All interested parties had the opportunity to submit questions in writing by email to Samol Hefley. The answers to the questions received are provided below and posted to the City's website at www.TacomaPurchasing.org: Navigate to Current Contracting Opportunities / Public Works and Improvements, and then click Questions and Answers for this Specification. This information IS NOT considered an addendum. Respondents should consider this information when submitting their proposals.

**Question 1:** We are bidding on the welded steel tank for this project. Contract Specification 13209, Section 1.4-B-3 states that there is a nearby geotech report for a Communication Tower available by request.

**Answer 1:** Geotech report attached.

**Question 2:** I noticed in addendum 1 you added prequalified electrical contractors list, however I have not been prequalified through you guys. My question is if I get prequalified by the bid date will My quote be able to be used by prime contractors?

**Answer 2:** Per RCW 35.92.350, prequalification of the electrical contractors must be approved before bids are let for a project requiring such prequalification. Only those prequalified on or before the bids were advertised may be used.

**Question 3:** In Section 01300, Part 1.1, Item 2 States:

"A minimum of ten (10) documented years’ experience in building or facilities construction supervision by superintendent. Bidders shall submit a resume of named superintendent with their bids."

Can this be clarified? Is for the entire project, which would make it our superintendent, or if it should be our subcontractors superintendent of the 60,000 gallon Water Tank. We didn't see a building or facilities construction portion of this project aside from the tank so we were looking for clarification on this.

**Answer 3:** The experience requirement is for the superintendent of the General Contractor.

**Question 4:** Section 1.09 B of the General Conditions, requires that the all electrical contractors be prequalified with Tacoma Power, to bid on this project. Can this requirement be changed to allow electrical contractors to prequalify after bid?

**Answer 4:** No. Per RCW 35.92.350 bidders must be pre-qualified prior to advertising bids.

**Question 5:** On the EIC Requirement Form in the specs, I see there is a 2% Women Business Enterprise Requirement, and a 4% Small Business Enterprise Requirement.
Is this goal a condition of award goal, or is it a voluntary goal that bidders are encouraged to achieve?

Answer 5: EIC Goal is a requirement and condition of award. The EIC documents has instructions on how to achieve the goals or submit request for waiver,

Question 6: In the Insurance Requirements For Contracts, Section 4.5 Professional Liability Insurance or Errors & Omissions calls out for $1,000,000 per claim and $2,000,000 in the aggregate covering acts.

This seems excessive for this size project, can it be changed to $1,000,000 in the aggregate covering acts?

Answer 6: This requirement remains unchanged. Bidders shall provide the insurance as originally required.
January 22, 2002

City of Tacoma
Tacoma Power
3628 South 35th Street
Tacoma, WA 98409

Attn: Mr. Terry Ryan

Geotechnical Report
Proposed Mayfield Cell Tower Site
Near the Mayfield Powerhouse
Job: TacomaPower.01P

INTRODUCTION AND SCOPE

The report presents the results of our geotechnical evaluation for the proposed Mayfield microwave tower site to be constructed north of the Power House and northeast of the Switchyard near the Mayfield Dam. The site is located at the top of a localized hill and an existing water tank. A Vicinity Map and Site Plan are included as Figures 1 and 2. The site is accessed by an existing gravel road to a water tank located at the site.

Our understanding of the project is based on our discussions with you and our review of the project documents provided. We understand that the microwave tower will be approximately 220 feet in height and constructed using a conventional latticework tower. A support building will be located near the tower, likely between the tower and the existing water tanks at the site.

The purpose of our services is to evaluate the site conditions as a basis for developing and providing geotechnical recommendations and design criteria for the proposed site development. Specifically, our scope of services for this project included the following:

1. Review of the available surface and subsurface soil and ground water information, including the existing geotechnical data, USGS and DNR maps, and County Soil Conservation Service documents.
2. Visiting the site to conduct a geologic reconnaissance.
3. Evaluation of the subsurface conditions at the site by monitoring the excavation of two power borings near the proposed location of the structures. Soil samples were collected on a 5-foot increment.
4. Evaluation of the engineering characteristics of the soils encountered at the site.
5. Provide information related to groundwater conditions encountered and/or expected during construction.
6. Provide our opinion regarding construction feasibility for the proposed tower structure foundation and provide alternative options if necessary.
7. Provide geotechnical recommendations for site grading including site preparation, subgrade preparation, fill placement criteria, suitability of on-site soils for use as structural fill, temporary and permanent cut and fill slopes, drainage and erosion control measures.
8. Provide geotechnical recommendations and design criteria for tower foundation, including allowable bearing capacity, subgrade modulus, lateral resistance values and estimates of settlement.
9. Provide site-specific seismic criteria based on the subsurface conditions encountered at the site.
10. Provide a stormwater infiltration rate for the structures, if/ as appropriate.
11. Provide pavement subgrade geotechnical recommendations for the utility, roadway and parking areas, as appropriate.
SITE CONDITIONS

SURFACE CONDITIONS

The proposed Mayfield cell tower site is located north of the Cowlitz River in an area mapped as Skookumchuck Formation, Eocene sandstone and siltstone bedrock. The site area is bounded to the north by established rural property and on the south, east and west by property owned and operated by Tacoma Power. The proposed cell tower site is situated at the top of a localized hill or knob located north of the Mayfield Power House and northeast of the Mayfield Switchyard. The tower and communications building are to be located west of an existing water tank located at the site.

The ground surface at the proposed cell tower/building area is flat to slightly sloping. The ground surface slopes increase to the north, west and south as shown on the Site Plan, Figure 2. Relative elevations at the site range from about 712 feet to about 610 feet. Slope inclinations at the site range from less than 5 percent to approximately 110 percent, with localized steeper areas. Topography is illustrated on the Site Plan, Figure 2. We understand that proposed grading at the tower site will consist of cuts of approximately 3 to 5 feet and localized fills with engineered structural fill material. The fill slopes will be constructed as 2 to 1 (Horizontal to Vertical) or flatter slopes.

Vegetation at the site generally consists of native grasses and second growth trees and brush along the margins of the water tank area. No surface water flow or groundwater seepage was observed in the site area at the time of our reconnaissance. The general topography of the site area indicates that the site drains in a number of directions, as it is located at the top of a hill.

SITE GEOLOGY

The site is situated in an area mapped as Skookumchuck Formation. The Skookumchuck sediments were deposited in near shore environments during the Eocen time and generally consist of sandstone and siltstone. Although these soils are classified as bedrock, it is important to note that portions of these soils weather to clay material. Based on our experience, the weathering of these soils in this area ranges from several feet up to 10 feet locally. A description of the surficial soils is included in the "Site Soils" section of this report.

In general the site is underlain by bedrock sandstones and siltstones of the Skookumchuck Formation. The soil materials observed at the site consist of silty sandstone and sandy siltstone with minor clay and occasional gravel, cobbles and boulders. The shallow soil material was observed to be in a loose to medium dense condition near the surface (0.5 feet to approximately 3 feet), increasing in density with depth. The soils grade to a dense and very dense condition with depth, as discussed in the "Subsurface Conditions" section of this report. The underlying and exposed material in the lower road cuts at the site consist of very dense and lithified sandstone and siltstone bedrock.

It should be noted that large boulders were observed in the site area, generally in the road cut and slope below the tower site.

SITE SOILS

The SCS (Lewis County Soil Conservation Survey) has mapped the following soils in the site area as Cinebar Silt Loam (52). The Cinebar soils are described as having a slight to severe erosion hazard, based on slope inclination. We observed no active erosion in the site area during our reconnaissance. Based on our observations, the site soils appear to have little susceptibility to erosion, particularly where vegetation is established.

SUBSURFACE CONDITIONS

The subsurface condition in the site area were evaluated by completing two truck mounted hollow stem auger borings at the proposed cell tower and building site and reviewing the geologic maps and data for the site area. The data review and explorations were augmented by observations of soils exposed in road cuts located at the site.

During drilling, soil samples were obtained on 5-foot depth intervals using the Standard Penetration Test (SPT) procedure (ASTM: D 1586). This test and sampling method consists of driving a standard 2-inch outside diameter (OD) split-barrel sampler a distance of 18 inches into the soil with a 140-pound hammer, free-falling a distance of 30 inches. The number of blows required to drive the sampler through each of the three, 6-inch intervals is noted. The total number of blows struck during the final 12 inches of penetration is considered the Standard Penetration Resistance, or "blow count". If 50 or
more blows are struck within one 6-inch interval, the driving is ceased and the blow count is recorded as 50 blows for the actual number of inches of penetration. The resulting Standard Penetration Resistance values provide a measure of the relative density of granular soils or the relative consistency of cohesive soils.

The boring log appended to this report describes the various types of soils encountered in the boring, based primarily on visual interpretations made in the field. The log also indicates the approximate depth of the contacts between different soil types, although these contacts may be gradational or undulating. Where a change in soil type occurred between sampling intervals, we inferred the depth of contact. In addition, the log indicates the depth of any groundwater observed in the boring; the Standard Penetration Resistance at each sample location, and any laboratory tests performed on the soil samples.

The two borings were completed to depths of 19.5 feet and 24 feet below the adjacent ground surface. Boring B-1 was located west of the existing water tank at the top of the hill. Boring B-2 was located on a topographic bench several feet below and north of the water tank. Boring B-1 encountered medium dense to dense or hard siltstone at a depth of approximately 7 feet and refusal at 19.5 feet, likely a large cobble or boulder. Boring B-2 encountered medium dense to dense or hard siltstone at a depth of approximately 4 feet, and very hard material at a depth of 22.5 feet. Based on this, we expect that loose to medium dense weathered soil material extends to a depth of approximately 4 feet below the existing ground surface of the bench below the water tank.

In general, fine sandy silt was encountered the borings to the full depth explored. The fine sandy silt was in a medium dense to dense condition. The upper 4 to 6 feet of the soil material was observed to be weathered to a loose to medium dense condition. It should be noted that large cobbles or boulders were observed in road cuts in the site area, and encountered in B-1 at a depth of approximately 19 feet. Copies of the boring logs for the site area are attached in Appendix A. Based on our site observations and experience, the soils at the site are generally consistent with those mapped in the area. Therefore, no additional subsurface explorations or borings are required.

No ground water seepage was reported in the borings excavated at the site. However, the soil samples from the borings were in a damp to wet condition, indicating that the soils are likely above the optimum moisture condition. Based on the nature of the soils, a fine sandy silt, we expect that perched water conditions may occur during and following periods of wet weather. Groundwater conditions will vary with seasonal variations in precipitation and changes in site utilization, as well as other factors.

**SLOPE STABILITY**

Slopes at the site range from 5 to greater than 110 percent inclination. In general, the underlying native soils at the site consist of fine sandy silt and silty fine sand with variable amounts of gravel, cobbles and boulders, and minor clay material. These soil materials are in a medium dense to very dense condition except where they have been disturbed by natural weathering processes. The soils encountered at depth in the borings and exposed in the road cuts at the site consist of very dense well lithified bedrock.

These soil materials are generally stable relative to deep-seated slope failure. No evidence of soil movement or erosion was observed at the site at the time of our site visit.

Weathering and erosion are natural processes that affect all exposed soil areas. The ground surface at the site is flat to steeply sloping and vegetated in the undisturbed areas. We observed no evidence of active erosion at the site at the time of our site visit. Erosion control recommendations for disturbed areas are provided in the "Erosion and Sediment Control" section of this report.

**Seismic Conditions**

According to the Seismic Zone Map of the United States contained in Figure 16-2 of the 1997 Uniform Building Code (UBC), the project site lies within Seismic Risk Zone 3. Based on our subsurface exploration, we interpret the site conditions closely correspond to a seismic Soil Profile type Sc, for Dense soil and Soft Rock Soil Profile, as defined by Table 16-J of the 1997 Uniform Building Code, based on the observed range of Standard Penetration Test (SPT) blow counts. The shallow soil conditions were assumed to be representative for site conditions beyond the depths explored.
CONCLUSIONS AND RECOMMENDATIONS

GENERAL

Based on the results of our subsurface exploration program, it is our opinion that the site is suitable for the proposed cell tower and associated structures. The proposed project will consist of construction of a lattice communication tower and building. Based on site topography and the subsurface conditions encountered in our borings, the proposed tower be supported on either a reinforced concrete pad or drilled pier foundation. Options for both are provided below.

No evidence of significant erosion or evidence of soil movement was observed at the site at the time of our site visit. The underlying bedrock material at the site has a very high strength. The native Skookumchuck soils observed at the site are suitable for use as structural fill material during extended periods of dry weather. These silty soils are moisture-sensitive and susceptible to disturbance when wet. Perched ground water conditions will likely be associated with these soils during and following periods of wet weather. Compaction of these soils will be difficult during periods of wet weather and will likely require treatment. Typically, blending with cleaner soils or aeration of the soils will be adequate to treat the soils. Large cobbles and occasional boulders may require special handling or removal from structural fill and utility areas.

Pertinent conclusions and geotechnical recommendations regarding the design and construction of the proposed development are presented below.

SLOPE STABILITY

General

Slopes at the site range from 5 to greater than 110 percent inclination. The underlying native soils at the site consist of fine sandy silt and silty fine sand with variable amounts of gravel, cobbles and boulders, and minor clay material. These soil materials are in a medium dense to very dense condition except where they have been disturbed by natural weathering processes. The soils encountered at depth consist of very dense lithofied bedrock material. These soil materials are generally stable relative to deep-seated slope failure. No evidence of soil movement or erosion was observed at the site at the time of our site visit.

Seismic Considerations

According to the Seismic Zone Map of the United States contained in Figure 16-2 of the 1997 UBC (Uniform Building Code), the project site is located within Seismic Risk Zone 3. Based on the subsurface conditions observed at the site, we interpret the site conditions to correspond to a seismic Soil Profile type Sc, for Dense Soil, as defined by Table 16-J (UBC). This is based on the range of SPT (Standard Penetration Test) blow counts in the borings at the site. The shallow soil conditions were assumed to be representative for the site conditions beyond the depths explored. The site and the structures will be at similar seismic risk as the adjacent areas. Based on the subsurface conditions encountered in the borings, no liquefaction risk is expected at the site.

EROSION AND SEDIMENTATION CONTROL

Erosion hazard areas are defined by Lewis County as "those areas that are classified as having moderate to severe, severe or very severe erosion potential by the Soil Conservation Service, United States Department of Agriculture (USDA)." The subject property is located in an area mapped by the Soil Conservation Service as Cinebar soils. The erosion hazard for these soils ranges from slight to very severe based on the slope inclination.

It is our opinion that the potential erosion hazard of the site is not a limiting factor for the proposed development. Removal of natural vegetation should be minimized and limited to the active construction areas. Temporary and permanent erosion control measures should be installed and maintained during construction or as soon as practical thereafter to limit the additional influx of water to exposed areas and protect potential receiving waters. Erosion control measures should include but not be limited to berms and swales with check dams to channel surface water runoff, ground cover/protection in exposed areas and silt fences. Graded areas should be shaped to avoid concentrations of runoff onto cut or fill slopes, natural slopes or other erosion-sensitive areas. Temporary ground cover/protection such as jute matting, excelsior matting, wood chips or clear plastic sheeting should be used until permanent erosion protection is established.
EARTHWORK
Site Preparation

Construction of the cell tower and the associated structures and roadways will require clearing of the vegetation and organic rich soil material (topsoil), and minor grading to reach design grades. All areas to be graded/excavated should be cleared of deleterious matter including any existing structures, foundations, abandoned utility lines, debris and vegetation. Graded areas should be stripped of any forest duff and organic-laden soils. Based on our explorations, we estimate that stripping on the order of 6 or 12 inches will be necessary to remove the root zone and surficial soils containing organics. Areas with deeper, unsuitable organics should be expected in the vicinity of local depressions or dense vegetation. Stripping depths of up to 2.0 feet may occur in these areas. This material may be stockpiled and later used for erosion control and landscaping/revegetation. Materials which cannot be used for landscaping should be removed from the project site.

We recommend that a member of our staff evaluate the exposed subgrade conditions after removal of vegetation and topsoil stripping is completed and prior to placement of structural fill. The exposed subgrade soil should be proof rolled with heavy rubber-tired equipment during dry weather or probed with a 1/2-inch-diameter steel rod during wet weather.

After clearing, any soft, loose or otherwise unsuitable areas delineated during proof rolling or probing should be recompacted, if practical, or over excavated and replaced with structural fill, based on the recommendations of our site representative. Based on our site observations and subsurface explorations, we expect that it may be necessary to over excavate to a depth of approximately 1.5 to 5.0 feet below the existing ground surface to reach the medium dense to dense soils. The deeper depth will occur in the southwest upper bench area (at water tank grade).

Where placement of fill is required, the exposed subgrade areas should then be compacted to a firm and unyielding surface, 95 percent MDD (maximum dry density in accordance with ASTM D-1557). In fill areas, we recommend that trees be removed by overturning so that a majority of the roots are removed. Excavations for tree stump removal should be backfilled with structural fill compacted to the densities described in the "Structural Fill" section of this report.

Structural Fill

All new fill material/trench backfill should be placed as structural fill. The structural fill should be placed in horizontal lifts of appropriate thickness to allow adequate and uniform compaction of each lift. Fill should be compacted to at least 95 percent of MDD (maximum dry density) as determined in accordance with ASTM D-1557.

The appropriate lift thickness will depend on the fill characteristics and compaction equipment used. We recommend that the appropriate lift thickness be evaluated by our field representative during construction. We recommend that our representative be present during site grading activities to observe the work and perform field density tests.

The suitability of material for use as structural fill will depend on the gradation and moisture content of the soil. As the amount of fines (material passing No. 200 sieve) increases, soil becomes increasingly sensitive to small changes in moisture content and adequate compaction becomes more difficult to achieve. During wet weather, we recommend use of well-graded sand and gravel with less than 5 percent passing the No. 200 sieve based on that fraction passing the 3/4-inch sieve. If prolonged dry weather prevails during the earthwork and foundation installation phase of construction, a somewhat higher (up to 10 to 12 percent) fines content will be acceptable.

Material placed for structural fill should be free of debris, organic matter, trash and cobbles greater than 6 inches in diameter. The moisture content of the fill material should be adjusted as necessary for proper compaction.

Suitability of On-Site Materials as Fill

During dry weather construction, any nonorganic on-site soil may be considered for use as structural fill, provided it meets the criteria described above in the structural fill section and can be compacted as recommended. If the material is over-optimum moisture content when excavated, it will be necessary to aerate or dry the soil prior to placement as structural fill.

The workability of material for use as structural fill will depend on the gradation and moisture
content of the soil. As the amount of fines increases, soil becomes increasingly more sensitive to small changes in moisture content and adequate compaction becomes more difficult or impossible to achieve.

In general, the native soils at the site, contain high amounts of silt and minor clay, and will be moisture sensitive. These materials will not be suitable for use as fill under wet weather conditions, unless mitigated. As previously discussed, the soils encountered in the borings were above the optimum moisture content. Mixing or blending of these silty materials with cleaner granular material, or aeration, may be utilized to mitigate the fines content and moisture sensitivity. If fill material is imported to the site for wet weather construction, we recommend that it be a sand and gravel mixture such as high quality pit run with less than 5 percent fines, or a crushed rock material.

Even when properly compacted, the soil materials can be disturbed and soften when exposed to significant moisture. We recommend that completed areas be restricted from traffic or protected during wet weather conditions. During wet weather, traffic should be confined to protected areas.

CUT AND FILL SLOPES

All job site safety issues and precautions are the responsibility of the contractor providing services/work. The following cut/fill slope guidelines are provided for planning purposes.

Temporary cut slopes will be necessary during utility installation operations. As a general guide, temporary slopes of 1.5 to 1 (horizontal to vertical) or flatter may be used for temporary cuts in the upper 3 to 4 feet of the soils that are heavily weathered to a loose/medium dense condition. Temporary slopes of 1 to 1 or flatter may be used in the unweathered dense to very dense soil or rock material. These guidelines assume that all surface loads are kept at a minimum distance of at least one half the depth of the cut away from the top of the slope and that significant seepage is not present on the slope face. Flatter cut slopes will be necessary where significant seepage occurs.

We recommend a maximum of 2 to 1 for permanent cut and fill slopes. Where 2 to 1 slopes are not feasible, retaining structures should be considered.

FOUNDATION SUPPORT

Based on our site evaluation, it is our opinion that the lattice cell tower may be supported on either a conventional spread foundation or a drilled pier foundation. The foundation elements should be founded on the medium dense native soils or on structural fill that extends to suitable native soils. The associated building may be supported on spread footings founded on the medium dense native soils. The soils at the base of the foundation excavations should be disturbed as little as possible. All loose, soft or unsuitable material should be removed or recompacted, as appropriate. A representative from our firm should observe the foundation excavations to determine if suitable bearing surfaces have been prepared.

Spread Footing — Slab Criteria

Conventional spread footings are recommended for the building and may be utilized for the lattice cell tower. The spread footings should be supported on medium dense or denser native soils, or properly prepared structural fill material. Based on our explorations, we expect that foundation support in the cell tower area would be available at embedment depths of approximately 2.5 to 6.0 feet. We recommend that the structural fill consist of well-graded granular material. Large cobbles and boulders (12 inches or greater) should be removed. The structural fill should extend beyond the margin of the cell tower and building foundations a minimum of 4 feet horizontally. Where the structural fill is placed on slopes of 15 percent or more, it should be constructed in accordance with the recommendations provided in the “Hillside Grading” section of this report.

In general, footings founded on medium dense native soils can be designed using a net allowable soil bearing pressure of 2,000 pounds per square foot (psf) for combined dead and long-term live loads, exclusive of the weight of the footing and any overlying backfill. Where the foundation elements extend into the undisturbed dense/very dense native bedrock soils, the allowable soil bearing pressure may be increased to 3,500 psf. We expect that the dense/very dense material will be encountered at a depth of approximately 4 to 6 feet below the upper bench level (water tank), or 2 to 3 feet below the lower bench. These values may be increased by 20 percent per foot of depth as described by the UBC to a maximum allowable of 6,000 pounds per square foot. If higher bearing values are necessary, we suggest that a site-specific foundation analysis be completed. These design values may be increased by one-third for transient
loadssuch as those induced by seismic events or wind loadings.

All exterior-footing elements should be embedded at least 18 inches below the lowest adjacent finished grade. We recommend that any disturbed soils in the footing excavations be removed, or if practical, recompacted prior to concrete placement. All foundation subgrades should be examined by a representative of our firm to verify adequate bearing surface preparation prior to placing concrete.

In areas where the native soils are unsuitable, gap graded, organic rich, soft/loose, or over-optimum in moisture content, we recommend that the unsuitable material be removed and recompacted if practical, or replaced with structural fill as described previously. The horizontal limits of the structural fill below the equipment building foundation may be determined by extending a line outwards and down from the edge of the footing to the bearing horizon on an angle of 1 horizontal to 1 vertical.

We recommend a minimum width of 2 feet for isolated footings and at least 16 inches for continuous wall footings for ancillary facilities. Footings founded as described above can be designed using an allowable soil bearing capacity of 2,000 psf (pounds per square foot) for combined dead and long-term live loads. The weight of the footing and any overlying backfill may be neglected. The allowable bearing value may be increased by one-third for transient loads such as those induced by seismic events or wind loads.

We estimate that settlements of footings designed and constructed as recommended will be less than 1 inch, for the anticipated load conditions, with differential settlements between comparably loaded footings of 1/2 inch or less. Most of the settlements should occur essentially as loads are being applied. However, disturbance of the foundation subgrade during construction could result in larger settlements than predicted.

Slabs-on-grade should be supported on medium dense or denser native soil or on structural fill prepared as previously recommended. We recommend that the building floor slab at the site be underlain by a 6-inch thickness of uniformly graded gravel or sand containing no more than 3 percent fines to provide a capillary break. The capillary break material should be placed in one lift and compacted to 95 percent of the MDD. Where a structural fill layer is used below the slab and the material meets the criteria of the capillary break criteria, the 12-inch drainage layer may be eliminated. The capillary break material should be connected to a suitable drain outlet to provide an exit for any accumulated seepage.

A vapor barrier, such as a polyethylene liner, is also recommended. A thin layer of "clean" sand may be placed over the vapor barrier and immediately below the slab to protect the polyethylene liner during steel and/or concrete placement. Typically, 3 to 4 inches is utilized.

A subgrade modulus of 250 kcf (kips per cubic foot) may be used for design. We estimate that static settlement of equally loaded floor slabs designed and constructed as recommended, will be 1-inch or less over a span of 50 feet.

Drilled Pier Foundation Criteria

The proposed tower should be supported on drilled pier foundations. The following recommendations and comments are provided for purposes of drilled pier design and construction:

**Compressive Capacities:** We recommend that the drilled pier penetrate at least 15 feet below the ground surface at the location of boring B-1. For vertical compressive soil bearing capacity, we recommend using the unit end bearing capacity presented in Table 1 below. The allowable end bearing capacity, presented in Table 1, includes a safety factor of 1.5 or more.
Table 1
Allowable End Bearing Capacity

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Allowable Bearing Capacity (tsf)</th>
<th>Limiting Point Resistance (tsf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-22.5</td>
<td>2.5 D/B</td>
<td>5 TSF</td>
</tr>
<tr>
<td>22.5-23.5</td>
<td>6.0 D/B</td>
<td>30 TSF</td>
</tr>
</tbody>
</table>

Notes:  
D = the embedment depth (in feet) into the bearing layer.  
B = pier diameter (feet).

Frictional Capacities: For frictional resistance of the drilled piers, acting both downward and in uplift, we recommend using the allowable skin friction value listed in Table 2. We recommend that frictional resistance be neglected in the uppermost 2 feet below the ground surface. The allowable skin friction value presented includes a safety factor of 1.5.

Table 2
Allowable Skin Friction Capacities

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Allowable Skin Friction (tsf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>0.0</td>
</tr>
<tr>
<td>2-8</td>
<td>0.25</td>
</tr>
<tr>
<td>8-23.5</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Lateral Capacities: For design against lateral forces acting against the drilled pier, two methods are typically used. The parameter used to select the appropriate design method is the length to pier stiffness ratio L/T, where L is the pier length in inches, and T is the relative stiffness factor. The relative stiffness factor (T) should be computed by:

\[ T = \left( \frac{EI}{nh} \right)^{0.2} \]

where  
E = modulus of elasticity (psi)  
I = moment of inertia (in^4)  
nh = constant of horizontal subgrade reaction (pci)

The factors E and I are governed by the internal material strength characteristics of the pier. A representative value of nh for the soil types encountered at this site is presented below in Table 4. Piers with a L/T ratio of less than 2 may be assumed to be relatively rigid and acting as a pole. The passive pressure approach may be used for this condition. For piers with a L/T ratio greater than 2, the modulus of subgrade reaction method is typically used. Both of these methods are discussed below:

Passive Pressure Method: The passive pressure approach is conservative by neglecting the redistribution of vertical stresses and shear forces that develop near the bottom of the pier and contribute to resisting lateral loads. We recommend using the allowable passive earth pressure (expressed as equivalent fluid unit weights) listed in Table 3. We have discounted the passive pressure in the upper soils due to the presence of fill soils and the adjacent slope.
Table 3
Allowable Passive Pressures

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>Allowable Passive Pressure (pcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>0</td>
</tr>
<tr>
<td>2-8</td>
<td>300</td>
</tr>
<tr>
<td>8-23.5</td>
<td>400</td>
</tr>
</tbody>
</table>

The allowable passive earth pressure presented in Table 3 may be assumed to be acting over an area measuring 2 pier diameters in width by 8 pier diameters in depth, neglecting the uppermost 2 feet of embedment below the ground surface. According to the NAVFAC Design Manual 7.2, a lateral deflection equal to about 0.01 times the pier length would be required to mobilize the allowable passive pressure presented above. Higher deflections would mobilize higher passive pressures. When developing the allowable passive pressure listed in Table 3, we have incorporated a safety factor of at least 1.5, which is commonly applied to transient or seismic loading conditions.

Modulus of Subgrade Reaction Method: Using this method, the pier is designed to resist lateral loads based on acceptable lateral deflection limits. For sandy soils, the coefficient of horizontal subgrade reaction (k_h) is considered to be directly proportional to the depth along the pier. The formula to determine k_h is k_h = n_h * x, where x is the depth below the ground surface in inches. We recommend using the value for the constant of horizontal subgrade reaction (n_h) for the various soil types presented in Table 4 below.

Table 4
Constant of Horizontal Subgrade Reaction (n_h)

<table>
<thead>
<tr>
<th>Depth (feet)</th>
<th>n_h (pci)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>0</td>
</tr>
<tr>
<td>2-8</td>
<td>25</td>
</tr>
<tr>
<td>8-23.5</td>
<td>70</td>
</tr>
</tbody>
</table>

Construction Considerations: At this site, dense to very dense native soils were encountered at a depth of 19.5-feet bgs in B-1. Boring B-1 was terminated at 19.5 feet due to auger refusal on very dense soils. Boring B-2 was terminated at a similar depth (approximately 24 ft.) Difficult drilling conditions and the presence of cobbles and oversize cobbles or boulders should be anticipated at depth. The contractor should be prepared to case the pier excavation to prevent sloughing or raveling of the pier sidewalls. Groundwater was not encountered at this site during drilling. In our opinion, dewatering of the drilled shaft will not likely be required. Should unanticipated heavy groundwater inflows be encountered during drilling at shallow depths, it may be necessary to pump the accumulated groundwater prior to pier concrete placement. Alternatively, the use of bentonite slurry could be utilized to stabilize the drilled pier excavation.

The drilling contractor should be prepared to clean out the bottom of the pier excavation if loose soil is observed or suspected, with or without the presence of groundwater. As a minimum, we recommend that the drilling contractor have a cleanout bucket on site to remove loose soils and/or mud from the bottom of the pier. If groundwater is present and abundant within the pier hole, we recommend that the foundation concrete be tremied from the bottom of the hole to displace the water and minimize the risk of contaminating the concrete mix. The Drilled Shaft Manual published by the Federal Highway Administration recommends that concrete be placed by tremie methods if more than 3 inches of water has accumulated in the excavation.

LATERAL RESISTANCE

Lateral loads may be resisted by friction on the base of footings and slab and as passive pressure on the sides of footings and stem walls. We recommend a coefficient of friction of 0.4 be used to
calculate friction between the concrete and soil. Passive pressure may be determined using an equivalent fluid weight of 300 pcf (pounds per cubic foot) above the water table. This assumes that structural fill is placed against the sides of the footings and that the top of the fill is confined by either a concrete floor slab or pavement. A safety factor of 1.5 has been applied to these values.

SITE DRAINAGE
All ground surfaces, pavements and sidewalks (where utilized) at the site should be sloped away from the structures. Roof runoff from the building and the runoff from the slab below the cell tower should be allowed to sheet flow to the east portion of the site (where flatter and well vegetated) or collected and directed to a spreader system located in the east portion of the site. Footing drains should be installed adjacent to all exterior footings. The footing drains should not be connected to the roof drain system until sufficient gradient will prevent roof water from entering or surcharging the footing drain.

Drains should be provided behind all retaining or subgrade walls. Driveway/sidewalk surfaces should be sloped such that surface water runoff is directed away from the structure, and where appropriate collected and routed to suitable discharge points.

ROADWAY SUBGRADE
Road, parking or pavement subgrade areas should be prepared as previously described in the site preparation section of this report. The prepared subgrade should be evaluated by proofrolling with a fully-loaded dump truck or equivalent point load equipment. Soft, loose or wet areas that are disclosed should be recompacted or removed, as appropriate. Over-excavated areas should be backfilled with compacted structural fill and sub-base material.

LIMITATIONS
We have prepared this report for use by Tacoma Power and members of the project team involved in the design of the proposed reservoir, roadways and utilities. The data and report may be provided to prospective contractors for bidding or estimating purposes; but our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

If there are any changes in the grades, location, configuration or type of facility planned, the conclusions and recommendations presented in this report might not be fully applicable. If such changes are made, we should be given the opportunity to review our conclusions and recommendations and to provide written modification or verification, as appropriate. When the design is finalized, we recommend that we be engaged to review those portions of the specifications and drawings that relate to geotechnical considerations to see that our recommendations have been interpreted and implemented as intended.

There are possible variations in subsurface conditions between the locations of the explorations and also with time. Some contingency for unanticipated conditions should be included in the project budget and schedule. We recommend that sufficient monitoring, testing and consultation be provided by our firm during construction to confirm that the conditions encountered are consistent with those indicated by the explorations; to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated; and to evaluate whether or not earthwork and pipeline installation activities comply with the contract plans and specifications.

The scope of our services does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.
Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No other warranty, express or implied, should be understood.

Respectfully submitted,

GeoResources

Brad P. Biggerstaff, RPG
Principal

LSI/ADaPT Engineering, Inc.

Kurt W. Groesch, P.E.
Principal

[Signature]

EXPRES 8/15/02
DIRECTIONS
FROM TACOMA, TAKE I-5 SOUTH. DRIVE 68 MILES TO STATE ROUTE 12 (EXIT 68 "MORTON").
TURN LEFT ON STATE ROUTE 12 EASTBOUND AND DRIVE APPROXIMATELY 14 MILES TO
GERSHEK ROAD. TURN RIGHT AND FOLLOW TO THE GATES OF MAYFIELD DAM AND
POWERHOUSE, APPROXIMATELY 0.6 MILE.
# Soil Classification System

## Major Divisions

<table>
<thead>
<tr>
<th>Coarse Grained Soils</th>
<th>Cassel Gravel</th>
<th>Clean Gravel</th>
<th>Group Symbol</th>
<th>Group Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 50% of Coarse Fraction Retained on No. 4 Sieve</td>
<td>More Than 50% of Coarse Fraction Retained on No. 4 Sieve</td>
<td>Gravel with Fines</td>
<td>GW</td>
<td>Well-Graded Gravel, Fine to Coarse Gravel</td>
</tr>
<tr>
<td>More than 50% of Coarse Fraction Retained on No. 200 Sieve</td>
<td>Sand</td>
<td>Clean Sand</td>
<td>SW</td>
<td>Well-Graded Sand, Fine to Coarse Sand</td>
</tr>
<tr>
<td>Fine Grained Soils</td>
<td>Sand with Fines</td>
<td>GM</td>
<td>Silty Gravel</td>
<td></td>
</tr>
<tr>
<td>More than 50% of Coarse Fraction Retained on No. 200 Sieve</td>
<td>Silty Sand</td>
<td>SM</td>
<td>Silty Clay</td>
<td></td>
</tr>
<tr>
<td>More than 50% of Coarse Fraction Retained on No. 200 Sieve</td>
<td>Clayey Sand</td>
<td>SC</td>
<td>Clayey Sand</td>
<td></td>
</tr>
<tr>
<td>Silty Clay</td>
<td>Clean Sand</td>
<td>SP</td>
<td>Poorly-Graded Sand</td>
<td></td>
</tr>
<tr>
<td>Organic Silts</td>
<td>Inorganic</td>
<td>OL</td>
<td>Organic Silts, Organic Clay</td>
<td></td>
</tr>
<tr>
<td>Organic Clay</td>
<td>Inorganic</td>
<td>CH</td>
<td>Clay of High Plasticity, Fat Clay</td>
<td></td>
</tr>
<tr>
<td>Organic Clay</td>
<td>Inorganic</td>
<td>OH</td>
<td>Organic Clay, Organic Silts</td>
<td></td>
</tr>
</tbody>
</table>

## Highly Organic Soils

- PT | Peat

## Notes:

1. Field classification is based on visual examination of soil in general accordance with ASTM D2488-90.
2. Soil classification using laboratory tests is based on ASTM D2487-90.
3. Descriptions of soil density or consistency are based on interpretation of blow count data, visual appearance of soils, and/or test data.

## Soil Moisture Modifiers:

- **Dry**: Absence of moisture, dusty, dry to the touch
- **Moist**: Damp, but no visible water
- **Wet**: Visible free water or saturated, usually soil is obtained from below water table
# BORING LOG

**PROJECT:** MANFIELD DAM  
**Job Number:** 98-957  
**Boring No.:** 1

---

<table>
<thead>
<tr>
<th>Depth</th>
<th>Material Description</th>
<th>Sample Number</th>
<th>Sample Count</th>
<th>Slow Count</th>
<th>Ground Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>STIFF, WET, ORANGE/BROWN, SANDY SILT (ML)</td>
<td>S-1</td>
<td>4</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>V. STEFF, WET, GRAYISH BROWN W/ORANGE MOTTLES, F. SANDY SILT W/GRANIL (CARBONIZED ORGANICS @ 9') (ML)</td>
<td>S-2</td>
<td>11</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HARD, WET, GRAYISH BROWN, F. SANDY SILT W/TRACE GRAVELLY/MORONITOUS W/ ORANGE MOTTLED SAND ZONES (34 FT) OVERSIZE @ 14 (ML)</td>
<td>S-3</td>
<td>10</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>HARD, WET, BROWN, SANDY SILT W/OVERSIZE; TAN CONCRETIONS (ML)</td>
<td>S-9</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.5'</td>
<td>REFUSAL @ 19.5'</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-20</td>
<td>No GW, but WET</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**LEGEND**

- 2-inch D. D. Split Spoon Sample
- Basic Water Level at Drilling
- Grab Sample
- Depth of Water Level
- Perched Groundwater
- Type of Analytical Testing Used
- Sample Not Recovered
- No Recovery
- Time of Drilling

**Drilling Start Date:**  
**Drilling Completion Date:**  
**Logged By:** mpb
### BORING LOG

**PROJECT:** MAYFIELD DAM

**Tacoma Power**

**Job Number:** 98-907

**Boring No.:** 2

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Type</th>
<th>Sample Number</th>
<th>Below Ground</th>
<th>Zone</th>
<th>Groundwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>V. STEFF, WET, ORANGE/BROWN, F. SANDY SILT</td>
<td>S-1</td>
<td>4</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>-5</td>
<td>V. STEFF, WET, GRAYISH BROWN/ORANGE/BROWN, F. SANDY SILT W/TRACE GRAVEL, CONCRETION, ORANGE, MOTTLED SAND ZONES, CARBONIZED ORGANICS THROUGHOUT</td>
<td>S-2</td>
<td>7</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>-10</td>
<td>HARD, WET, GRAY/BROWN F. SANDY SILT W/TRACE GRAVEL, ORANGE, MOTTLED SAND ZONES</td>
<td>S-3</td>
<td>17</td>
<td>30</td>
<td>90</td>
</tr>
<tr>
<td>-15</td>
<td>6&quot; V. STEFF, WET, BROWN, F. SANDY SILT W/TRACE GRAVELS, TAN CONCRETIONS, ORANGE, MOTTLED SAND ZONES OVER 4&quot; GRAYISH GREEN F. SANDY SILT W/ TAN CONCRETIONS OVER 4&quot; PENKESH RIDGE, ORANGE, GRAY SILT SAND</td>
<td>S-4</td>
<td>9</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>-20</td>
<td>HARD, WET, TAN, MOTTLED F. SAND</td>
<td>S-5</td>
<td>50/4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-25</td>
<td>ORANGE, MOTTLED SAND ZONES OVER 9&quot; TAN/GRAY/BROWN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-30</td>
<td>TERMINATED @ 24'</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend**
- Birch O. D. Split-Spoon Sample
- Static Water Level at Drilling
- Grab Sample
- Site Description
- Sample not Recovered
- Perched Groundwater

**Drilling Start Date:**

**Drilling Completion Date:**

**Logged By:** mpb