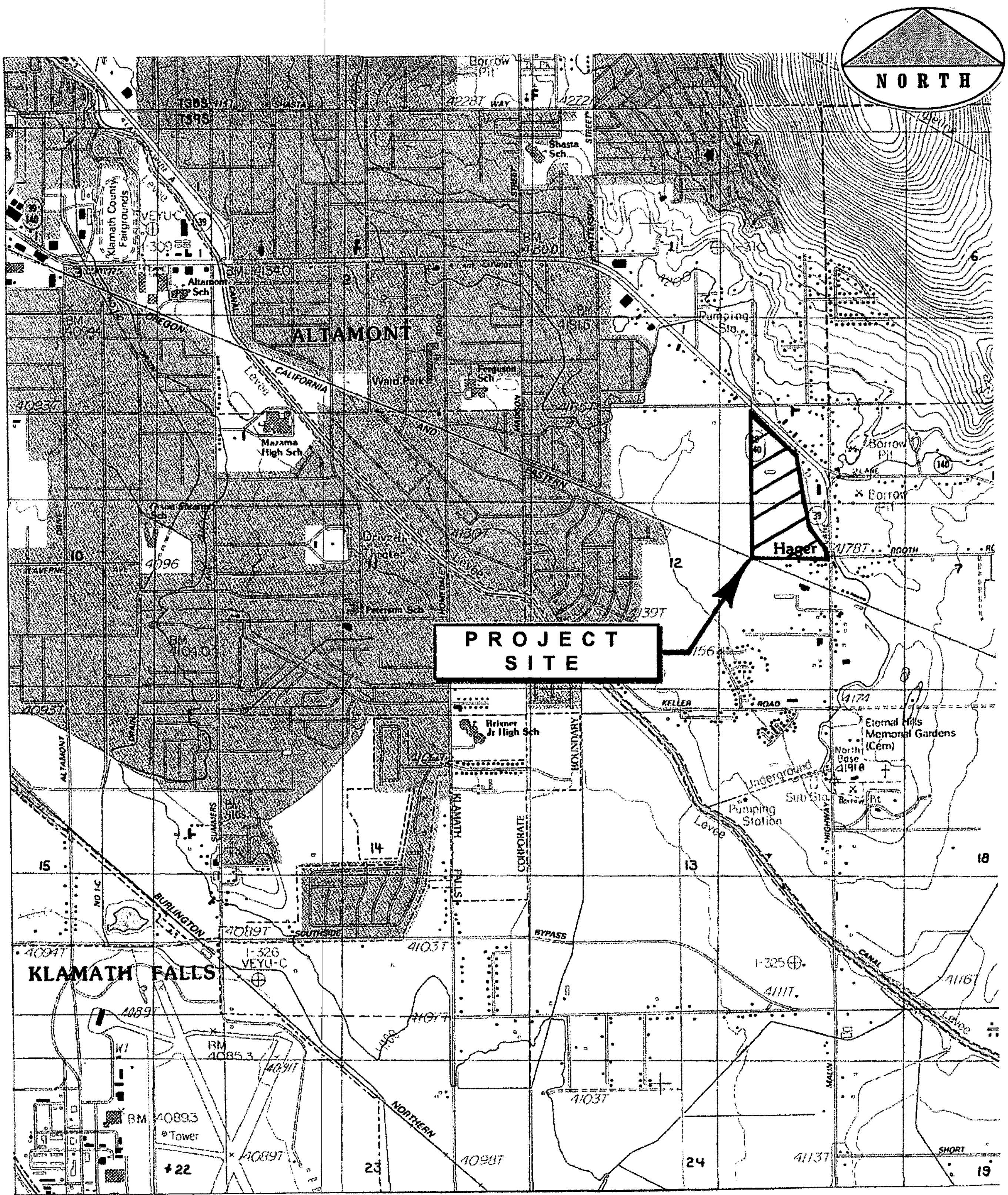
This report was prepared for the use of the owner/developer and his design team in the evaluation, design and construction of the subject project. It should be made available to others for information and factual data only. This report should not be used for contractual purposes as a warranty of site subsurface conditions. It should also not be used at other sites or for projects other than the one intended.

We have performed these services in accordance with generally accepted geotechnical engineering practices in Oregon, at the time the study was accomplished. No other warranties, either expressed or implied are provided.

THE GALLI GROUP
GEOTECHNICAL CONSULTING

Paul A. Sellke
Project Engineer

William F. Galli, P.E.
Principal Engineer



THE GALLI GROUP
GEOTECHNICAL CONSULTING
612 NW 3rd Street
Grants Pass, OR 97526

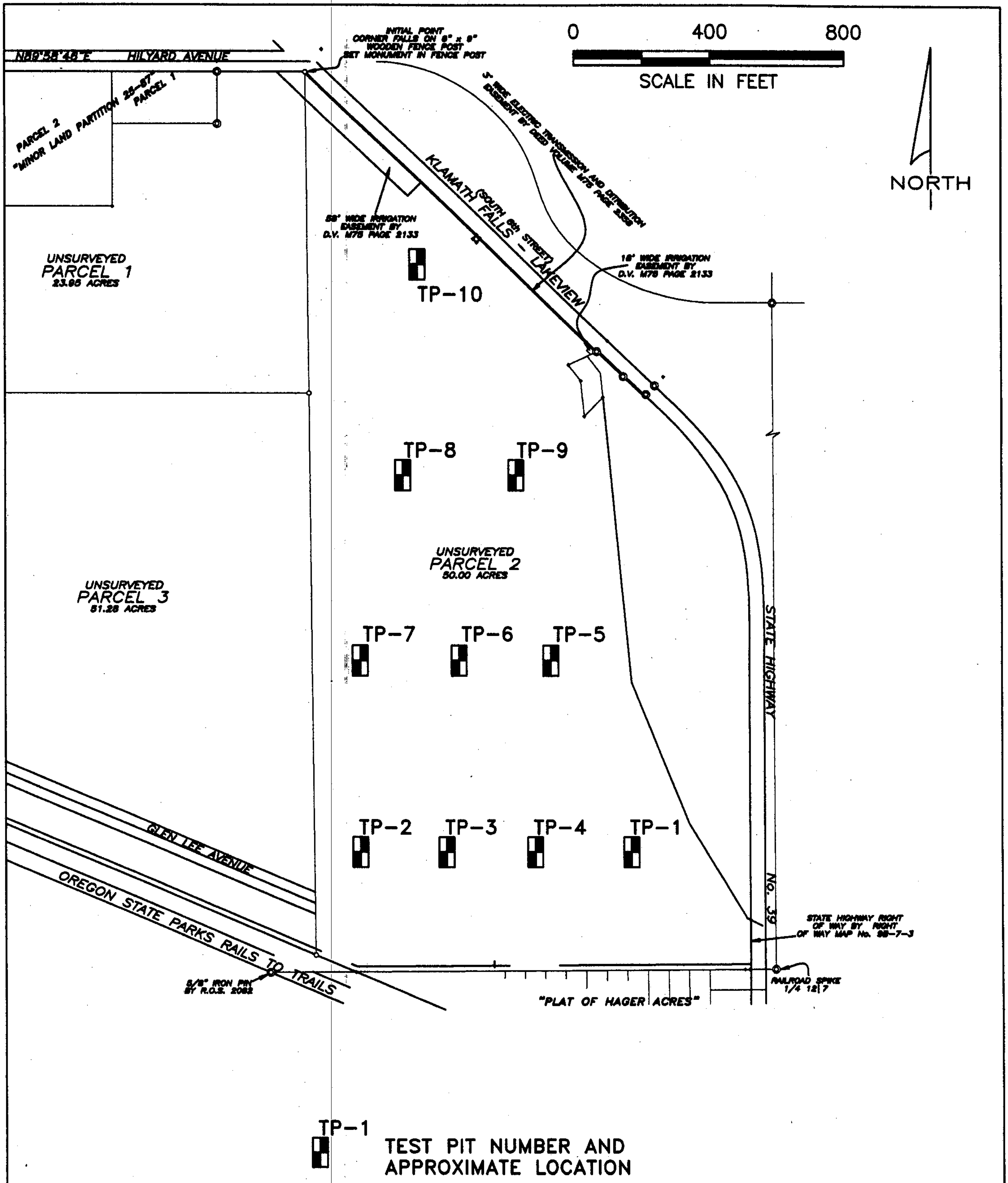
TITLE: VICINITY MAP

JOB: KLAMATH FALLS COMMUNITY COLLEGE
KLAMATH FALLS, OREGON

DATE: DEC. 2000

JOB NO. 02-2235-01

FIG. 1



THE GALLI GROUP GEOTECHNICAL CONSULTING 612 NW 3rd Street Grants Pass, OR 97526	TITLE SITE PLAN	DATE JAN. 2001	FIG. 2
	JOB KLAMATH COMMUNITY COLLEGE KLAMATH FALLS, OREGON	JOB NO. 02-2235-01	

TEST PIT LOGS

Please note that the soil descriptions given below are representative of how the field representative observed and classified them at the time of test pit excavation. However, these should not be used as a guarantee of subsurface conditions across the site

TP-1

0.0 - 0.75	Topsoil / Rootzone
0.75 - 2.8	Medium dense, brown, silty, clayey Sand; moist.
2.8 - 5.5	Dense to very dense, brown, cemented, silty, clayey Sand.
5.5 - 7.2	Very dense, brown, cemented, silty, clayey Sand; very slow digging

No Free Groundwater or Seepage Observed.
Bottom of Test Pit at 7.2 Feet.

TP-2

0.0 - 0.75	Topsoil / Rootzone
0.75 - 3.2	Medium dense, brown, silty, clayey Sand; moist.
3.2 - 5.0	Dense to very dense, brown, cemented, silty, clayey Sand.
5.0 - 7.7	Very dense, brown, cemented, silty, clayey Sand; very slow digging, several passes with teeth to obtain material for removal, close to refusal.

No Free Groundwater or Seepage Observed.
Bottom of Test Pit at 7.7 Feet.

TP-3

0.0 - 1.0	Topsoil / Rootzone
1.0 - 4.0	Soft to medium stiff, brown, silty Clay; moist to wet.
4.0 - 10.0	Soft to medium stiff, light brown, silty Clay; wet to saturated, caving in below 5.8 feet.

Seepage Observed at 5.8 feet. Standing water at 8.5 feet.
Bottom of Test Pit at 10.0 Feet.

TP-4

0.0 - 0.75	Topsoil / Rootzone
0.75 - 2.8	Medium dense, yellow-brown, silty, clayey Sand; moist.
2.8 - 4.8	Loose, dark brown, silty, clayey Sand; wet.
4.8 - 10.0	Soft, light brown, silty Clay; wet.

Seepage Observed at 4.8 feet. Standing water at 7.5 feet.
Bottom of Test Pit at 10.0 Feet.

TP-5

0.0 - 1.0	Topsoil / Rootzone
1.0 - 1.3	Medium dense, dark brown, silty, clayey Sand; moist.
1.3 - 5.0	Medium dense to dense, yellow-brown, silty, clayey Sand; moist to wet.
5.0 - 8.0	Very dense, yellow-brown, cemented, silty, clayey Sand; **very slow digging**,

Seepage Observed at 6.0 feet. Standing water at 7.0 feet.
Bottom of Test Pit at 8.0 Feet.

TP-6

0.0 - 1.0	Topsoil / Rootzone
1.0 - 5.8	Medium dense, brown, silty, clayey Sand; moist.
5.8 - 8.1	Dense to very dense, brown, cemented, silty, clayey Sand.

Very Slight Seepage Observed at 7.8 feet.
Bottom of Test Pit at 8.1 Feet.

TP-7

0.0 - 0.8	Topsoil / Rootzone
0.8 - 2.9	Dense, yellow-brown, slightly cemented, silty, clayey Sand; moist.
2.9 - 4.2	Medium dense, yellow-brown, cemented, silty, clayey Sand; damp.
4.2 - 8.0	Dense to very dense, yellow-brown, cemented, silty, clayey Sand; moist, very slow digging.

No Free Groundwater or Seepage Observed.
Bottom of Test Pit at 8.0 Feet.

TP-8

0.0 - 0.8	Topsoil / Rootzone
0.8 - 2.2	Dense, yellow-brown, silty, clayey Sand; moist.
2.2 - 8.0	Dense to very dense, brown, cemented, silty, clayey Sand; very slow digging below 6.0 feet.

No Free Groundwater or Seepage Observed.
Bottom of Test Pit at 8.0 Feet.

TP-9

0.0 - 0.75	Topsoil / Rootzone
0.75 - 5.1	Medium dense, dark red-brown, silty, clayey Sand; moist.
5.1 - 8.5	Dense to very dense, brown, cemented, silty, clayey Sand.

Seepage Observed at 5. 1 Feet.
Bottom of Test Pit at 8.5 Feet.

TP-10

0.0 - 0.5	Topsoil / Rootzone
0.5 - 1.3	Medium dense, dark brown, silty, clayey Sand; moist.
1.3 - 3.5	Medium dense to dense, brown, cemented, silty, clayey Sand; moist.
3.5 - 9.0	Dense to very dense, brown, cemented, silty, clayey Sand.

Slight Seepage Observed at 8.0 Feet.
Bottom of Test Pit at 9.0 Feet.

Lab Testing Summary

Klamath Community College
Klamath Falls, OR (02-2235-01)

Test Pit #	Field Moisture-%	Expansion Index	In-place Density
TP#1 @ 1.5'	21.8%	-	-
TP#1 @ 3.5'	34.4%	-	-
TP#3 @ 1.0'	30.8 %	36	-
TP#3 @2.3' to 2.8'	27.4%	-	110.2 PCF(wet) 86.5 PCF (dry)
TP#3 @ 3.0'	27.5%	-	-
TP#3 @ 5.3'	37.5%	-	-
TP#3 @ 10.0'	65.6%	-	-
TP#4 @ 1.0'	15.0%	-	-
TP#4 @ 3.4'	30.9%	-	-
TP#4 @ 9.0'	35.0%	-	-
TP#5 @ 1.0'	14.4%	-	-
TP#5 @ 3.0'	20.3%	-	-
TP#5 @ 5.5'	79.5%	-	-
TP#6 @ 2.0'	18.%2	-	-
TP#6 @ 4.0'	19.5%	-	-
TP#6 @ 5.8'	48.3%	-	-
TP#7 @ 2.0'	12.2%	-	-
TP#7 @ 4.0'	23.5%	-	-
TP#7 @ 5.0'	24.3%	-	-
TP#8 @ 2.0'	16.1%	-	-
TP#8 @ 3.5'	29.5%	-	-
TP#9 @ 1.0'	14.8%	-	-
TP#9 @ 3.5'	21.2%	-	-
TP#9 @ 5.5'	47.4%	-	-
TP#10 @ 1.0'	23.9%	-	-
TP#10 @ 2.0'	23.5%	-	-

Expansion Index Test

Project: Klamath Community College; Klamath Falls, OR (Job # 02-2235-01)
Lab No: 956
Date: 1/8/01
Sample: TP#3 @ 1.0'
Visual Classification: brown silty clay (100% passing #4 sieve)
Test Method: ASTM D-4829

Moisture content of sample as compacted for testing: 15.2%
Dry Density of sample as compacted for testing: 97.8 PCF
Saturation (S) of sample as compacted for testing: 57%
Moisture content of sample after testing: 26.5%
Measured Expansion Index (EI) of sample: 32
Calculated (ASTM Equation 10.1.2) EI_{50}: 36

Expansion Index of sample: 36

Expansion Index Worksheet

Client:	
Project	Klamath Community College; Klamath Falls, OR
Date:	1/8/01
Job No:	02-2235-01
Sample Location:	TP#3 @ 1.0'
Lab No:	**956**
Description of Soil:	brown silty clay

Expansion Index measured (Elm):

EI_m=I▶H/H_{orig}*1000

begin dial :	0.0132
end dial:	0.0454
EI_m:	**32**

Weight of ring (g):	365.9
Wt. Wet sample in ring(g):	739.9
Sample Wet Weight (g):	374
Sample Length (in.):	1
Sample Diameter (in.):	4.01
Volume of sample (ft^3):	0.007309
Sample Unit Wt. (PCF):	**112.7**
Sample Dry Unit Wt. (PCF):	**97.8**

Saturation (S):

S=(SG)(*w*)γd)/(SG)*62.4)-γd

SG:	2.7
▶ d:	97.8
%*w* :	15.2
S=	**57**

<u>As prepared for testing:</u>

can no.	G-10
wet weight of soil + can (g)	1275.15
dry weight of soil + can (g)	1234.68
weight of can (g)	969.23
weight of dry soil (g)	265.45
weight of water (g)	40.47
moisture content (% of dry weight)	15.2

<u>After testing:</u>

can no.	G-10
wet weight of soil + can (g)	1376.2
dry weight of soil + can (g)	1291.04
weight of can (g)	969.3
weight of dry soil (g)	321.74
weight of water (g)	85.16
moisture content (% of dry weight)	26.5

EI_{50} calculation

EI_{50}=Elm - (50-Sm)*[(65+Elm)/(220-Sm)]

EI_M	32
S	57
E_{I50}	**36**