W0760004

GEOTECHNICAL ENGINEERING EVALUATION

Fairfield's Pusch Ridge, Lots 1-37

East of Buckridge Place & Pusch Wilderness Dr.

PATTISON ➢ EVANOFF ➢ ENGINEERING, LLC
Project No. 04-020

Geotechnical &
Environmental
Consultants

PATTISON ➢ EVANOFF
ENGINEERING, LLC

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PATTISON ➢ EVANOFF
ENGINEERING, L.L.C

February 27, 2004

Geotechnical Engineering
Construction Inspection
Materials Testing

Electronic Communities
10940 N. Stallard Place
Tucson, Arizona 85737

Mr. Mark Donatelli

ADDITIONAL SLOPE STABILITY RECOMMENDATIONS
Fairfield's Pusch Ridge Lots 1-37
East of Buckridge Place and Pusch Wilderness Dr.
Oro Valley, Arizona

Project Number 04-020
Addendum No. 1

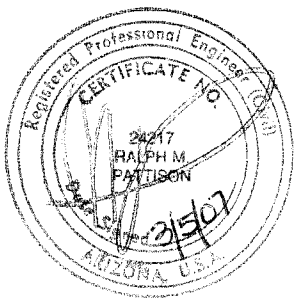
The site soils are predominantly dense to very dense sands with silt, gravel, cobbles, and boulders. We believe that cut slopes will be stable at inclinations of 1 to 1 for slopes less than 8 feet high if the slope is protected by grouted riprap and less than 6 feet high if protected with hand-placed riprap. All slopes faces should also be protected according to Oro Valley Guidelines to resist erosion.

The Geotechnical Engineer should view all exposed slopes to confirm that the soils are similar to what we encountered during our geotechnical evaluation. Positive drainage must be provided in all areas close to slopes: increased moisture levels in slope soils could lead to failure of the slopes. Fill slopes should be constructed according to the recommendations of our report.

Based on the soil type encountered on site, we recommend a pavement section of 2 inches of asphaltic concrete over 4 inches of aggregate base course for both Pusch Drive and subdivision streets provided that the traffic does not exceed 1050 vehicles per day.

We thank you for selecting PATTISON EVANOFF ENGINEERING, L.L.C. and look forward to being a member of your team on the remainder of this project. This letter should be attached to and made a part of our original report. If you have any questions, or require additional consultation, please call us.

Sincerely,
PATTISON ➢ EVANOFF ➢ ENGINEERING, L.L.C.
Geotechnical, Materials, and Environmental Services



Ralph M. Pattison, P.E.
Principal

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PATTISON ➢ EVANOFF
ENGINEERING, LLC

Geotechnical Engineering
Construction Inspection
Materials Testing

February 4, 2004

Electronic Communities
10940 N. Stallard Place
Tucson, Arizona 85737

GEOTECHNICAL ENGINEERING EVALUATION
Fairfield's Pusch Ridge, Lots 1-37
East of Buckridge Place and Pusch Wilderness Drive
Oro Valley, Arizona

Project No. 04-020

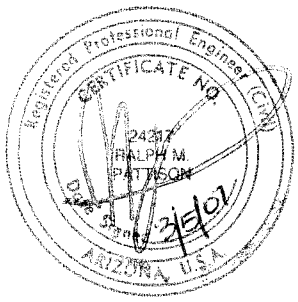
We have completed the geotechnical evaluation for the proposed subdivision, in accordance with our Proposal Number 04-P002 dated, January 6, 2004. Our project study results are attached.

In our opinion, the site's subsurface soil conditions are suitable for the proposed development provided the report's recommendations are followed. Our evaluation showed dense to very dense sands with silt, gravel, cobbles, and boulders. The soil conditions and specific recommendations are presented in the report.

We are available for consultation during the various design stages. To provide continuity of geotechnical services, we should perform construction observation and testing.

We thank you for selecting PATTISON EVANOFF ENGINEERING, L.L.C. and look forward to being a member of your team on the remainder of this project. If you have any questions about this report, or require additional consultation, please call us.

Sincerely,
PATTISON ➢ EVANOFF ➢ ENGINEERING, L.L.C.
Geotechnical, Materials, and Environmental Services



Ralph M. Pattison, P.E.
Principal

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INTRODUCTION

This report presents the results of our geotechnical engineering services for the proposed Fairfield's Pusch Ridge, Lots 1-37, located east of Buckridge Place and Pusch Wilderness Drive, in Oro Valley, Arizona. The site is in the southeast quarter of Section 8, Township 12 South, Range 14 East, of the Gila and Salt River Base and Meridian, Oro Valley, Arizona. The Site Plan in the Appendix shows the location of the site.

We obtained information on site conditions, performed field and laboratory testing, and performed geotechnical engineering analyses. This report presents our conclusions and recommendations regarding the engineering properties of the soils encountered and their relationship to the proposed development. Specifically, the report addresses the following information:

- General site and subsurface conditions encountered during our evaluation.
- Recommendations and design criteria for foundation systems, including allowable bearing capacity, lateral earth pressures and estimated settlements.
- Recommendations for support of concrete floor slabs.
- Recommendations for grading requirements, including site and building area preparation, fill placement, and suitability of existing soils for fill.

The Appendix contains the results of the field explorations and tests and provides a site plan showing the exploration locations.

Project Information

We understand that a new subdivision is planned for this site. We assume that houses will use frame or masonry construction with concrete slab-on-grade floors. We have not been given structural details but expect that maximum wall and column loads will be less than 3 klf and 30 kips, respectively. We have not been provided with a grading plan but we assume that finished grades will be at or near existing grades.

Evaluation and Testing

To obtain information on the conditions at this site and to determine applicable soil properties, we completed an on-site evaluation. The extent of our evaluation and testing programs is described in the following section.

- Field Evaluation

  Richard Jones, a Field Specialist with our firm, reviewed the site to obtain information on the general surface conditions. He also observed the excavation of 6 borings to depths ranging between 2 and 4 feet below existing site grade. The site plan shows the approximate exploration locations. The Appendix contains logs of the subsurface conditions encountered at the explorations.

  During the field exploration, the subsurface conditions were described and the encountered soils were visually logged and sampled. We used the Unified Soil Classification System to classify soils. The soil classification symbols appear on the exploration logs and are briefly described in the Appendix.

FINDINGS

Site Conditions

At the time of our exploration the site was primarily undeveloped property. The ground surface had been brushed and graded and was firm, dry, and rocky. The surface topography is relatively flat with rock outcrops.

Subsurface Conditions

The soils encountered in our exploration were generally dense to very dense sands with silt, gravel cobbles, and boulders. No zones of carbonate cementation were encountered in any of the borings.

We encountered auger refusal at all of our borings at depths ranging between 2 and 4 feet. Many factors can cause or contribute to auger refusal: strongly cemented soil; coarse gravel, cobbles, or boulders; thin rock seams; the upper surface of continuous rock; or borehole confinement. Special exploration procedures are needed to determine the character and continuity of refusal. Such procedures were not within the scope of our current services, but we believe that refusal was probably caused by the presence of cobbles and boulders and borehole confinement.

Soil moisture contents were low at the time of our field evaluation and no free groundwater was encountered in any of the explorations. The logs in the Appendix show details of the subsurface conditions encountered during the field evaluation.

Conclusions

In our opinion, the site's natural subsurface soil and conditions are suitable for support of the proposed development provided the designers, contractors, and owners follow the report recommendations. Our conclusions regarding the soils and planned development are given in the following discussion.

- Compressive Properties

  At their existing and increased moisture contents, the natural soils are expected to have low compressive potentials under the loads expected for the construction. We expect that total settlement of the proposed structures, supported as recommended, will be less than 1 inch. Differential settlement should be approximately half of the total settlement. Most settlement is expected to occur soon after construction, although additional foundation movements could occur if water from any source infiltrates the underlying soils.

- Expansive Properties

  The surface soils at this site are granular and have low to medium plastic fines. We expect the swell potential of these soils to be low; special provisions relative to heave are probably unnecessary.

- Existing Fill

  The existing fill we encountered appears to have been compacted, but may not be sufficient to provide suitable support of structural elements. We are unaware of records of compaction for this fill, therefore we consider the fill to be uncontrolled and potentially unsuitable for support of structures without first stripping and recompacting. Additional field evaluations will be required to delineate the vertical and lateral extents of existing fill. Depending on the conditions encountered at the time of construction, it may be possible to leave the existing fill in place.

RECOMMENDATIONS

General

All structural elements will experience at least some differential movement and the various components must accommodate this potential. We recommend that you have the Architect, the Structural Engineer, Civil Engineer, Landscaper, and all other design team members and contractors read this report and consider our comments. The basis for our comments on foundation and slab design details is primarily our experiences with recurring problems associated with many of these items.

In the following section, we provide recommendations for the supporting system that we believe is appropriate for the construction conditions. We do not intend to provide recommendations that prevent all undesirable effects resulting from structural movements. We intend to provide reasonable solutions to help control effects the soil may have on the structure.

Shallow Conventional Foundations

The proposed structures can be supported by conventional shallow, spread foundations bearing on native soil or constructed subbase fill, constructed according to the recommendations given in the *Earthwork* section of this report. The supporting system may consist of continuous wall footings and independent spread footings and slabs-on-grade. Monolithic foundations and slabs could be used provided they are properly designed and constructed.

The following table presents alternative foundation depths and allowable bearing pressures:

Footing Depth Below Finished Grade, ft.[1]	Allowable Bearing Pressure, psf[2]
1	1700
1.5	2200
2	2700

[1] Finished grade is the lowest adjacent grade for perimeter footings and floor level for interior footings.

[2] Allowable bearing pressures depend on compliance with the Earthwork recommendations of this report.

Footings should have minimum widths of 12 inches for walls and 24 inches for columns. Governing building codes may require greater widths. A one-third increase in the bearing pressures is allowable for transient wind or seismic loads. The bearing values given are net bearing values so the weight of the concrete in the footings may be ignored.

Foundations adjacent to descending slopes should be setback at least 3 feet, horizontally, from the top of the slope. Additionally, an imaginary line extending downward at 45 degrees from a foundation edge should not intersect the slope face.

All footings, stemwalls, and masonry walls should be reinforced to reduce the effects of potential differential movements. Reinforcement should be consistent with structural requirements to minimize the possibility of longitudinal cracking along the wall. We suggest continuous reinforcement through these areas because we frequently see cracks in the slab portions of

monolithic construction parallel to the thickened beams. This cracking occurs because of differential movement between the slab and beam and insufficient reinforcing to resist the shear and flexural stresses. In our opinion, such differential movement should be expected because of the different loading conditions and potential variations in soil properties.

The Geotechnical Engineer or his representative *must* observe the site preparations and foundation excavations. The purpose of this review would be to determine if the soils and conditions are similar to those expected for support of the footings. Any soft, loose or unacceptable soils should be properly compacted and may require additional undercutting.

Shallow Post-Tensioned or Mat Foundations

As an alternative to a conventional foundation with a slab on grade, we suggest either a post-tensioned or reinforced-mat foundation and slab system for the planned structures. The floor areas of these systems should, however, be supported by at least 4 inches of base course. These structural systems must be designed by a Structural Engineer, who should specify the concrete strength, concrete strength required for post tensioning, required thicknesses of elements, post-tensioning force, and expected post tensioning cable elongation; we are providing the following parameters needed for the commonly used design methods.

- Allowable Bearing Capacity: 1000 psf at grade
  1800 psf at a depth of 1.0 foot below lowest adjacent grade
  2300 psf at a depth of 1.5 foot below lowest adjacent grade
  2800 psf at a depth of 2.0 feet below lowest adjacent grade

- Modulus of Subgrade Reaction: 250 pci

- Soil Modulus of Elasticity: 3000 psi

- Coefficient of Friction: 1.0

- Edge Moisture Variation Distance, e_m
  - Center Lift Condition 5.5 feet
  - Edge Lift Condition 3.0 feet

- Differential Soil Movement, y_m
  - Center Lift Condition 0.5 inches
  - Edge Lift Condition 0.6 inches

A one-third increase in the bearing pressure is allowable for transient wind or seismic loads. The bearing values given are net bearing values so the weight of the concrete in the footings may be ignored. The Structural Engineer should specify the concrete strength, concrete strength required for post-tensioning, required thicknesses of elements, post-tensioning force, and expected post-tensioning cable elongation.

Although post-tensioning the foundation and slabs will help close minor cracks that form during hydration, it is still beneficial to properly cure the concrete. The proper curing of concrete, especially for flatwork (slabs), is extremely important in minimizing plastic shrinkage cracks and slab curling. We believe that many slab cracking problems can be mitigated or possibly eliminated by proper curing. We strongly suggest moist-curing slabs for at least a week after placement. Curing promotes more complete hydration of the cement and reduces plastic drying shrinkage, especially near the exposed upper portion of the slab. Alternatively, moist-curing for several days and then applying a liquid membrane curing compound would also be beneficial. Also important are the mix design and quality control during construction.

All concrete placement and curing operations should follow recommendations of the American Concrete Institute manual. Improper curing and excessive slump (water-cement ratio) could cause excessive shrinkage, cracking, or curling of the concrete. Concrete slabs should be allowed to cure adequately before placing vinyl or other moisture-sensitive floor covering.

- **Important Comments Regarding Post-Tensioned Systems**
  On the basis of our experience, it appears that many people have a misunderstandi of the performance of post-tensioned systems and the need for ground preparations. The of a post-tensioned supporting system ***does not*** preclude the need for appropriate ground preparation. If soils capable of volume change underlie any shallow system, there is still the possibility of differential slab/foundation movement and damage. A post-tensioned system can merely lessen the effects of differential movement, especially to the superstructure that it supports. It does this primarily by redistributing stresses because of its higher internal strength (as compared to a conventional unreinforced slab and separate foundations). One cannot expect to design a single, specific post-tensioned system for ***any*** soil and loading situation and have it perform adequately under all conditions. The design should be specific to the site soils and structural loading and good construction practices should be followed.

  The need for appropriate soil preparation is not diminished by using a post-tensioned system. In fact, prior to actually tensioning the cables, the system is an *unreinforced* monolithic slab/foundation, deriving all of its support directly from the soil during its critical hydration period. Subgrade preparation, subbase fill construction, base course provisions and compaction,

and utility backfill compaction are all important aspects of the construction and should be done in accordance with the geotechnical report and plans.

It is also important to avoid overstressing the planned post-tensioned system (by stacking supplies or by premature construction of the superstructure) prior to gaining appropriate concrete strength and stressing the cables. These service-load-induced stresses can also adversely affect the performance of the system.

To help determine suitable phasing and types of construction activities, we should meet together with you, the structural engineer, and the appropriate subcontractors. Our intention is to help you secure a product that performs as expected.

Floor Slabs

If either the post-tensioned or mat foundation alternatives are used, the floor areas are part of the structural system. Our recommendations for support of the slab portions are included in the previous section of this report.

Floor slabs may be supported on properly prepared subgrade or properly placed and compacted fill. The contractor should prepare the slab subgrade, subbase fill, and base course as outlined in the ***Earthwork*** section of this report. For lightly loaded slabs, a minimum 4-inch layer of base course should be provided beneath all slabs to provide uniform support and help prevent capillary rise and a damp slab.

The slab thickness, concrete strength, and reinforcing should be designed by the Structural Engineer. We recommend that slabs supporting typical light loads be at least 4 inches thick. We believe using reinforcing steel in slabs is beneficial for minimizing cracks and strengthening the cross-section in the event tensile or flexural stresses develop. If a *nonreinforced* slab is chosen, we still suggest using steel reinforcing at least in interior or re-entrant corners.

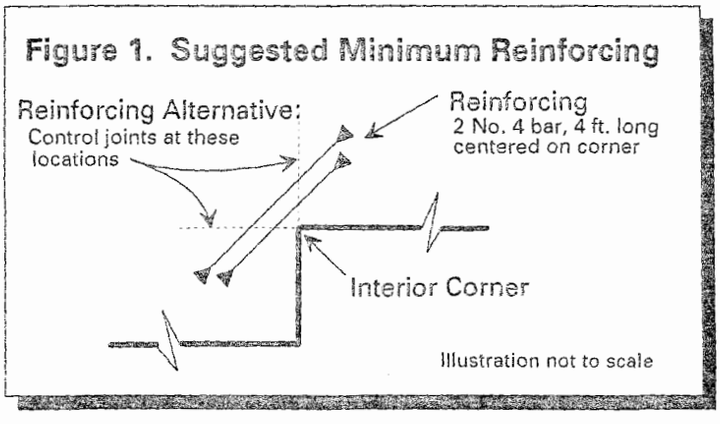


Figure 1. Suggested Minimum Reinforcing

Reinforcing should be placed diagonally across the interior projection of corners as shown in Figure 1. Reinforcement should be positioned as near the mid-height of the slab as possible while maintaining codes. Alternatively, control joints may be used for this situation as shown in Figure 1. Slabs should be jointed around columns and along footing

supported walls so the slab and footings are able to settle independently. If steel reinforcing is not used, we recommend using a fibermesh additive to the concrete to aid in controlling cracks from drying shrinkage and thermal changes.

To provide stress relief and help eliminate random cracking, we suggest providing control joints at spacings less than 12 feet. Wider joint spacings are possible depending on the slab thickness, absence or presence of reinforcing, concrete mix design, and the curing environment. The joint locations should be determined by the Structural Engineer. Joint locations should be developed considering such items as shrinkage potential, slab thickness, curing, fixed element restrictions, slab penetrations, type of floor covering, and specialized equipment placement.

The proper curing of concrete, especially for flatwork (slabs), is extremely important in minimizing plastic shrinkage cracks and slab curling. We believe that many slab cracking problems can be mitigated or even eliminated by proper curing. We strongly suggest moist-curing slabs for at least a week after placement. Curing promotes more complete hydration of the cement and reduces plastic drying shrinkage, especially near the exposed upper portion of the slab. Alternatively, moist-curing for several days and then applying a liquid membrane curing compound would also be beneficial. Also important are the mix design and quality control during construction.

All concrete placement and curing operations should follow recommendations of the American Concrete Institute manual. Improper curing and excessive slump (water-cement ratio) could cause excessive shrinkage, cracking, or curling of the concrete. Concrete slabs should be allowed to cure adequately before placing vinyl or other moisture-sensitive floor covering. To prevent incomplete bonding, distortion, and water vapor entrapment, flooring should not be placed until the moisture content of the slab is at or below the manufacturer's requirements.

Lateral Earth Pressures

For cantilevered walls above any free water surface with level backfill and no surcharge loads, the recommended equivalent fluid pressures and coefficients of base friction are presented in the following table.

EARTH PRESSURE STATE**		EQUIVALENT FLUID PRESSURE, psf/ft
Active		
	Undisturbed Native Soil	35
	Granular Backfill	30
Passive		
	Undisturbed Native Soil	400
	Granular Backfill	450
At-rest		
	Undisturbed Native Soil	55
	Granular Backfill	50
Coefficient of Base Friction = 0.45*		

* For short retaining walls with minimal cover on the outside face, the coefficient of base friction should be reduced to 0.35 when used in conjunction with passive pressure.

We do not expect submerged soil conditions; the lateral earth pressures shown therefore do not include this condition. We should be consulted for additional recommendations if submerged conditions are to be included in the design. Any surcharge from adjacent loading will also increase the lateral pressure and must be added to the above earth pressures.

The contractor should use granular, relatively free-draining soil for retaining wall backfill to reduce the potential for hydrostatic pressure buildup. Retaining walls should be designed with a backdrain that either drains to lower ground or to a sump with a float-activated pump. The level of this drain should be lower than the lowest retained earth behind the wall; the perforations in the drain pipe should be at least 8 inches lower than the top of any interior slabs in front of the wall.

Properly place and compact all backfill as recommended in this report. Cobbles, if present, should be removed from the soils placed adjacent to walls so high-intensity point loads do not occur. Avoid nesting of larger particles because voids could form and cause subsidence of the backfill.

Waterproof the exterior face of below-grade walls that are exposed to interior living spaces to retard moisture penetration. It is important that all backfill be properly placed and compacted. Mechanically

compact all backfill in layers. Water settling or flooding is not acceptable. Care should be taken to avoid damaging the walls when placing the backfill. Backfill should be inspected and tested during placement and compaction, especially if there will be overlying elements supported by the backfill such as foundations, stairs, walls, and planters.

Exterior Features

Exterior slabs-on-grade, exterior architectural features, and utilities may experience some movement due to the volume change of the underlying soils. The potential for movement and resulting distress could be reduced by the following measures:

- Minimizing moisture increases in the soil
- Moisture-density control during placement of soil
- Use of designs which allow vertical movement between the exterior features and adjoining structural elements
- Placement of effective control joints on relatively close centers
- Allowance for vertical movements in utility connections

Temporary Construction Excavations

Temporary unsurcharged construction excavations should be sloped or shored. Slopes should not be steeper than 1.5 to 1 (horizontal to vertical) in the natural soil. Slopes may need to be flattened depending on conditions exposed during construction. If there is not enough space for sloped excavations, shoring should be used.

Various shoring systems are possible; their selection and design, however, is beyond the scope of our current evaluation. The design of a retaining system is dependent on the construction method, the sequence of operations, and adjacent construction. The contractor's and designer's responsibilities for design and construction should be clearly defined. Exposed slopes should be kept moist (not saturated) during construction. Traffic and surcharge loads should be at least 10 feet from the the excavation. All excavations should be completed in accordance with the most recent OSHA requirements.

Slopes and Soil Erodibility

Both cut and fill slopes should be 2 to 1 (horizontal to vertical) or flatter and should be covered as quickly as possible with grass or other covers such as mulch, rock mulch, or jute mesh to avoid unnecessary soil losses.

Slopes should be scraped or raked across the slopes (perpendicular to flow), unless they are *trackwalked*, to aid in providing greater infiltration rates of surface water. If the slopes are shaped by *trackwalking*, with tracked vehicles, they should be worked up and down as the tread imprints will create grooves parallel to the slope which will aid infiltration rates and trap seeds.

During construction, graded unprotected areas should retain as much natural vegetation as possible. Vegetation along the perimeters of graded areas should be left intact to control erosion and serve as a sediment trap. Exposed soil areas should be sprinkled with water during construction to reduce transportation of soil by wind. If rains are anticipated during construction, flows over the disturbed areas can be minimized by diverting upslope surface water with berms or ditches.

Erosion will increase soil loss and could cause loss of support to structures and other facilities. Periodic maintenance and prompt repair of erosional features is important to prevent unnecessary soil losses. The effectiveness of erosion control should be evaluated after heavy or prolonged rains.

Surface Drainage

A major cause of soil-related damage to structures in this region is moisture increases in the supporting soil. It is therefore extremely important to provide positive drainage away from the structure, both during construction and throughout its life. Infiltration of water into utility or foundation excavations must be prevented.

Waterlines and sewerlines should be carefully tested and inspected for leaks prior to backfilling. Planters and other surface features that could retain water in areas adjacent to the structure should be eliminated or constructed so that accumulated water is discharged onto a positive gradient at least 5 feet from the structure. Roof rainwater, water from cooling unit condensation, and water heater drains should also be discharged onto a positive gradient at least 5 feet from the structure.

In areas where sidewalks or paving do not immediately adjoin the structure, protective slopes should be provided with an outfall of at least 3 percent for at least 5 feet from perimeter walls. Backfill against footings, exterior stemwalls, and in utility and sprinkler line trenches should be well compacted and free of all construction debris to minimize the possibility of moisture infiltration.

Some drainage facilities, such as rock-lined drainage swales, often degrade over time and become inefficient or ineffective. The potential harmful effects of water infiltrating the supporting soils beneath the structure must be made clear to the owners.

Construction Review

The Geotechnical Engineer or his representative must observe the site preparations and foundation bearing conditions. The purpose of this review would be to determine if the soils and conditions are similar to those expected for support of the footings. Any soft, loose or unacceptable soils should be properly compacted and may require supplemental recommendations.

We recommend surveying the finished floor elevation of all slabs-on-grade and maintaining this record. In the event of future movement, this information could be extremely helpful in assessing the conditions and providing remedial measures.

EARTHWORK

General

Our recommendations for foundations and slabs supported on compacted fills or prepared subgrade depend on compliance with the recommendations presented in this section. Observation and testing of earthwork, supervised or performed by a geotechnical engineer, is necessary to assess compliance with these recommendations.

During our field evaluation we did not observe any underground facilities such as septic tanks, cesspools, basements and utilities. However, underground features could be present as a consequence of the existing nearby development.

Site Clearing

Strip and remove any existing fill, vegetation, debris, loose or wet soil and other deleterious materials from the building areas and at least 5 feet beyond. The contractor should remove any remnants from previous construction from the proposed building areas. If pipes and other underground structures are not removed, they may serve as conduits for subsurface erosion resulting in voids and possible settlement of overlying facilities. Over-excavated areas resulting from removal of boulders, cobbles, underground facilities and unsuitable materials should be backfilled as recommended in this report. All exposed surfaces should be free of mounds and depressions that could prevent uniform compaction. In areas that will receive fill, slopes steeper than 5 to 1 (horizontal to vertical) should be benched to reduce potential slippage between slopes and fills. Benches should be reasonably level and wide enough to allow appropriate use of compaction and earth-moving equipment on a level plane.

Foundation Preparation

Specialized treatment of the existing *undisturbed* natural soils in foundation areas is unnecessary. However, proper precautions should be taken to ensure that the foundation excavations bear in *undisturbed* natural soils and not in disturbed or loose soil. Excavation, however, will probably require the removal of some rock segments, boulders, and cobbles. Voids created by this removal should be carefully backfilled in compacted lifts or left open and filled with concrete. All disturbed or loose soil should be removed and foundation excavations must be reviewed by the Geotechnical Engineer or his representative prior to placing reinforcing steel and concrete to determine if the soils and conditions are as expected.

The contractor should construct any subbase fill in a manner resulting in *uniform* water contents and densities after compaction. All subgrade and subbase fill should be constructed according to the report requirements. The contractor should notify the Geotechnical Engineer if the soil conditions vary significantly from those shown in this report or if there are any questions regarding the type of soil or its condition.

Floor Slab Preparation

The contractor should scarify, moisten or dry as required, and recompact the exposed subgrade soil to a depth of at least 12 inches. This includes areas to be filled and exposed cut-to-grade areas. The contractor should notify the Geotechnical Engineer if the soil conditions vary significantly from those shown in this report or if there are any questions regarding the type of soil or its condition.

The contractor should prepare the subgrade and construct any subbase fill in a manner resulting in *uniform* water contents and densities after compaction. Place and compact at least four inches of base course beneath interior slabs to provide more uniform support and help prevent a damp slab. This four-inch thickness of base course may be included in the required amount of engineered f ill.

Utility Trench Backfill

Utility trenches within and beyond the building pad should be made as narrow as possible to reduce the potential for settlement of overlying slabs and other structures. The practice of digging wide trenches for the convenience of plumbers and electricians should be avoided, unless such trenches are carefully backfilled in lifts compacted to 95 percent of Standard Proctor Maximum Dry Density according to ASTM D-698.

Materials

Imported soils and existing granular soils with low expansive potentials and all particles passing the 6-inch sieve may be used as fill material for the following areas:

- Foundation areas
- Interior slab areas
- Backfill

Imported soils should conform to the following requirements:

IMPORT SOIL PROPERTIES	
SIEVE SIZE	PERCENT PASSING, by dry weight
6"	100
No. 4	50-100
No. 200	40 max.
Maximum Expansive Potential = 1.5%*	
Maximum Soluble Sulfates = 0.10%	

*Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at about three percent below optimum water content. The sample is confined under a 100 psf surcharge and submerged

Aggregate base course below concrete floor slabs should conform to the following requirements:

AGGREGATE BASE COURSE	
SIEVE SIZE	PERCENT PASSING, by dry weight
1"	100
3/4"	90 to 100
1/4"	45 to 75
No. 200	2 to 10
Plasticity Index = 5 max.	
The sum of PI and percent passing 200 should be at least 5	

Placement and Compaction

Place and compact fill in horizontal lifts using equipment and procedures that will produce the recommended moisture contents and densities throughout the lift.

Materials should be compacted to the following standards at near optimum moisture contents:

Soil Type and Area		Minimum Percent Compaction, ASTM D-698
On-site subgrade soils, on-site soils as subbase fill, and imported soils*		
	Below foundations**	95
	Below slabs-on-grade	95
Base Course below slabs		95
Non-structural backfill, *not providing lateral or vertical support of structural elements*		90

* Fill 5 feet or more below finished grade should be compacted to at least 100 percent of ASTM D-698.

** Undisturbed natural soils below foundations do not require compaction

CLOSURE

Additional Services

Field observation and testing during construction, and reviewing the plans and specifications are integral factors in developing and implementing our conclusions and recommendations. Our involvement during construction is important to observe compliance with the design concept, specifications, or recommendations, and to allow efficient design changes if the subsurface conditions differ from those anticipated. PATTISON EVANOFF ENGINEERING, L.L.C. offers these services and is the most qualified to determine consistency of field conditions with the data used in our analyses. It is the client's responsibility to make this report available, in its entirety, to all design team members, contractors, and owners.

Limitations

The services we performed for this project include professional opinions and judgments based on the data collected. We performed our professional services using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in southern Arizona. We do not intend to provide recommendations that prevent all undesirable effects resulting

from structural movements. We intend to provide reasonable solutions to help control effects the soil may have on the structure. We make no other warranty, expressed or implied.

We prepared the report as an aid for the design of the project. This report is not a bidding document and any contractors reviewing it must draw their own conclusions regarding site conditions and specific construction techniques to be used on this project.

Our services did not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in the soil, groundwater, or air, on or below or around, this site. All conditions documented or observed are strictly for the information of our client. If environmental information is required, we recommend that an environmental assessment be completed which addresses these concerns.

We based our recommendations on the assumption the soil and groundwater conditions across the site are similar to those encountered at the exploration locations. The extent and nature of subsurface soil and groundwater variations may not be evident until construction. If conditions encountered during construction appear to differ from those described in this report, we should be consulted to assess the impact and provide supplemental recommendations. Our evaluation and report does not include the effects, if any, of underlying geologic hazards or regional groundwater withdrawal and we express no opinion regarding their effects on surface movement.

APPENDIX

Geotechnical,

Materials &

Environmental

Consultants

PATTISON ➢ EVANOFF

ENGINEERING, LLC

UNIFIED SOIL CLASSIFICATION SYSTEM
CLASSIFICATION PROCEDURE

ANY SOIL

- **Less than 50% Fines** → Coarse Grained (Sieve Analysis)
  - *General Grouping*
  - *First Letter*: Whichever is present in Greatest Amount — SAND (S), GRAVEL (G)
  - *(Percent and Plasticity of Fines)*
    - **<5% Fines** → *Second Letter*: GW, SW
      - C_U: >4 (GW), >6 (SW)
      - C_C: 1-3 (GW), 1-3 (SW)
      - GW
      - GP
      - SW
      - SP
    - **5-12% Fines** → *(Gradation and Type of Fines)*

GW-GM	SW-SM
GW-GC	SW-SC
GP-GM	SP-SM
GP-GC	SP-SC

    - **12-40% Fines** → *(Type of Fines Plasticity Chart)*
      - CC
      - GM
      - SC
      - SM
- **Fibrous Organic Peat or Muck** → Pt
- **More than 50% Fines** → Fine Grained (Plasticity Chart)
  - Below A-Line-SILT (M)
  - Above A-Line-CLAY (C)
  - Color & Odor-Organic (O)
  - *(Value of Liquid Limit)*
    - W_L < 50 *(Low Compressibility)*
      - CL
      - ML
      - OL
    - W_L > 50 *(High Compressibility)*
      - CH
      - MH
      - OH

PHYSICAL PROPERTIES OF SOILS

GRAIN SIZE CHART

CLASSIFICATION	U.S. Standard Sieve Size
BOULDERS	Above 12"
COBBLES	12" to 3"
GRAVEL	3" to No.4
Coarse	3" to 3/4"
Fine	3/4" to No.4
SAND	No.4 to No.200
Coarse	No.4 to No.10
Medium	No.10 to No.40
Fine	No.40 to No.200
SILT & CLAY	Below No. 200

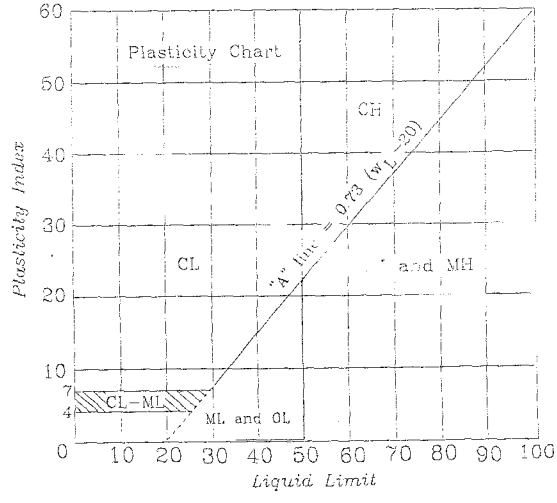
Coarse Grained Scale
(50% retained on #200 sieve)

ADJECTIVE	%
trace	0-10
some	10-20
with	20-30
"-y" or "-ey"	30-50

P = poorly graded
W = well graded

P.I.	*ADJECTIVE*
< 1	non-plastic
1-10	low plasticity
11-25	medium plasticity
>25	high plasticity

FINE GRAINED SOILS
(50% passing #200 sieve)



L = low compressibility
H = high compressibility

The number shown in **Boring No.** refers to the approximate location of the same number shown on the **Site Plan** as positioned in the field by pacing from property lines and/or existing features.

The number shown in **Blows/6"** refers to the number of blows of a 140-pound weight dropped 30 inches, required to advance the sampler. **H** in **Sample Type** is a hand sample from the auger cuttings. **RS** in **Sample Type** is a 2.42-inch-inside-diameter ring sampler. Refusal to penetration for the ring sampler is considered more than 50 blows per foot. **SS** in **Sample Type** is a 2.0-inch-outside-diameter split-spoon sampler. This sampler is used to perform the Standard Penetration Test (SPT) ASTM D1586. Refusal to penetration is considered to be one of the following items: 1. A total of 50 blows has been applied during any one of the three 6-inch increments; 2. A total of 100 blows has been applied; 3. There is no observed advance of the sampler during application of 10 successive blows of the hammer.

USCS Code refers to the soil type as defined by the **Unified Soil Classification System.** The soils were visually classified in the field and, where appropriate, classifications were modified by visual examination of samples in the laboratory and by appropriate test.

These notes and boring logs are intended for use in conjunction with the purposes of our services defined in the text. Boring log data should not be construed as part of the construction plans or as defining construction conditions.

Boring logs depict our interpretations of subsurface conditions at the locations and on the date(s) shown. Variations in subsurface conditions and soil characteristics may occur between borings. Groundwater levels may fluctuate due to seasonal variations and other factors.

In general, terms and symbols on the boring logs conform with **"Standard Definitions of Terms and Symbols Relating to Soil and Rock Mechanics"** (ASTM D653).

PATTISON > EVANOFF ENGINEERING, INC.

Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER B-1

SHEET 1 OF 1

Client: Electronic Communities

Project: Fairfield Pusch Ridge, Lots 1-37

Location: East of Buckridge Place and Pusch Wilderness Drive

Location of Boring: SEE SITE PLAN

Elevation: Datum:

Logged By: R.J. Date: 1/28/04

Subsurface Conditions or Remarks:
Previously Brushed and Graded - Terraced appearance - Brush and Desert Broom - Flat, hard, rocky and rock outcrops

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
				0	SM	GRAVELLY SAND/SANDY GRAVEL, some silt; brown, dry, dense,		
				1	GM	nonplastic, 15-30% cobbles and boulders		
					GP	BOULDERS, COBBLES AND GRAVEL with varying amounts of sand; trace fines, very dense, nonplastic		
				2		AUGER REFUSAL AT 2.5 FEET		
				3		*No Free Water Encountered*		
				4				
				5				
				6				
				7				
				8				
				9				
				10				
				11				
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				16				
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				18				
				19				
				20				
				21				
				22				
				23				
				24				

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:

Mobile B-53 Drill Rig equipped with 6" SSA, continuous-flight auger

PATTISON > EVANOFF ENGINEERING, INC.

Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER **B-2**

SHEET 1 OF 1

Client: Electronic Communities

Project: Fairfield Pusch Ridge, Lots 1-37

Location: East of Buckridge Place and Pusch Wilderness Drive

Location of Boring: SEE SITE PLAN

Elevation: Datum:

Logged By: R.J. Date: 1/28/04

Subsurface Conditions or Remarks:
Previously Brushed and Graded - Terraced appearance - Brush and Desert Broom - Flat, hard, rocky and rock outcrops

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
H				0	GM	SANDY GRAVEL some silt; brown, dry, dense, nonplastic, 25-40% cobbles and boulders		
				1	GP	BOULDERS, COBBLES AND GRAVEL with varying amounts of sand; trace silt, very dense, nonplastic		
				2		AUGER REFUSAL AT 2.6 FEET *No Free Water Encountered*		
				3				
				4				
				5				
				6				
				7				
				8				
				9				
				10				
				11				
				12				
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				19				
				20				
				21				
				22				
				23				
				24				

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:

Mobile B-53 Drill Rig equipped with 6" SSA, continuous-flight auger

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Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER **B-3**

SHEET 1 OF 1

Client: Electronic Communities

Project: Fairfield Pusch Ridge, Lots 1-37

Location: East of Buckridge Place and Pusch Wilderness Drive

Location of Boring: SEE SITE PLAN

Elevation: Datum:

Logged By: R.J. Date: 1/28/04

Subsurface Conditions or Remarks:
Previously Brushed and Graded - Terraced appearance - Brush and Desert Broom - Flat, hard, rocky and rock outcrops

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
				0	GM	SANDY GRAVEL some silt; brown, dry, dense, nonplastic, 20-35% cobbles and boulders		
				1	GP	BOULDERS, COBBLES AND GRAVEL with varying amounts of sand; trace fines, very dense, nonplastic		
				2		AUGER REFUSAL AT 2.6 FEET		
				3		*No Free Water Encountered*		
				4				
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				23				
				24				

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:

Mobile B-53 Drill Rig equipped with 6" SSA, continuous-flight auger

PATTISON > EVANOFF ENGINEERING, INC.

Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER B-4

SHEET 1 OF 1

Client: Electronic Communities

Project: Fairfield Pusch Ridge, Lots 1-37

Location: East of Buckridge Place and Pusch Wilderness Drive

Location of Boring: SEE SITE PLAN

Elevation: Datum:

Logged By: R.J. Date: 1/28/04

Subsurface Conditions or Remarks:
Brushed and Graded - Smooth - Flat - Brush - Scattered small Palo Verde and Mesquite Trees

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
				0	SM	Possible Fill - Gravelly sand, trace to some silt; brown, slightly moist, dense,		
				1	SP	nonplastic, 5-20% cobbles		
SS	50/5	5/5		2				
				3	GP	BOULDERS, COBBLES AND GRAVEL with varying amounts of sand; trace silt, very dense, nonplastic		
				4		AUGER REFUSAL AT 4 FEET		
						No Free Water Encountered		
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				24				

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:

Mobile B-53 Drill Rig equipped with 6-5/8" OD x 3 1/4" ID hollow stem, continuous-flight auger

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Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER **B-5**

SHEET 1 OF 1

Client: Electronic Communities

Project: Fairfield Pusch Ridge, Lots 1-37
Location: East of Buckridge Place and Pusch Wilderness Drive

Location of Boring: SEE SITE PLAN

Elevation: Datum:
Logged By: R.J. Date: 1/23/04
Subsurface Conditions or Remarks:
Native - small Palo Verde and Mesquite Trees - Cholla and P.P. Cacti - Scrub Brush - Flat, Hard surface - Rocky

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
H				0–1	GM SM	GRAVELLY SAND/SANDY GRAVEL, trace to some silt; brown, dry, dense, nonplastic, 15-30% cobbles		
				2		AUGER REFUSAL AT 2 FEET *No Free Water Encountered*		
				3–24				

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:

Mobile B-53 Drill Rig equipped with 6-5/8" OD x 3 1/4" ID hollow stem, continuous-flight auger

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Geotechnical Engineering
Construction Inspection
Materials Testing

BORING NUMBER **B-6**

SHEET 1 OF 1

Client: Electronic Communities

Project: Fairfield Pusch Ridge, Lots 1-37

Location: East of Buckridge Place and Pusch Wilderness Drive

Location of Boring: SEE SITE PLAN

Elevation: Datum:

Logged By: R.J. Date: 1/28/04

Subsurface Conditions or Remarks:
Native - small Palo Verde and Mesquite Trees - Cholla and P.P. Cacti - Scrub Brush - Flat, Hard surface - Rocky

SAMPLE TYPE	BLOWS PER 6"	INCHES DRIVEN/ INCHES RECOV'D	BULLNOSE BLOWS/FT	DEPTH (FEET)	USCS CODE	DESCRIPTION OF SUBSURFACE CONDITIONS	DRY DENSITY (PCF)	MOISTURE (%)
				0	SM GM	GRAVELLY SAND/SANDY GRAVEL, trace to some silt; brown, dry, dense, nonplastic, 15-30% cobbles		
				1				
				2	GP	BOULDERS, COBBLES AND GRAVEL with varying amounts of sand; trace fines, very dense, nonplastic		
				3		AUGER REFUSAL AT 3 FEET		
				4		*No Free Water Encountered*		
				5				
				6				
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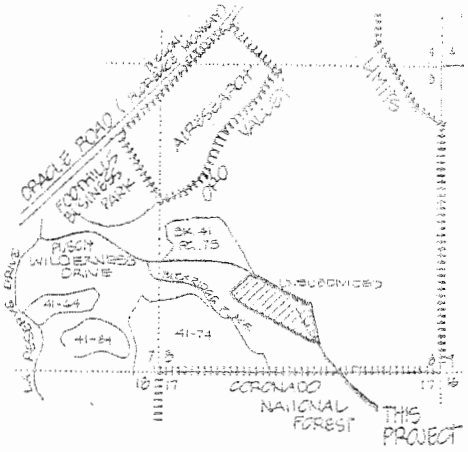
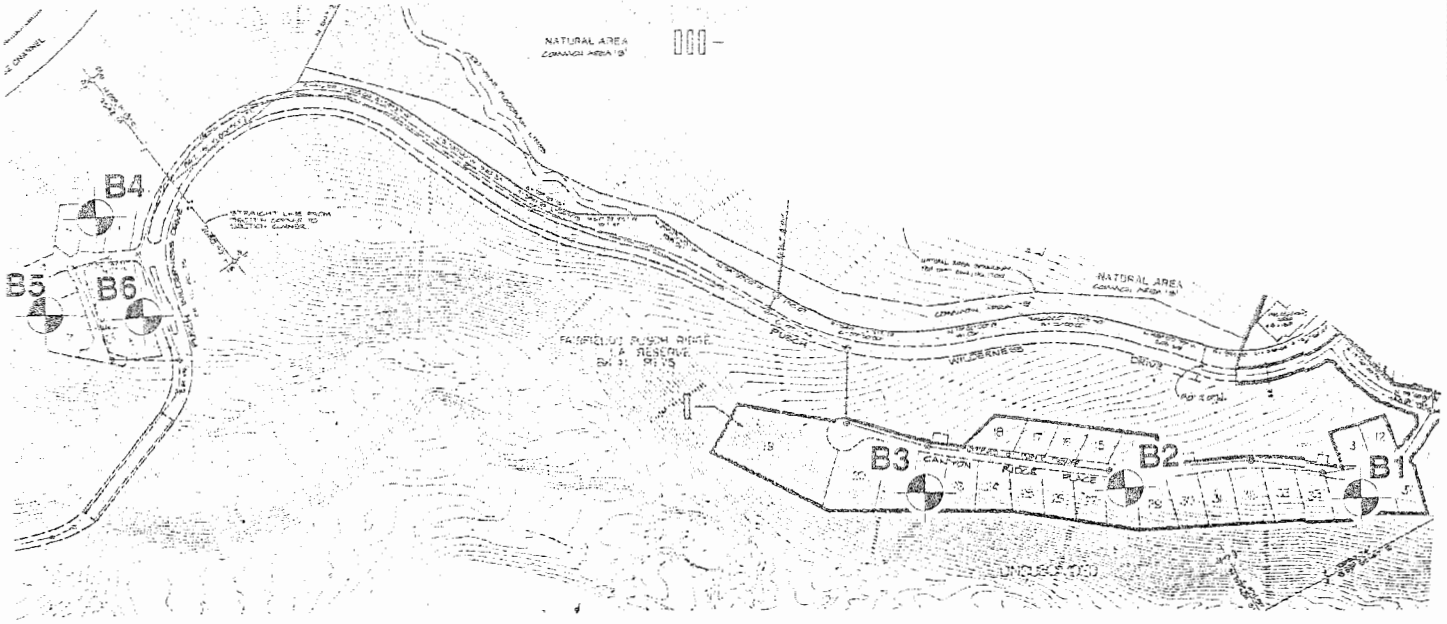
				24				

Sample Type Key:
SS = Split Spoon
RS = Ring Sample
H = Hand Sample

Drilling Equipment:

Mobile B-53 Drill Rig equipped with 6-5/8" OD x 3 1/4" ID hollow stem, continuous-flight auger





BORING LOCATIONS

N

APPROXIMATE SCALE (FEET)

0 230

PATTISON ➢ EVANOFF ➢ ENGINEERING, L.L.C.

Geotechnical & Environmental Consultants

SITE AND EXPLORATION LOCATION PLAN

Fairfield's Pusch Ridge, Lots 1-37
East of Buckridge Place & Pusch Wilderness Dr.
Oro Valley, Arizona

Project No. 04-020 FJJ 04February04