A.I.C.
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Geotechnical Report

prepared by: Chris Steven Russell, PG, PE

Filing 3, The Legends
28 ½ Road at Patterson
Grand Junction, Colorado

May 31, 2002

Summary

This office has conducted a geotechnical investigation for sixteen lots in Filing 3 of The Legends Subdivision upon the request of Abell Partners, LLC. Six boreholes were drilled to approximately 20 feet below grade and an additional 13 geotrenches were excavated to approximately 10 feet below ground level and in general the following soil profile was encountered:

0' - 5'	Topsoil and Fill - Silty Clay and Clayey Silt with Shale Fragments
5' - 15'	Small grading to Large Shale Fragments in Silty Clay and Clayey Silt
15' - 20'	Bedrock Mancos Shale Formation - Claystone and Siltstone

The surface soils on this site are generally classified as ASTM "CL" type. These soils are moderately expansive when wet. The bedrock Mancos Shale Formation under these surface soils also shows to be both expansive and collapsible under load when wetted. This and other studies[1] did not discern a pattern that would predict soil properties in a general area. The deeper soils' static swell pressures typically reach a maximum of approximately 1600 psf under a 500 psf dead load. The percentage of volume change under this swell pressure measured approximately 1%. The deeper soil samples that collapsed when wetted usually experienced a very small volume change under the noted dead load. The shallower samples experienced more movement when wetted under the 500 psf deadload.

It is recommended that proposed single family homes utilize drilled pier foundations due to uplift forces that may be found in the underlying expansive soils. This type of foundation is further recommended due to the low bearing capacity of the surface soils when wetted. Although the surface soil has the capacity to swell when wetted, it is most likely this wetted soil will settle under loaded conditions. Data showing this behavior is noted herein. The drilled pier foundation should bear onto the shale bedrock. This formation has shown to be relatively unaffected by weathering mechanisms and can provide a solid bearing surface.

[1] See GEG Report 502 Filing 1, 8/1/2000, AIC Report Filing 2, 2/08/02

It must be noted that conventional design in the Grand Valley does not generally consider extreme soil conditions. Under these conditions the foundation may move and cause damage to the structure. Therefore it is a primary consideration of the owner to assure that the subsurface conditions around the structure are kept stable and are not excessively moist. Guidelines for maintaining stable conditions are found in A Guide to Swelling Soils for Colorado Home buyers and Homeowners, Special Publication 43, Colorado Geological Society, The Day the House Fell: Homeowner Soil Problems from Landslides to Expansive Clays and Wet Basements, Richard L. Handy, ASCE Stock # 40104, and this report. Upon first evidence of cracks in drywall, concrete, or other like items, the owner should seek a professional engineer to evaluate the problem and prescribe mitigative efforts. It is our experience that most problems may be mitigated with a small effort when they are found in the initial stages.

It is also strongly recommended that builders be familiar with building in expansive soils. There are many simple considerations that can provide longevity to both the structure and the concrete flatwork surrounding the structure. A copy of Special Publication 43 A Guide to Swelling Soils for Colorado Home buyers and Homeowners, Colorado Geological Society, is included with this report. The builder should understand this publication and implement the recommendations therein as are economically feasible.

Purpose

The purpose of this report is to inform the owner, builder, and engineer of potential geotechnical hazards and typical soil design properties at the referenced site. This report is submitted solely for this purpose.

Geology, Topography, and Drainage

This site is located on Quaternary alluvium eroded from the Bookcliffs Monocline. The alluvium is principally composed of sediment from the Mesa Verde Formation and Mancos Shale Formation. The underlying bedrock is the Cretaceous Mancos Shale Formation. The local topography has rolling hills intermixed with relatively flat land. All area drainage runs to the south, towards the Colorado River.

Discussion of Soil Properties

A. General Site Characteristics

1. Soil Classifications: The surface design type soil is classified as an ASTM "CL". The properties for this soil[2] are as follows:

   LL = 30 - 40
   PL = 10 - 20
   PI = 10 - 20
   Passing 200 sieve: greater than 90% excluding shale fragments

[2] See Appendix for test results.

Soil Classifications: The deep design type soil is the Mancos Shale Fm.

2. Geologic Hazards: Expansive Soils

3. Potential Unstable Slopes: None were noted.

4. Swell Potential: The site's design soil types have a moderate swell characteristic. A swell-consolidation test for the deep type soil shows that the clay has a swell potential of 1600 psf at a confining dead load of 500 psf when wetted.

5. Consolidation Potential: The site's soil type has a moderate consolidation characteristic. Less than 1 % consolidation at a 500 psf load is typically experienced on the swell-consolidation test for the deep type soil when saturated.

6. Water Table: Free water was encountered in the southwest portion of the development (Geotrench #3, in Filing #1) at 12 feet below ground level or at nearly 4676' SL. A report by Geotechnical Engineering Consultants, Inc. shows free water at 4660' SL at a location south of Geotrench #3 of Filing 2. Therefore, a hydraulic gradient likely exists whereby water flows from north to south in this area. Our studies have found that the existence of free water is sporadic. This fact is likely attributed to the extensive vertical and horizontal fracture system found in the areal Mancos Shale.

7. Corrosivity : All concrete and buried material should be designed to resist corrosion due to local alkaline soil. Extra precautions, such as asphaltic painting of concrete, may be necessary to resist corrosion.

8. Rock Outcrops: None were noted.

9. Gamma Radiation: Gamma radiation was not measured.

B. Grading and Excavation Considerations

1. Potential Construction Difficulties: The geotrenches were excavated without problem to a depth of 10 -12 feet, therefore wall stability and excavation do not appear problematic. Our experience with pier construction indicates that drilling should also progress without incident within the first 10' of drilling into Mancos Shale Formation bedrock.

2. Suitability of Native Material for Trench Backfill and Structural Fill: The native material is not suitable for bedding but may be used for backfill given approval from the utility provider. The native material is not suitable for structural fill. All disturbed native earth is considered fill material and shall be treated as such. This type fill shall not contain shale pieces larger than 3" to prevent unusual settlement due to weathering processes.

3. Compaction of Subgrades and Fills: All native soil and fill material is to be compacted to 95% of ASTM D 698 maximum dry density. All compaction shall be tested. A record of the compaction densities shall be retained by the builder.

C. Retained Earth Information

1. Lateral Earth Pressures: Lateral earth pressures are dependent on the type of soil, moisture content of soil, the surcharge applied to the soil, and the design. A safety factor of 2.5 is usually recommended in structural design of retaining features.

   The native design soil has poor drainage characteristics. A minimum design active pressure of 70 psf may be used in retaining wall design. This pressure considers free draining conditions with no swell pressure. This active pressure should be increased by 33% for relatively rigid walls. A design passive pressure of 140 psf may be used in retaining wall design. The passive pressure should be disregarded if the front fill is less than 1/3 the height of the wall.

2. Coefficient of Friction to Lateral Movement: The coefficient of friction for the type soil is typically in the range of 0.2 - 0.6 depending on moisture content.

3. Backfill Compaction: Backfill compaction should be a minimum of 90% of ASTM D 698.

D. Foundations

1. Allowable Bearing Pressures: We recommend that structures be founded by means of concrete piers onto the Mancos Shale Formation. Standard penetration tests support using an end bearing pressure of 20 ksf at a depth of 5 feet into the bedrock formation for concrete piers. A frictional pressure of 1.5 ksf may be used for the concrete piers in the downward and upward direction. A maximum length of 5' may be utilized for frictional pressure. Each pier should be deadloaded at 5000 psf to resist swell. If required by design, the friction pressure may be used to provide a portion of the deadload resistance to swell. A design allowable surface bearing pressure of 1000 psf may be used in the decomposed shale ("CL" type soil) under moist conditions and should be reduced to 500 psf under wet conditions. The minimum design surface deadload is 1000 psf.

2. Soil Weights: The "CL" type soil density varies from 95 pcf - 120 pcf at 24% - 12% moisture contents. The native bulk densities typically measure 115 pcf at 1' below ground level.

3. Types of Foundations: We recommend that homes be founded on grade beam over piers. The grade beam should be designed as a simply supported beam spanning adjacent piers given the appropriate factored loads. The same top and bottom reinforcement is recommended. The grade beam should rest directly over the pier and be attached to same by means of a corrosion resistant steel rod that spans both the grade beam and the pier. This rod will allow the grade beam to move upward (or the pier downward). With this system the home may be easily leveled and repaired in the case of extreme movement. Void material should also be placed under the grade beams to mitigate any movement in the surface soil.

   Each pier hole should be drilled to at least 15' below ground level with at least 5' of penetration into the Mancos Shale. AIC shall set the depth of the holes in the field. Each pier should be drilled with a 10" O.D. or larger bit/auger. Pier holes should not be drilled closer than 7' O.C. unless the design necessitates. If the spacing is less than 7' o.c., the pier carrying capacity should be reduced in half. At the completion of each hole, the bottom should be cleaned clear of all cavings and cuttings. The holes should then be covered to prevent debris from falling into the hole.

   It is recommended that the holes are cemented via a grout pump. The grout should be placed at the bottom of the hole with sufficient velocity to create wall scour and remove all cavings and cuttings from the hole. A boom truck is probably most suitable for this operation. This method lessens the amount of cavings in the concrete and tends to fill the voided areas more effectively. In addition to filling from the bottom - the concrete may be worked/vibrated to further eliminate voided areas. A low shrink corrosion resistant concrete is recommended to prevent gaps between the pier and the hole. This allows for maximum attainable pier friction. The tops of piers shall not be mushroomed. Mushrooming may be eliminated by installation of short Sana tubes set to grade. Our office shall be contacted to monitor cementing and give clearance for this operation.

   To date, the drilled pier foundations in this subdivision have proven to be effective. Other foundations, that consider expansive shale, may also be used. These types of foundations include: stem wall and spread footing over structural fill, post tension slab on grade, and structurally reinforced slab on grade over structural fill. This office can make recommendations for these other types of foundations.

4. Perimeter Drains and Groundwater: All runoff water should be diverted from the building site. Gutters should be used around the perimeter of the roof. The use of v-pans and/or french drains is strongly recommended at each gutter termination. V-pans and like items should transport water away from the building for a minimum of 10' prior to release into soil. The best practice is to drop roof runoff directly to the concrete sidewalk, which in turn drops water to the street gutter or like conveyance. Follow Colorado Geological Survey Special Publication 43 for recommendations concerning drains and

groundwater.

E. Retaining and Basement Walls

1. Retaining and basement walls should be designed utilizing the lateral earth pressures noted above. These features should be designed to provide free drainage. No or minimal accumulation of water should be allowed behind these walls. Drain pipes should be placed behind the bottom of the footings and daylighted. A minimum of 2' of free draining material such as clean sand or gravel shall be placed behind each wall and over the drain pipe. No rock larger than 6" should be used in backfilling against retaining structures. Any previously designed walls in this subdivision should be modified to be free draining. Accumulation of water behind these walls could cause nearby piers to fail should water migrate to the vicinity of such piers. All excavation and backfilling for retaining and basement walls shall be monitored by a representative of AIC.

F. Drainage and Irrigation

1. Permeability: The surface soil permeability is nearly 5 x 10^{-8} cm/sec. The fractured shale has shown to freely conduct water. All effort should be made to keep surface water from entering the Mancos Shale Formation.

2. Hydrologic Soil Group: The site soil is a "C" type soil, which has poor infiltration rates when thoroughly wet.

3. Irrigation Practices: Do not plant closer than 5' from the edge of the foundation unless the plants have very low water requirements. Irrigation should be limited to the amount necessary to keep plants healthy. Follow Colorado Geological Survey Special Publication 43 for recommendations concerning planting and irrigation.

4. Grades Around Buildings: It is recommended that the grades around buildings are 10% for 10' extending from the perimeter of the building. At a bare minimum there should be 10% for 5' extending from the perimeter of the building. All drainage should be let to the street gutter in the quickest means possible. Drainage shall not be allowed to pond. All ponding shall be eliminated. All water should be allowed to flow freely away from the building without impediment. Follow Colorado Geological Survey Special Publication 43 for other recommendations concerning grades.

G. Concrete.

1. Concrete: All concrete shall be sulfate resistant. The mixing, transport and placement shall be consistent with current ACI recommended procedures. The structural engineer shall call out all required concrete yield strengths and associated reinforcing.

2. Concrete Flatwork: Concrete flatwork such as porch, driveway, and garage slabs are not considered structural items. They should be constructed in a manner that meets all recommended building codes while providing economical reliable performance for the homeowner. The use of compacted structural fill under slabs to prevent settlement and heaving is strongly recommended. The liberal use of rebar to prevent horizontal and vertical separation is also recommended. It is recommended that interior garage slabs lay over at least two feet of compacted structural fill.

H. Borings

1. Six boreholes and thirteen geotechnical test trenches were excavated on Filing #3.

Limitations

The content of this report is based on subsurface and surface observations made at the time of the site investigation. The content of this report is also based on laboratory testing and professional literature. Subsurface observations and lab test results are point-site specific. Subsurface conditions often change in a site both horizontally and vertically. Therefore, depending on the amount of testing and boring performed, the resulting data and interpretation thereof may or may not represent the overall site conditions. No warranty or representation either expressed or implied is included or intended in this report.

Due to changes in local practices and other occurrences, this report is valid for 2 years from the date of the report.

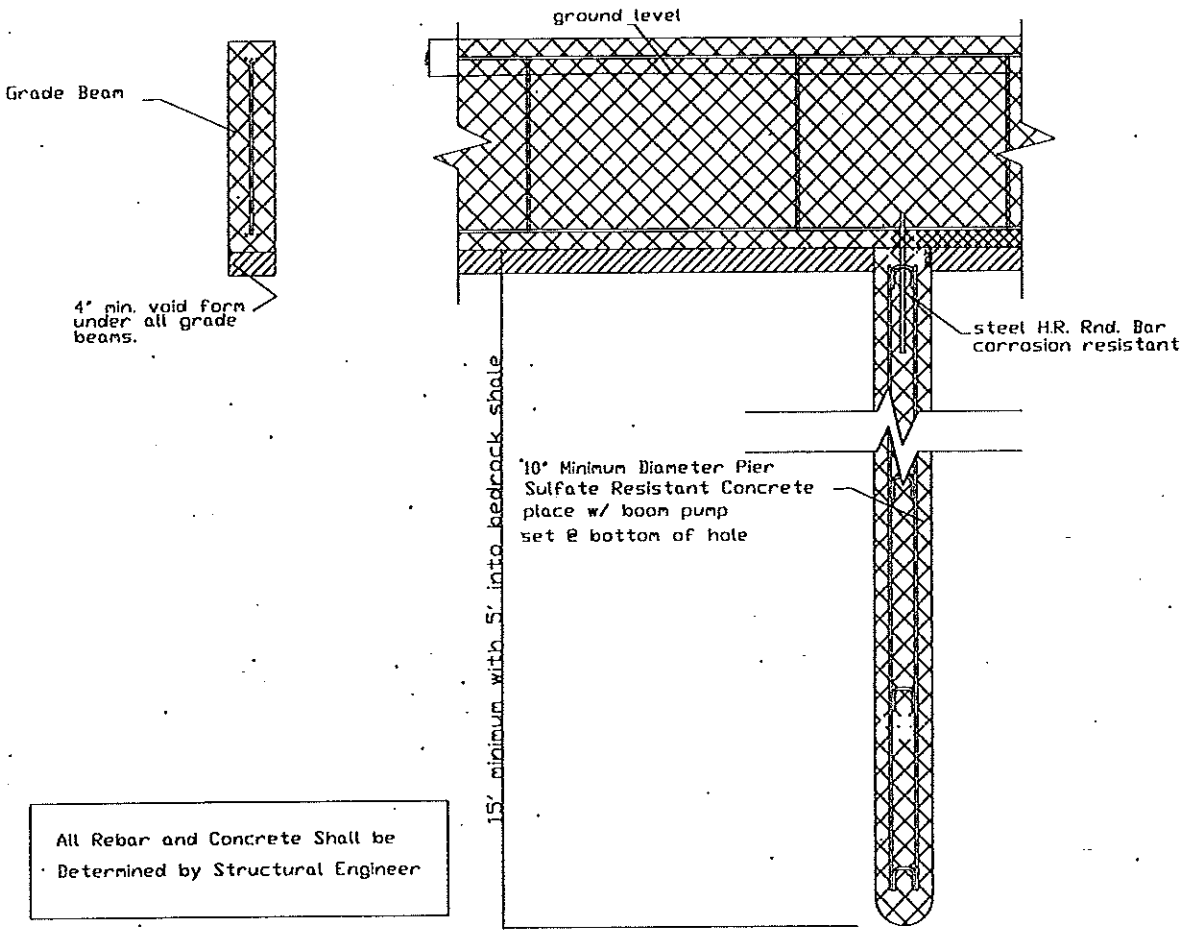
This site has expansive soils. The owner of properties showing expansive soils should read Special Publication 43, "A Guide to Swelling Soils for Colorado Home buyers and Homeowners. You may order this publication by calling the Colorado Geological Survey at 303 - 866 -2611.

Report prepared by,

Chris Steven Russell
Colorado Professional Geologist and Engineer
A.I.C. - Grand Junction, Inc.

APPENDIX

Typical Pier Detail



Typical Grade Beam & Pier Section

Scale: N.T.S.

SHEET A-1 PAGE 1 of 1

Geotechnical Report
The Legends Subdivision
Filing 3

A.I.C.- GRAND JCT., INC.
ALLIED INDEPENDENT CONSULTANTS
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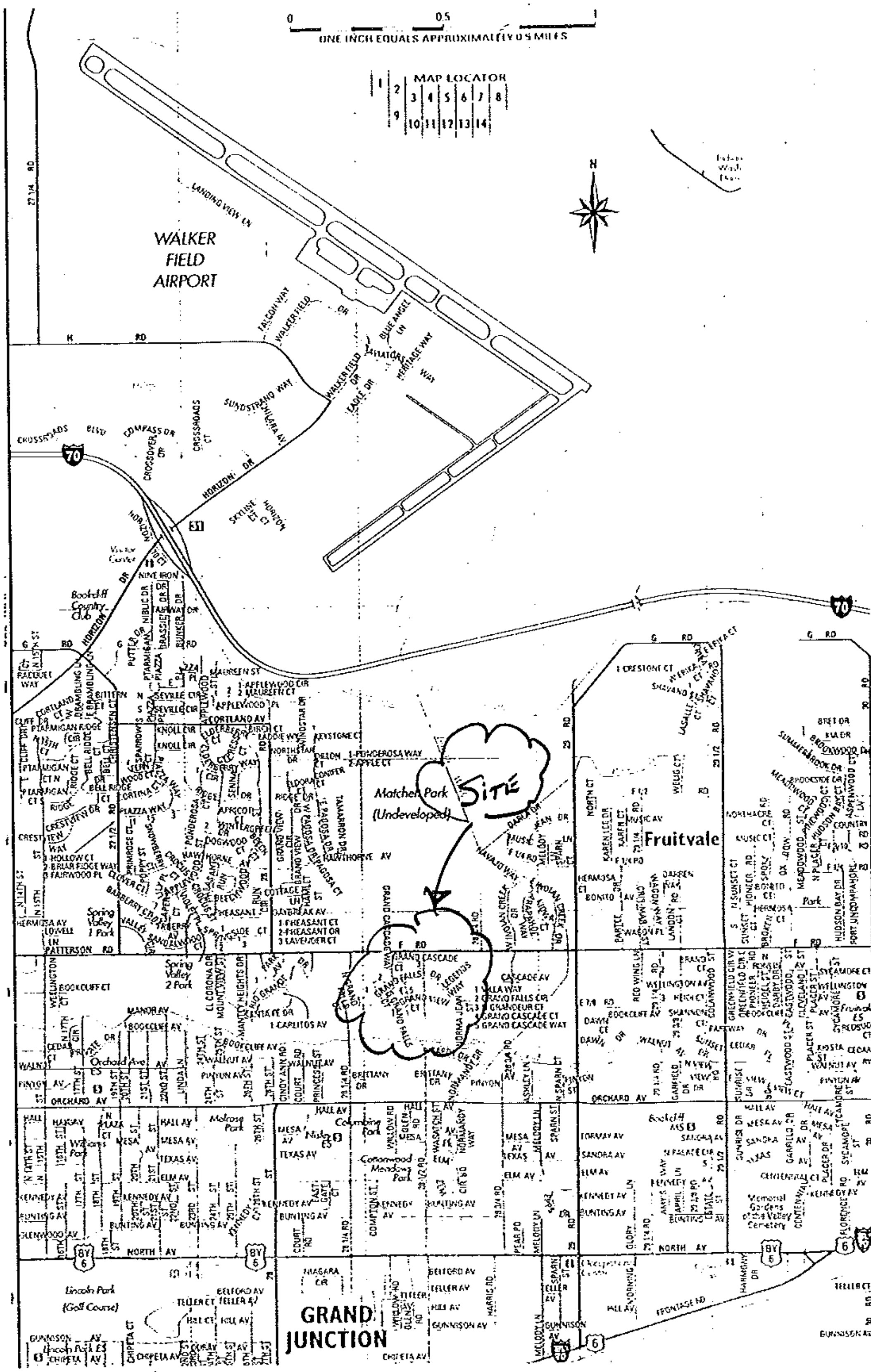
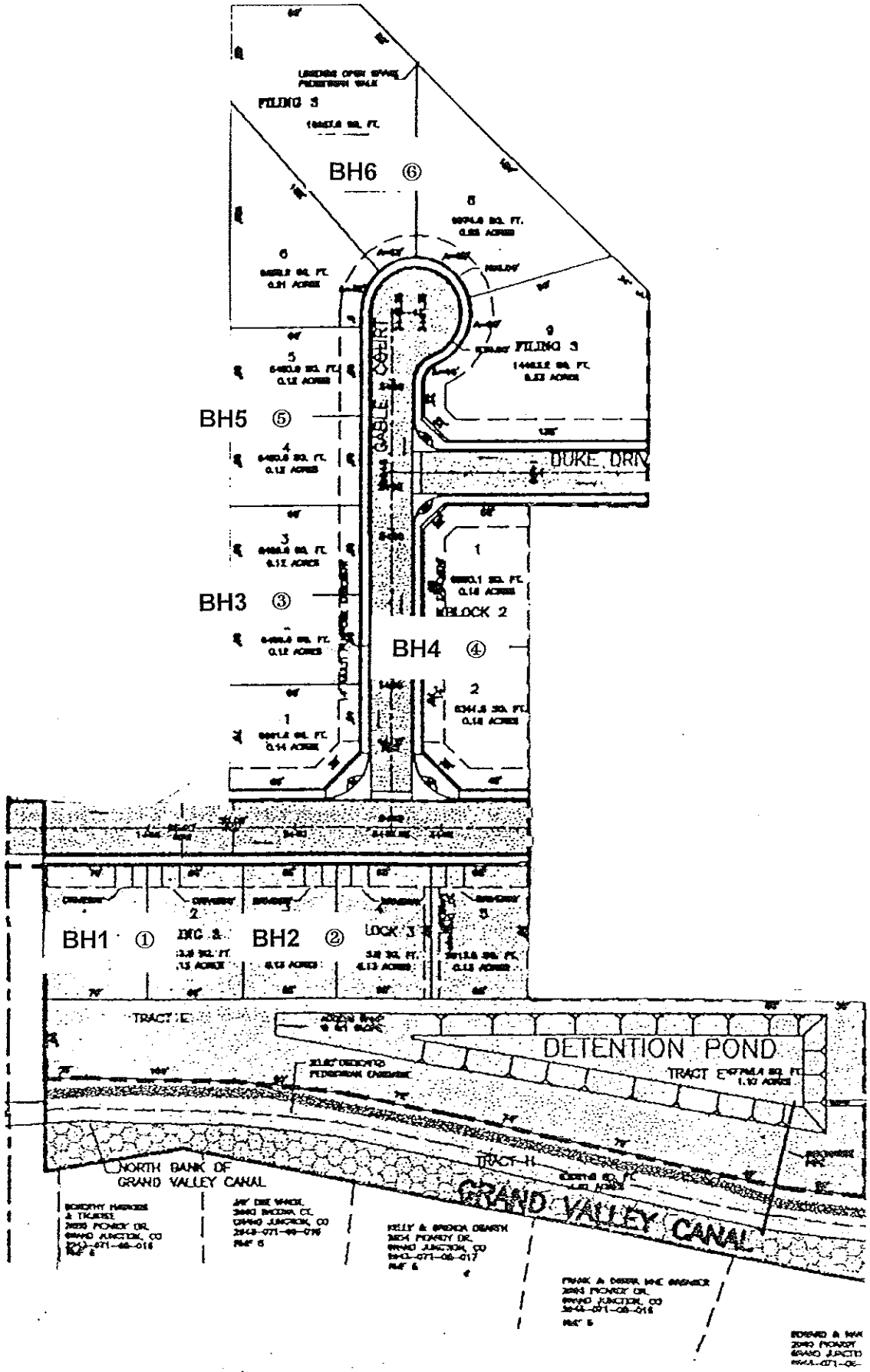
PHONE (970) 244-8703 FAX (970) 243-2681



Vicinity Map
The Legends Subdivision - Filing 3

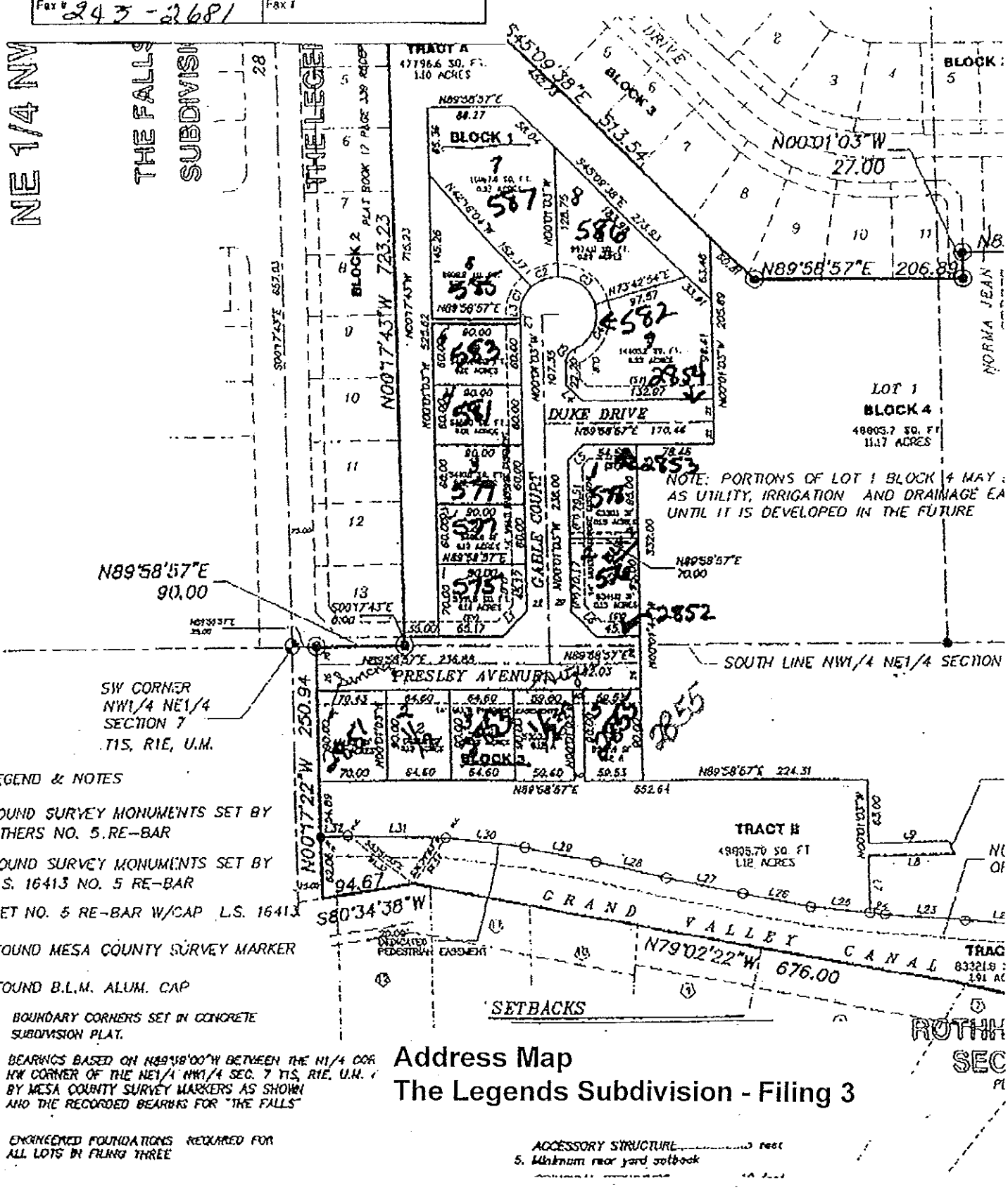


Site Map

The Legends Subdivision - Filing 3

The Legends
Filing III

Post-it® Fax Note 7671	Date 7/9	# of pages ▶
To Chris	From Landry	
Co./Dept.	Co.	
Phone #	Phone #	
Fax # 243-2681	Fax #	



LEGEND & NOTES

FOUND SURVEY MONUMENTS SET BY OTHERS NO. 5 RE-BAR

FOUND SURVEY MONUMENTS SET BY L.S. 16413 NO. 5 RE-BAR

SET NO. 5 RE-BAR W/CAP L.S. 16413

FOUND MESA COUNTY SURVEY MARKER

FOUND B.L.M. ALUM. CAP

BOUNDARY CORNERS SET IN CONCRETE SUBDIVISION PLAT.

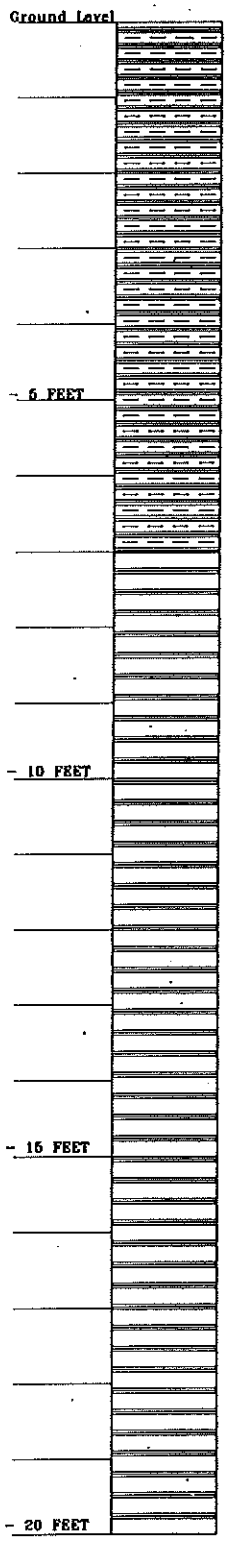
BEARINGS BASED ON N89°58'00"W BETWEEN THE N1/4 COR. NW CORNER OF THE NE1/4 NW1/4 SEC. 7 T1S, R1E, U.M. BY MESA COUNTY SURVEY MARKERS AS SHOWN AND THE RECORDED BEARING FOR "THE FALLS"

ENGINEERED FOUNDATIONS REQUIRED FOR ALL LOTS IN FILING THREE

ACCESSORY STRUCTURE.....3 feet
5. Minimum rear yard setback

Address Map
The Legends Subdivision - Filing 3

TYPICAL SOIL LOG – FILING 3



SOIL PROFILE

LEGEND

Decomposed Mancos Shale Fm
Section of soil at surface, typically under a thin layer of topsoil where the Mancos Shale Fm has decomposed due to weathering. The resultant soil is most often a silty clay.

Mancos Shale Fm
Interbedded layers of siltstn and clystn. Clystn: Gry – Gry Grn and Gry Blk. , lam – moss. Siltstn – Brn – lt brn. Shell fossils noted in Gry Blk shale series. Sections have vertical and horizontal fractures allowing water migration. Fractures often filled with precipitants that are white(gypsum/calcite?), yellow, and brn.

SHEET A – 1 PAGE 1 of 1

DRAWN C. RUSSELL

DATE 5-31-03

AS CONSTRUCTED (AC)

Geotechnical Exploration Trench
For Abell Partners LLC
Filing 3 of the Legends Subdivision

A.I.C.- GRAND JCT., INC.
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Legends
Filing # 3

Bore Hole # 2
Block 3 Lots 3 –4
2853 – 2853 ½ Presley Avenue

0′ Fill – light, dry, soft
3′ Native decomposed shale, darker moist, gray brown
7′ Harder native shale, dry brown, chucky moist
10′ Hard shale, gray moist
15′ SPT 8 / 16 / 28
20′ SPT 23 / 50^{R} /

Bore Hole # 1
Block 3 Lots 1 – 2
2851 – 2851 ½ Presley Avenue

0′ Fill, shaley tan, light
5′ Native decomposed shale
8′ Harder shale, fractured
12′ Hard shale – moist
15′ SPT 28 / $R^{4"}$ /
20′ Dark shale SPT $R^{5"}$ / - / -

Bore Hole # 3
Block 1 Lots 2 – 3
577 – 579 Gable Court

0′ Decomposed reworked shale
6′ Darker unworked decomposed shale
10′ Dark, moister hard shale
18′ Flakier hard shale
20′ SPT 28 / $R^{5"}$ / -

Bore Hole # 4
Block 2 Lots 1 – 2
578 – 576 Gable Court

0′ Fill, shaley dirt, gray – tan
8′ Native decomposed shale
10′ Hard, dark shale
15′ SPT 48 / $R^{2"}$ / -
20′ SPT R^{4} / - / -

Legends
Filing # 3

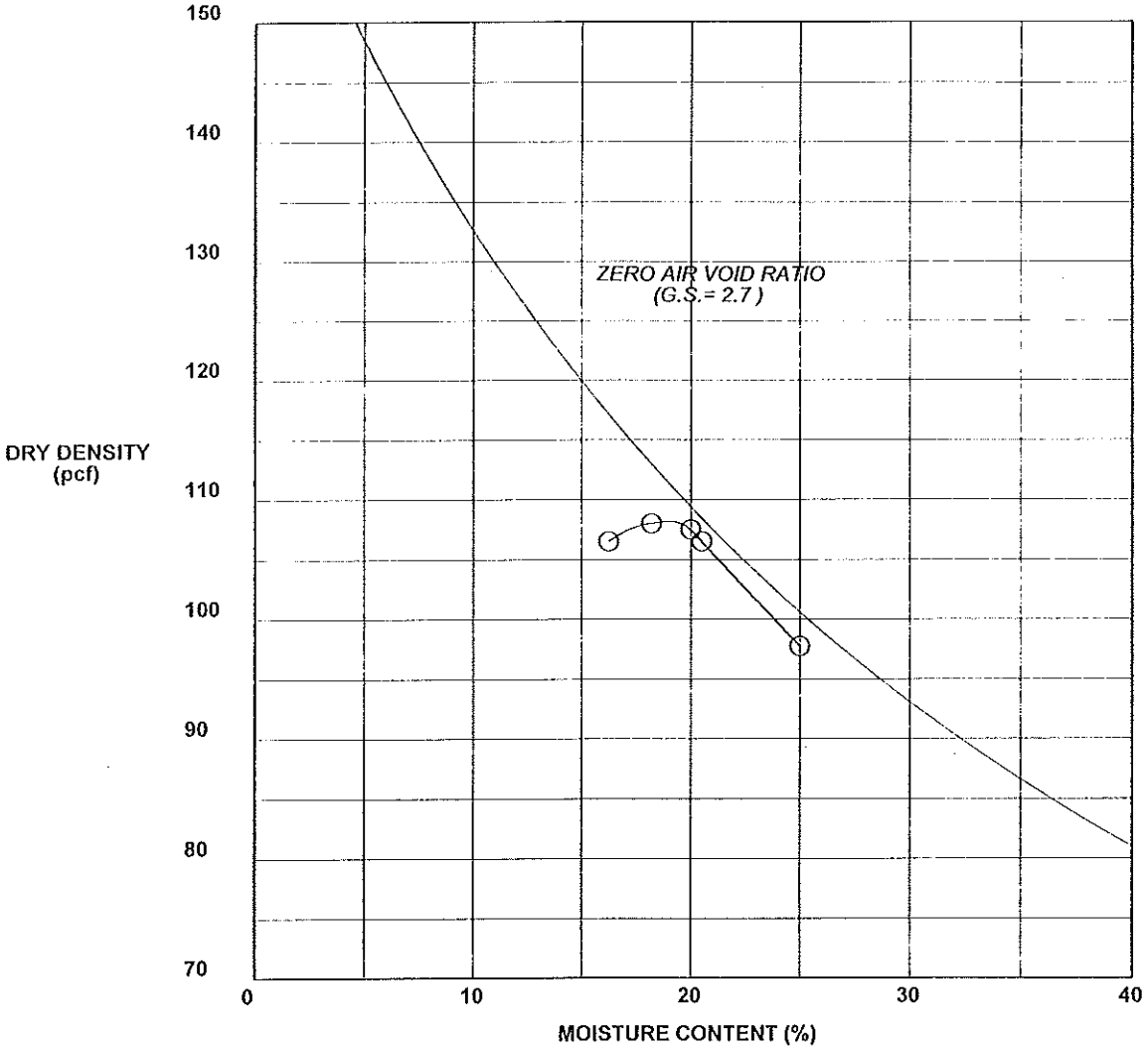
Bore Hole # 5
Block 1 **Lots 4 – 5**
583 – 581 Gable Court

0′ Dark brown, decompose
10′ Darker flakier native decomposed shale
13′ Hard shale brown – flaky
15′ SPT 18 / 21 / 33
20′ SPT $R^{4"}$ / - / -

Bore Hole # 6
Block 1 **Lots 7 – 8**
587 – 586 Gable Court

0′ Moist clayey fill light brown decomposed shale / fill
8′ Yellowish / Dark shale
12′ Hard shale, dark brown
15′ SPT Spoon refusal

COMPACTION TEST



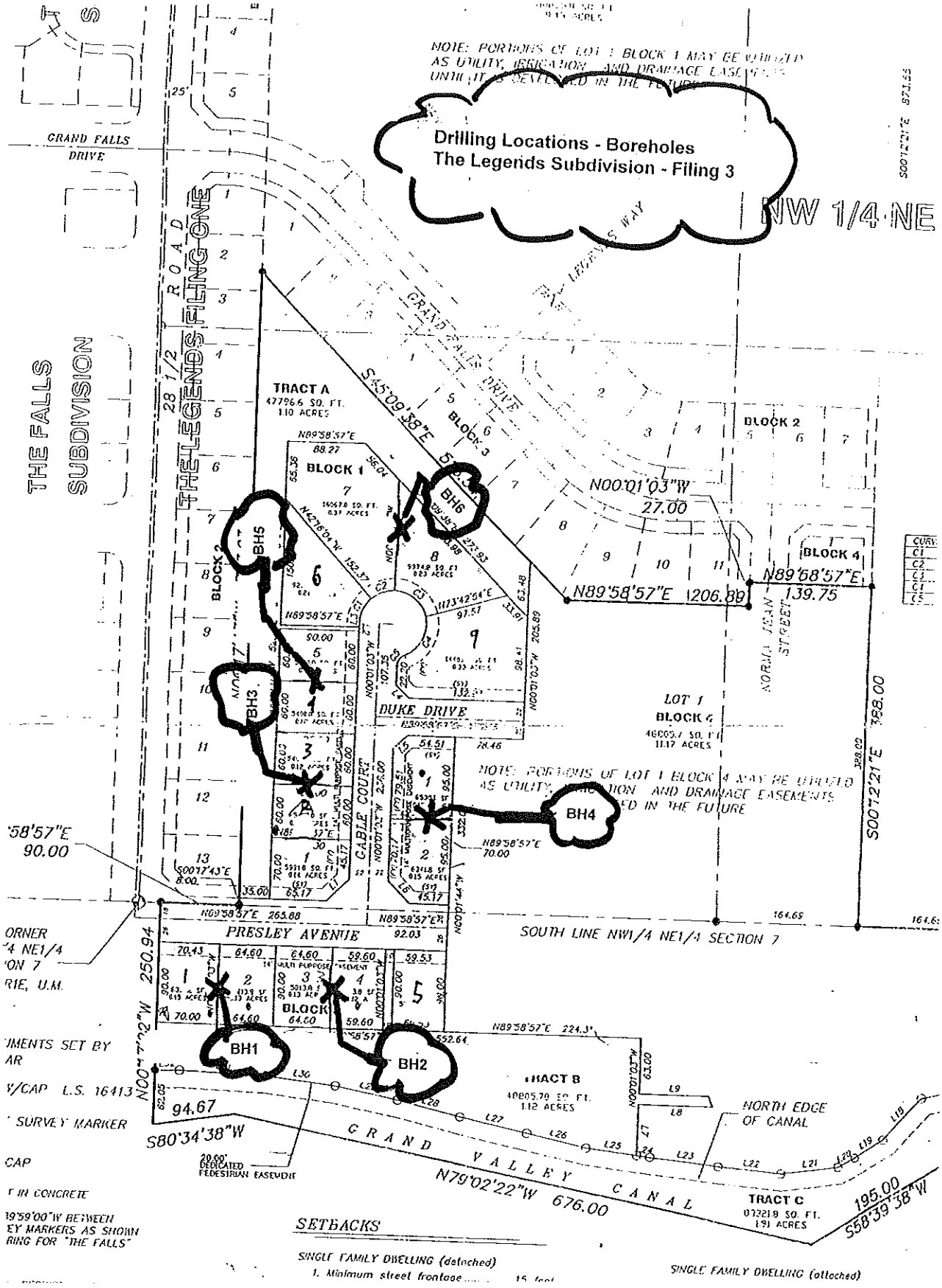
SYMBOL	SAMPLE LOCATION	DEPTH (ft)	DESCRIPTION	TEST METHOD	OPTIMUM MOISTURE(%)	MAX. DRY DENSITY(pcf)
○	Trench 3	3	Decomposed Shale - CL	698 a	18.9	108

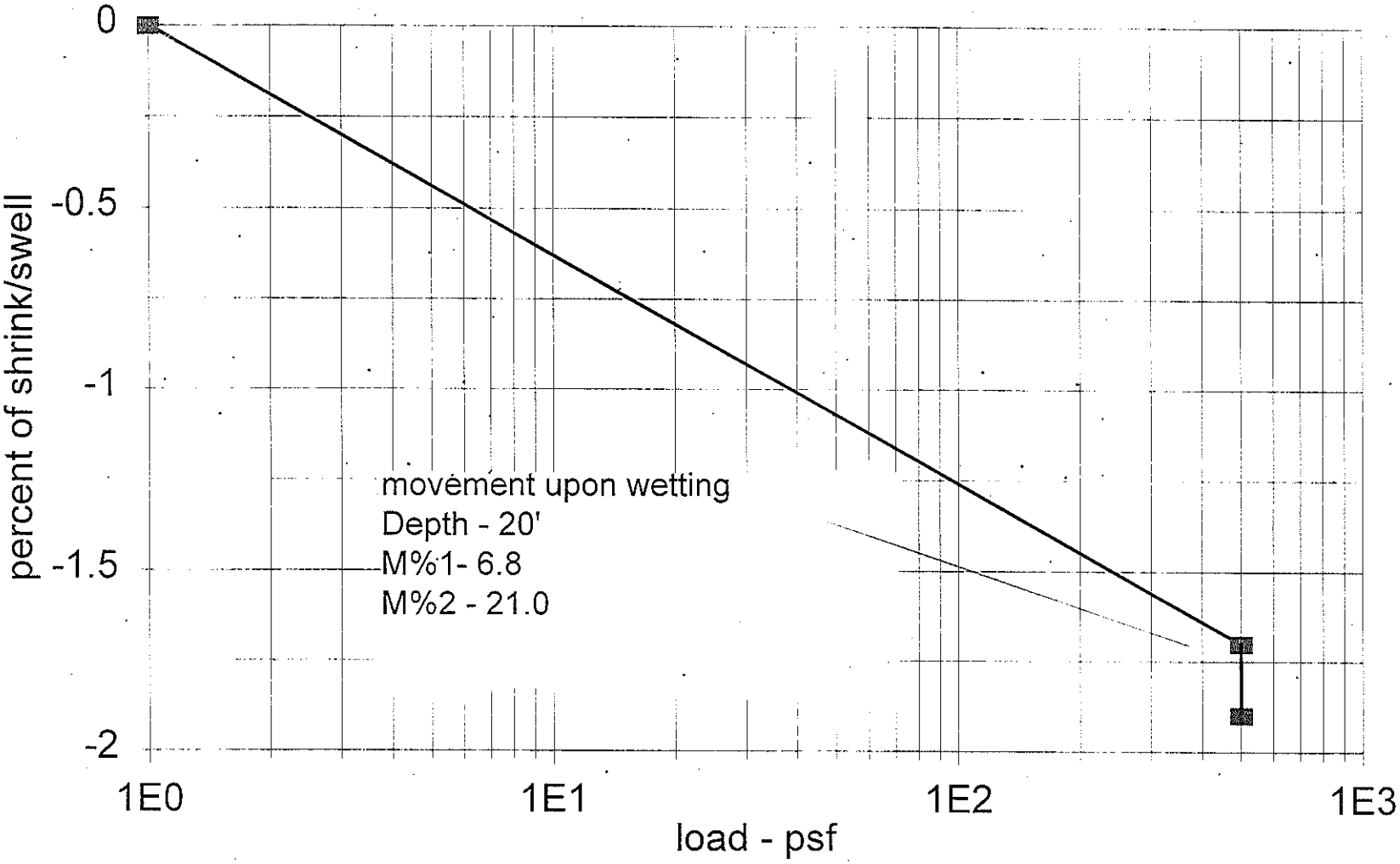
REMARK:

CIVILTECH

Representative Surface Soil Compaction Test
The Legends Subdivision - Filing 3

Legends


Drilling Locations - Boreholes
The Legends Subdivision - Filing 3
NW 1/4 NE
THE FALLS SUBDIVISION
THE LEGENDS FILING ONE
GRAND FALLS DRIVE
28 1/2 ROAD
TRACT A
477996 SQ. FT.
11.0 ACRES
BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4
BLOCK 5
BH1
BH2
BH3
BH4
BH5
BH6
DUKE DRIVE
CABLE COURT
PRESLEY AVENUE
GRAND VALLEY CANAL
NORTH EDGE OF CANAL
NORTH JEAN STREET
LOT 1 BLOCK 4
TRACT B
TRACT C
SETBACKS
SINGLE FAMILY DWELLING (detached)
SINGLE FAMILY DWELLING (attached)
SOUTH LINE NW1/4 NE1/4 SECTION 7
N89°58'57"E 1206.89
N89°58'57"E 139.75
S00°12'21"E 398.00
N00°01'03"W 27.00
S45°09'38"E 57.00
N89°58'57"E 265.88
N89°58'57"E 92.03
N89°58'57"E 224.3'
S80°34'38"W 94.67
N79°02'22"W 676.00
S58°39'38"W 195.00
N89°58'57"E 90.00
S00°17'43"E 8.00
N00°01'03"W 250.94
20.00' DEDICATED PEDESTRIAN EASEMENT
NOTE: PORTIONS OF LOT 1 BLOCK 1 MAY BE UTILIZED AS UTILITY, IRRIGATION AND DRAINAGE EASEMENTS UNTIL IT IS DEVELOPED IN THE FUTURE
NOTE: PORTIONS OF LOT 1 BLOCK 4 MAY BE UTILIZED AS UTILITY, IRRIGATION AND DRAINAGE EASEMENTS UNTIL IT IS DEVELOPED IN THE FUTURE

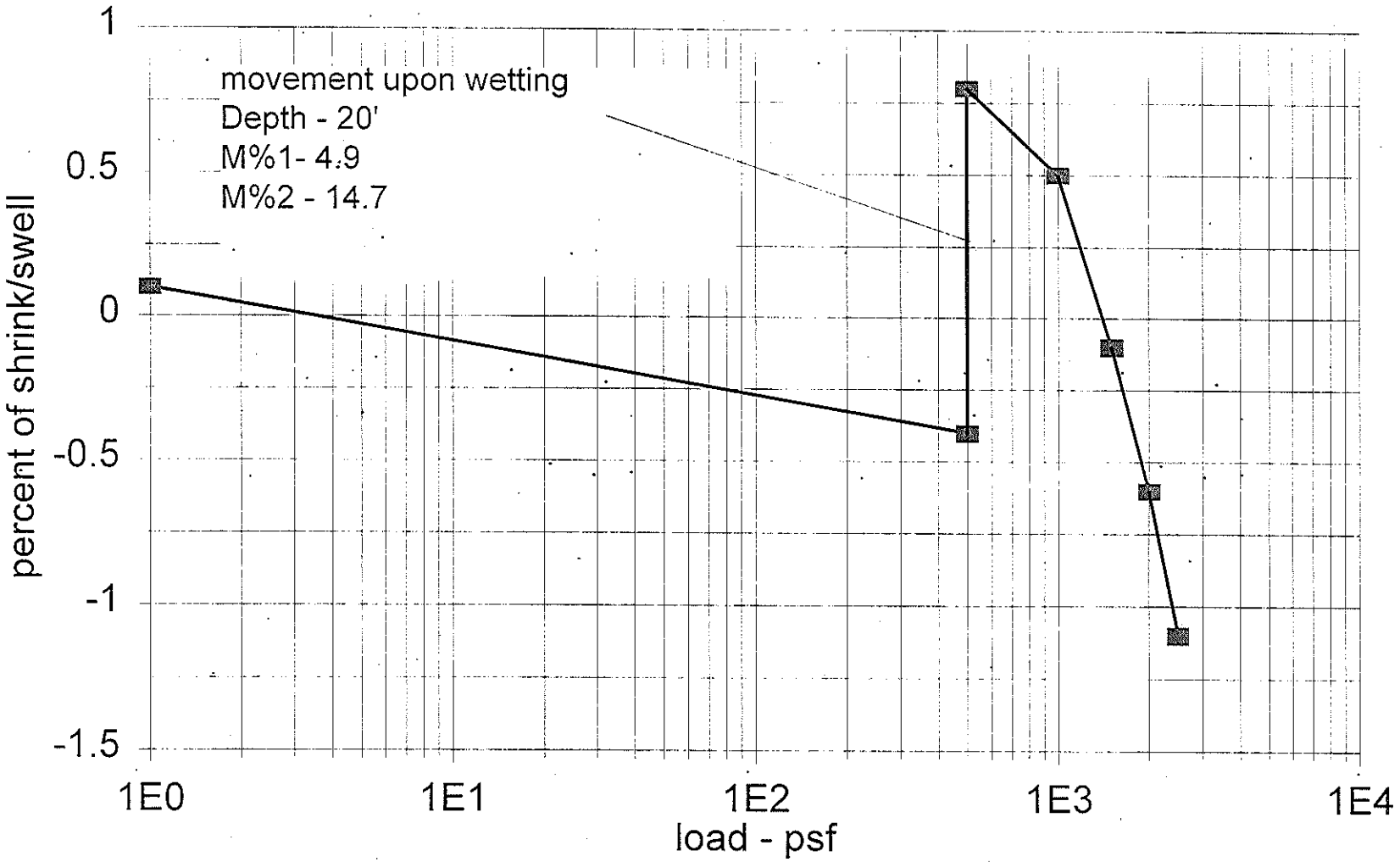


Borehole #1

One Dimensional Swell-Consolidation

AIC
The Legends
Filing 3

dd 101.3

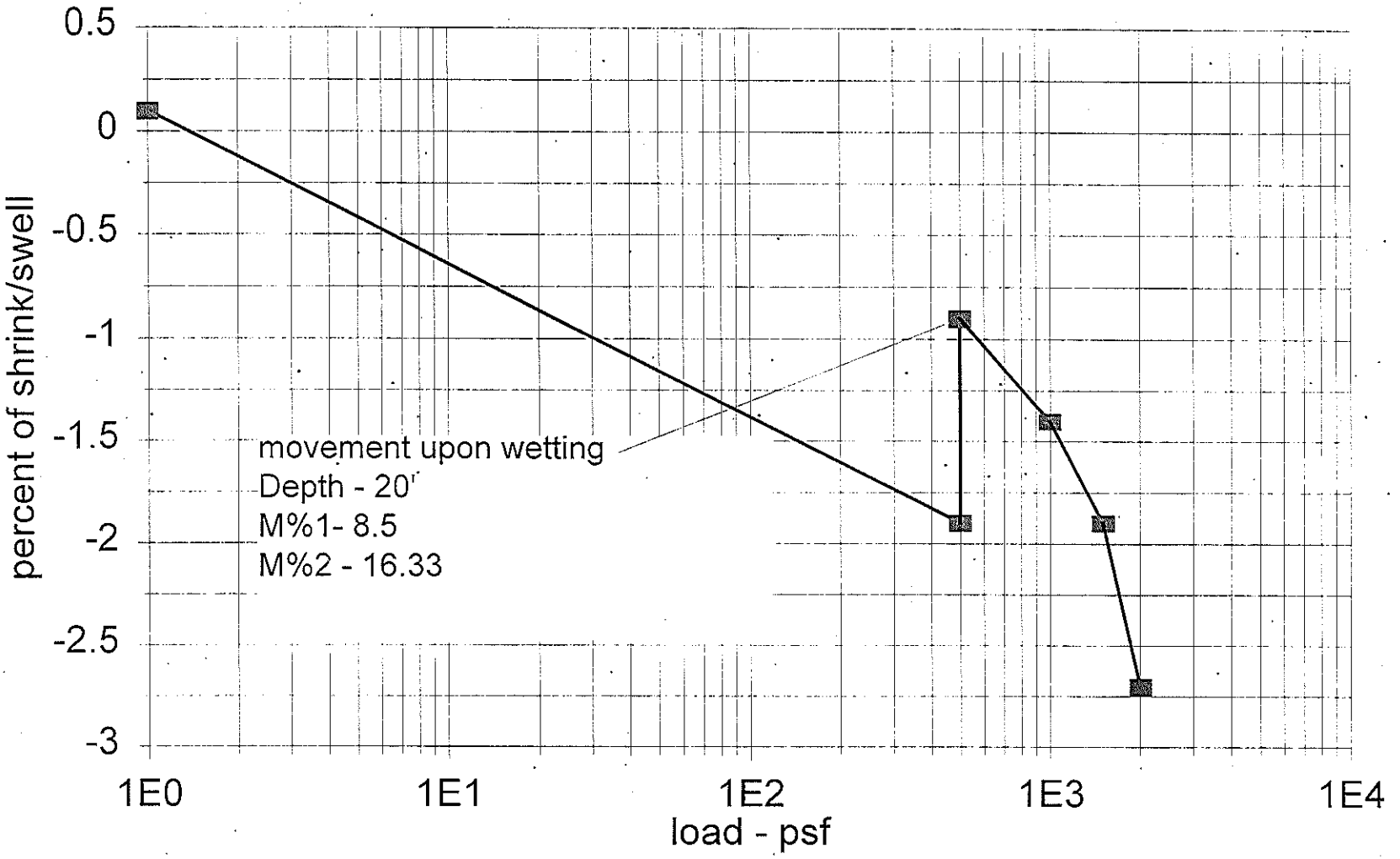


Borehole #2

One Dimensional Swell-Consolidation

AIC
The Legends
Filing 3

dd 108.8

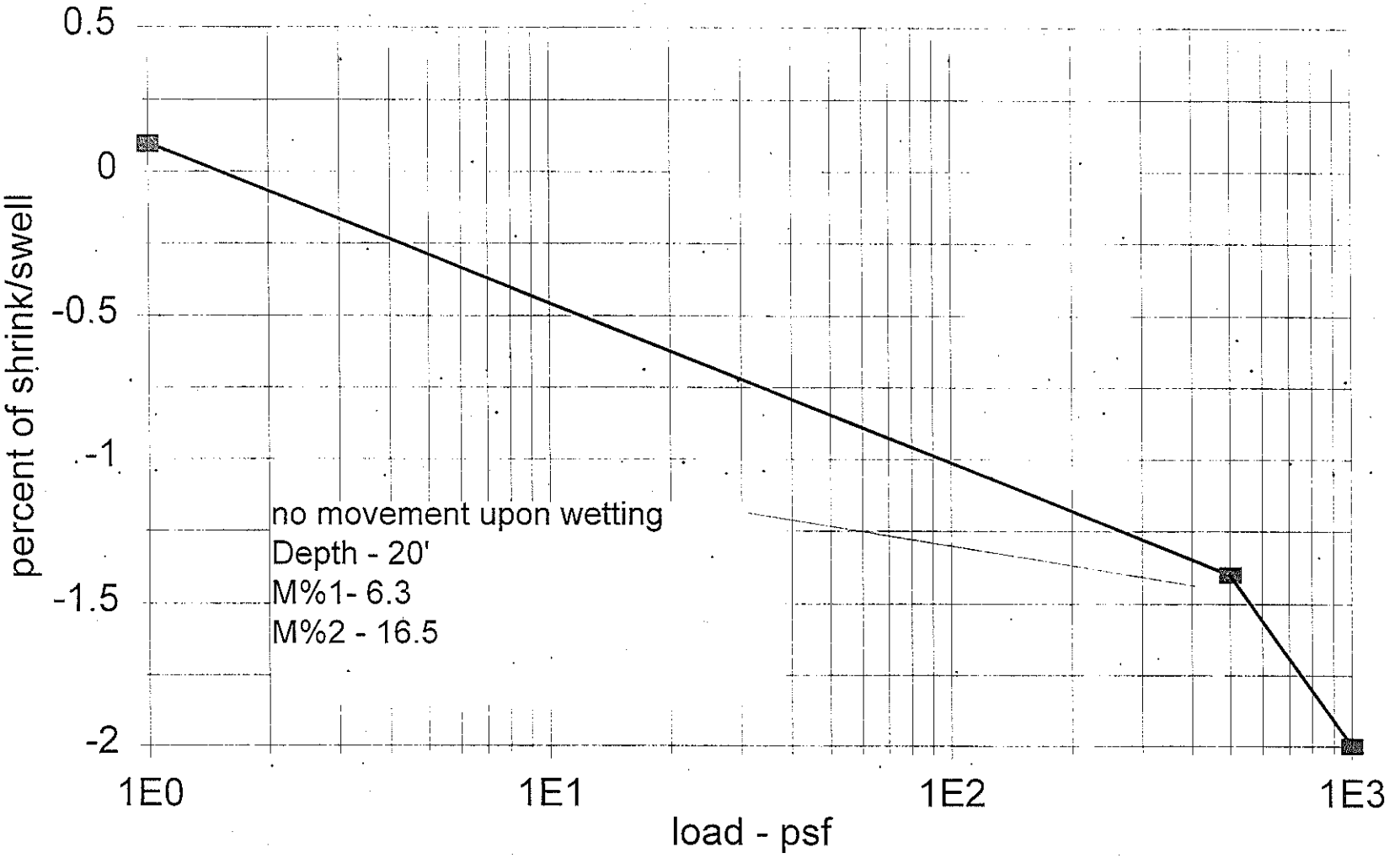


Borehole #3

One Dimensional Swell-Consolidation

AIC
The Legends
Filing 3

dd 1018

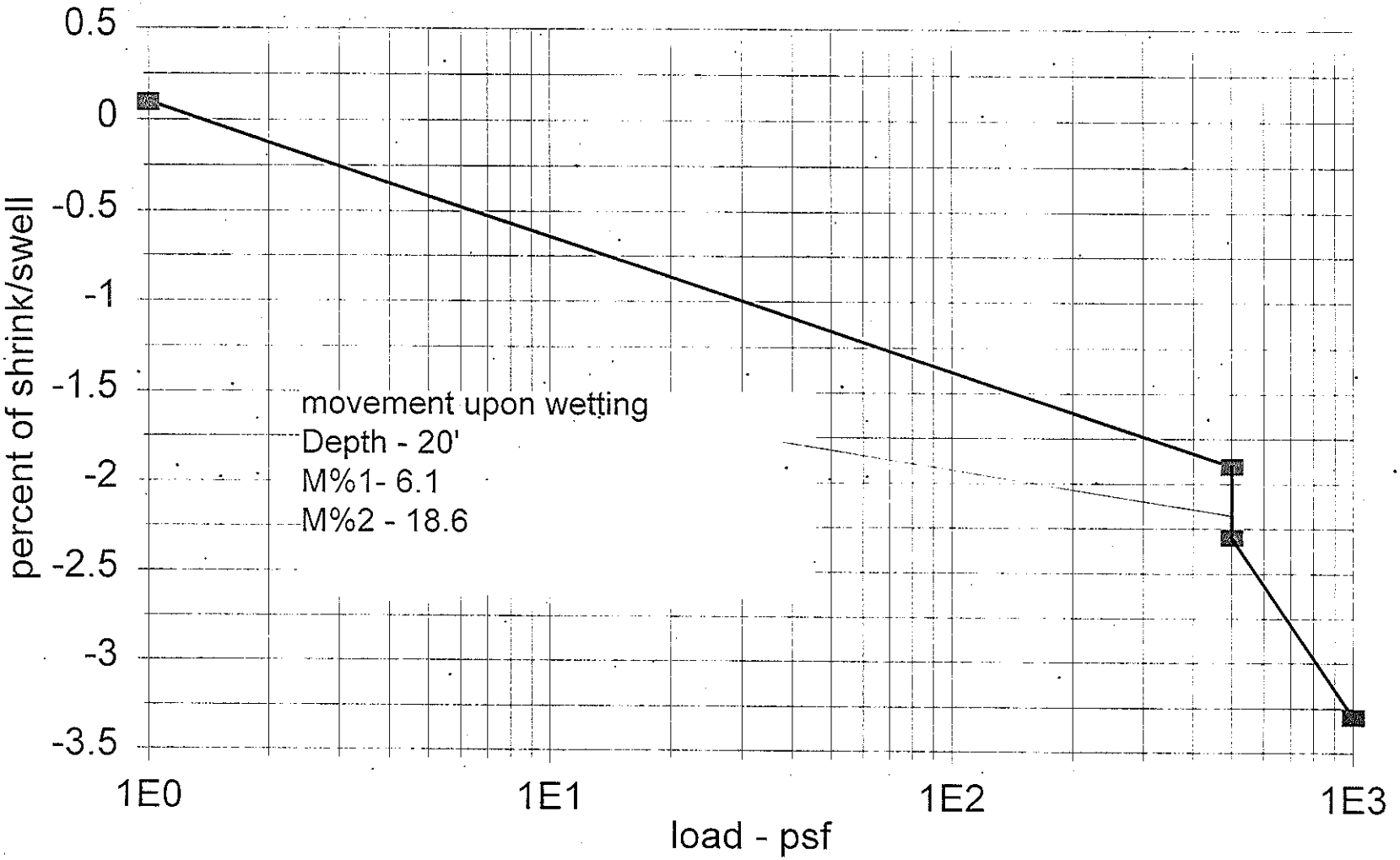


Borehole #4

One Dimensional Swell-Consolidation

AIC
The Legends
Filing 3

dd 98.1

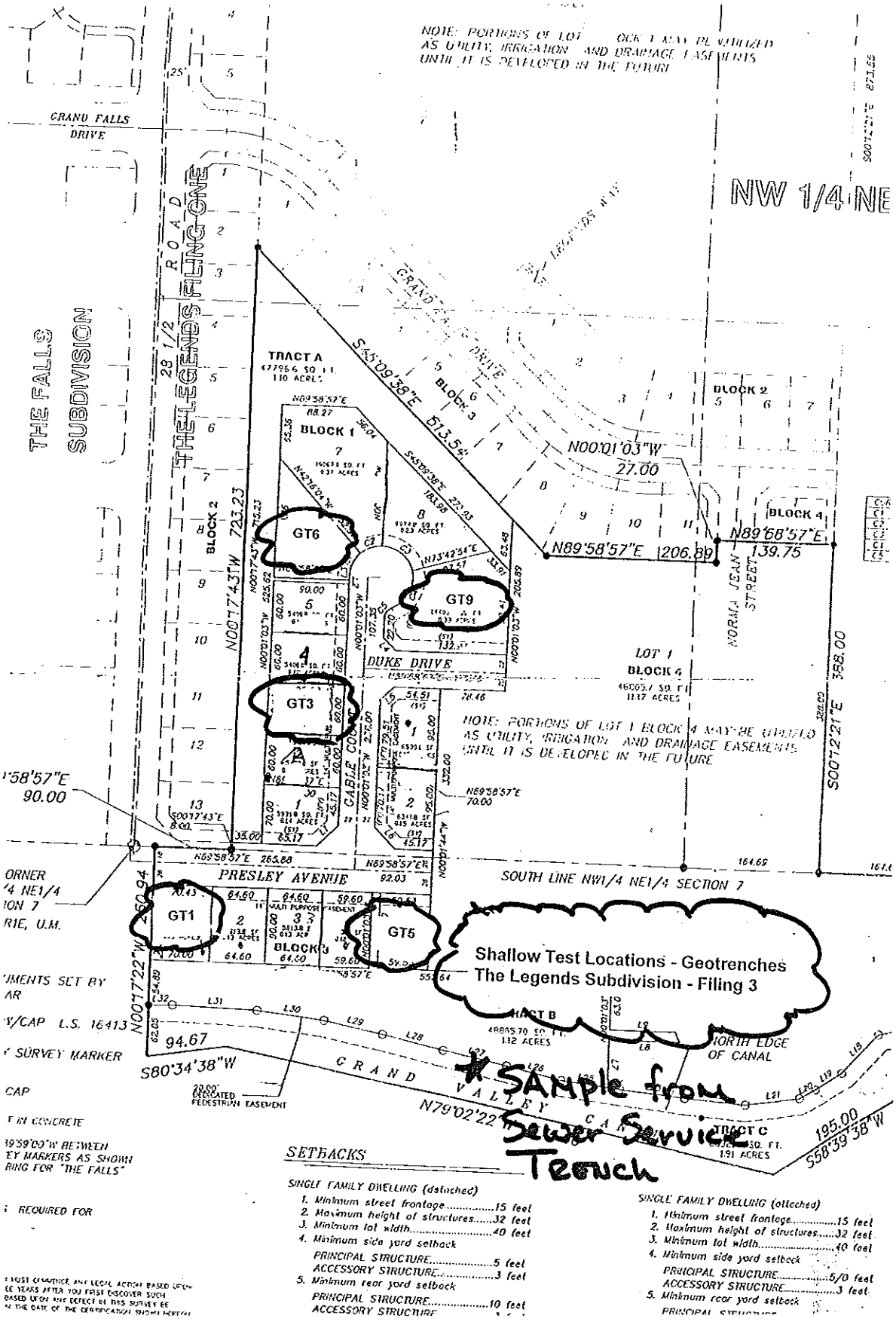


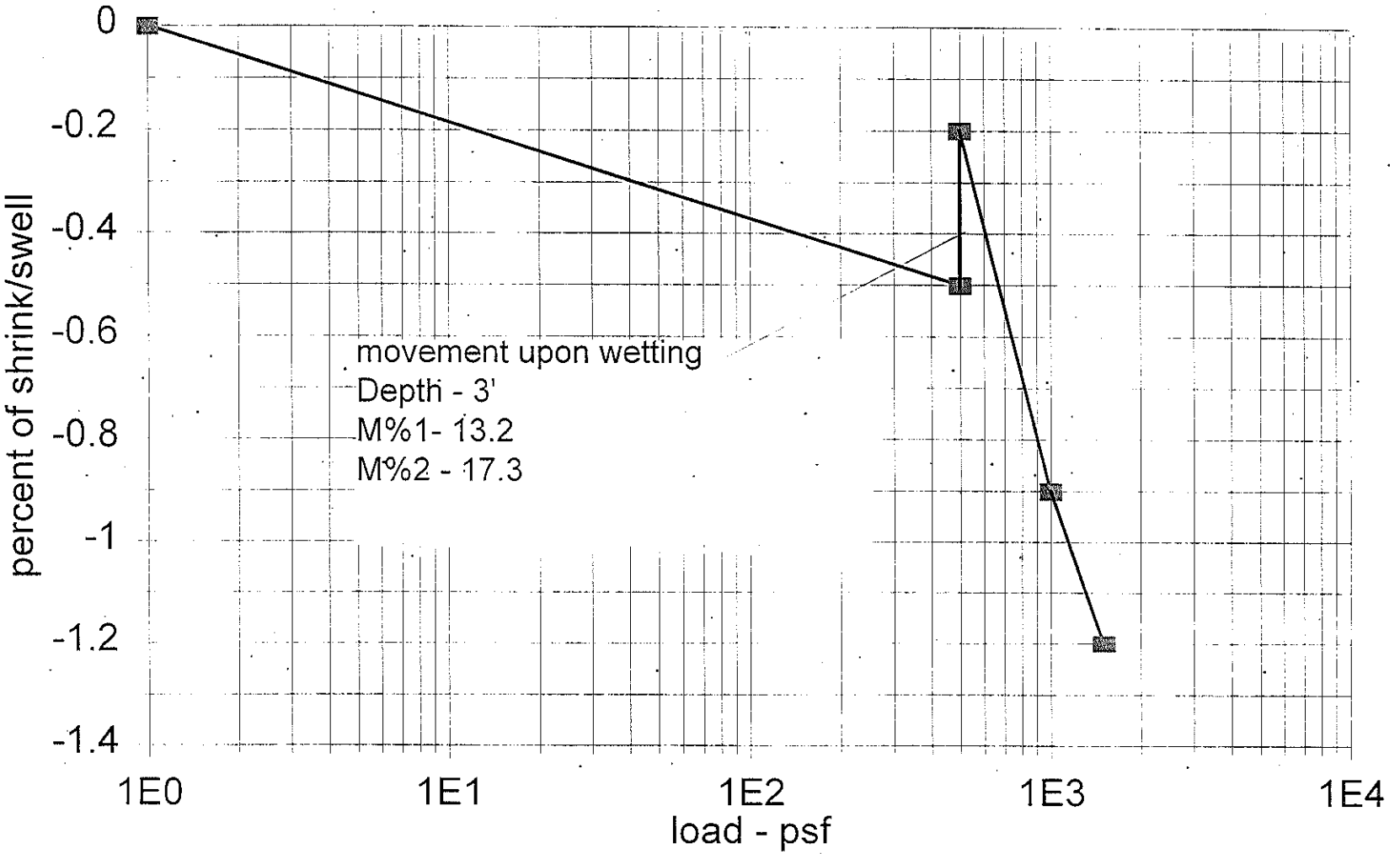
Borehole #5

One Dimensional Swell-Consolidation

AIC
The Legends
Filing 3

dd 96.48


NOTE: PORTIONS OF LOT OCK 1 MAY BE UTILIZED AS UTILITY, IRRIGATION AND DRAINAGE EASEMENTS UNTIL IT IS DEVELOPED IN THE FUTURE
GRAND FALLS DRIVE
THE FALLS SUBDIVISION
THE LEGENDS FILING ONE
28 1/2 ROAD
NW 1/4 NE
TRACT A
477966 SQ. FT.
11.0 ACRES
BLOCK 1
BLOCK 2
BLOCK 3
BLOCK 4
S45°09'38"E 513.54'
N00°01'03"W 27.00
N89°58'57"E 206.39
N89°58'57"E 139.75
NORMA JEAN STREET
N00°17'43"W 723.23
S00°12'21"E 356.00
GT6
GT9
GT3
GT1
GT5
DUKE DRIVE
CABLE COURT
PRESLEY AVENUE
N89°58'57"E 265.88
SOUTH LINE NW1/4 NE1/4 SECTION 7
LOT 1
BLOCK 4
1.137 ACRES
TRACT B
1.12 ACRES
TRACT C
1.91 ACRES
NORTH EDGE OF CANAL
GRAND VALLEY CANAL
S80°34'38"W 94.67
N79°02'22"E 195.00
S58°39'38"W
20.00' DEDICATED PEDESTRIAN EASEMENT
Shallow Test Locations - Geotrenches
The Legends Subdivision - Filing 3
* Sample from Sewer Service Trench
SETBACKS
SINGLE FAMILY DWELLING (detached)
1. Minimum street frontage.....15 feet
2. Maximum height of structures.....32 feet
3. Minimum lot width.....40 feet
4. Minimum side yard setback
PRINCIPAL STRUCTURE.....5 feet
ACCESSORY STRUCTURE.....3 feet
5. Minimum rear yard setback
PRINCIPAL STRUCTURE.....10 feet
ACCESSORY STRUCTURE
SINGLE FAMILY DWELLING (attached)
1. Minimum street frontage.....15 feet
2. Maximum height of structures.....32 feet
3. Minimum lot width.....40 feet
4. Minimum side yard setback
PRINCIPAL STRUCTURE.....5/0 feet
ACCESSORY STRUCTURE.....3 feet
5. Minimum rear yard setback

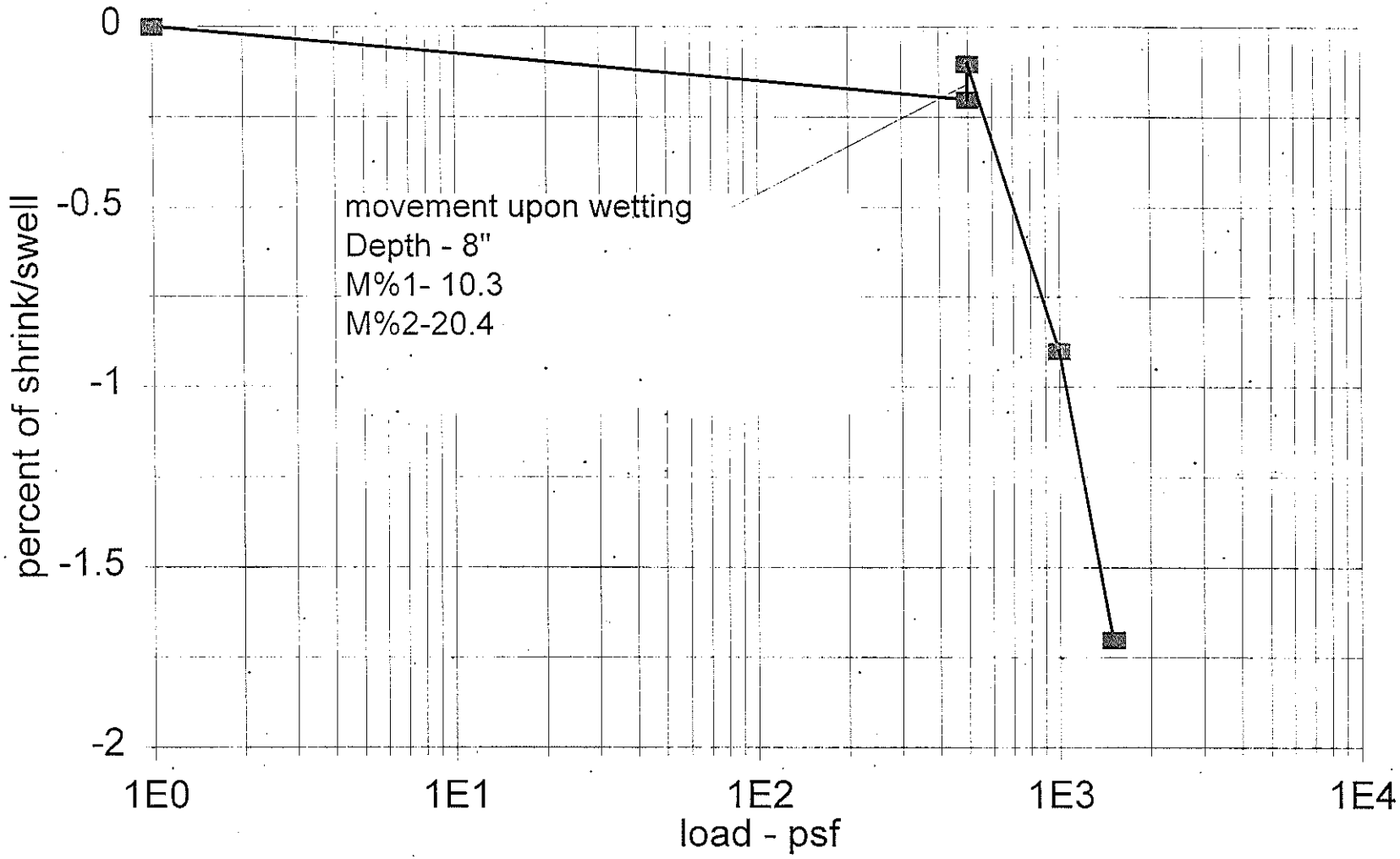


Geotrench #1

One Dimensional Swell-Consolidation

AIC
The Legends
Filing 3

dd-111.68

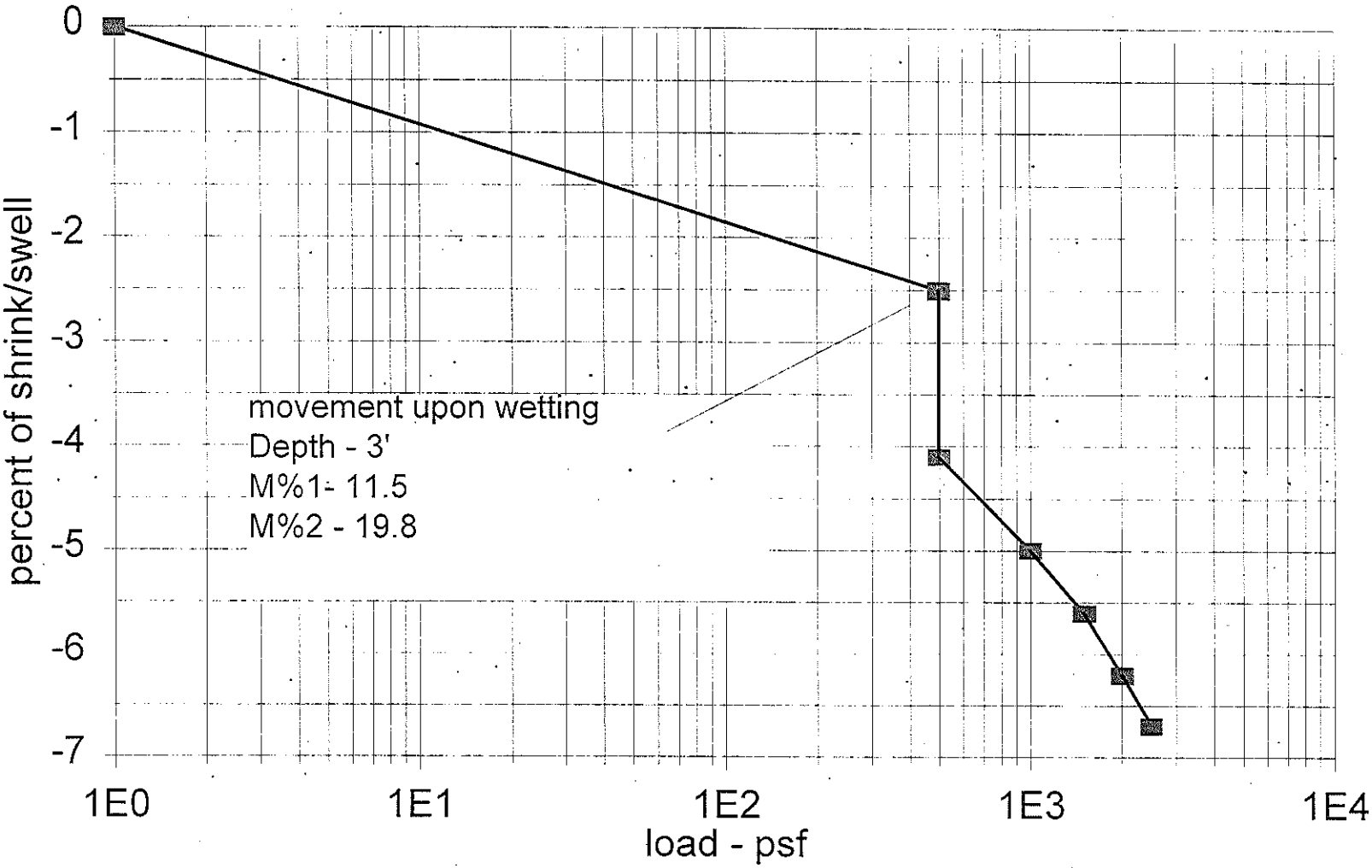


Geotrench #3

One Dimensional Swell-Consolidation

AIC
The Legends
Filing 3

Ld - 98.7

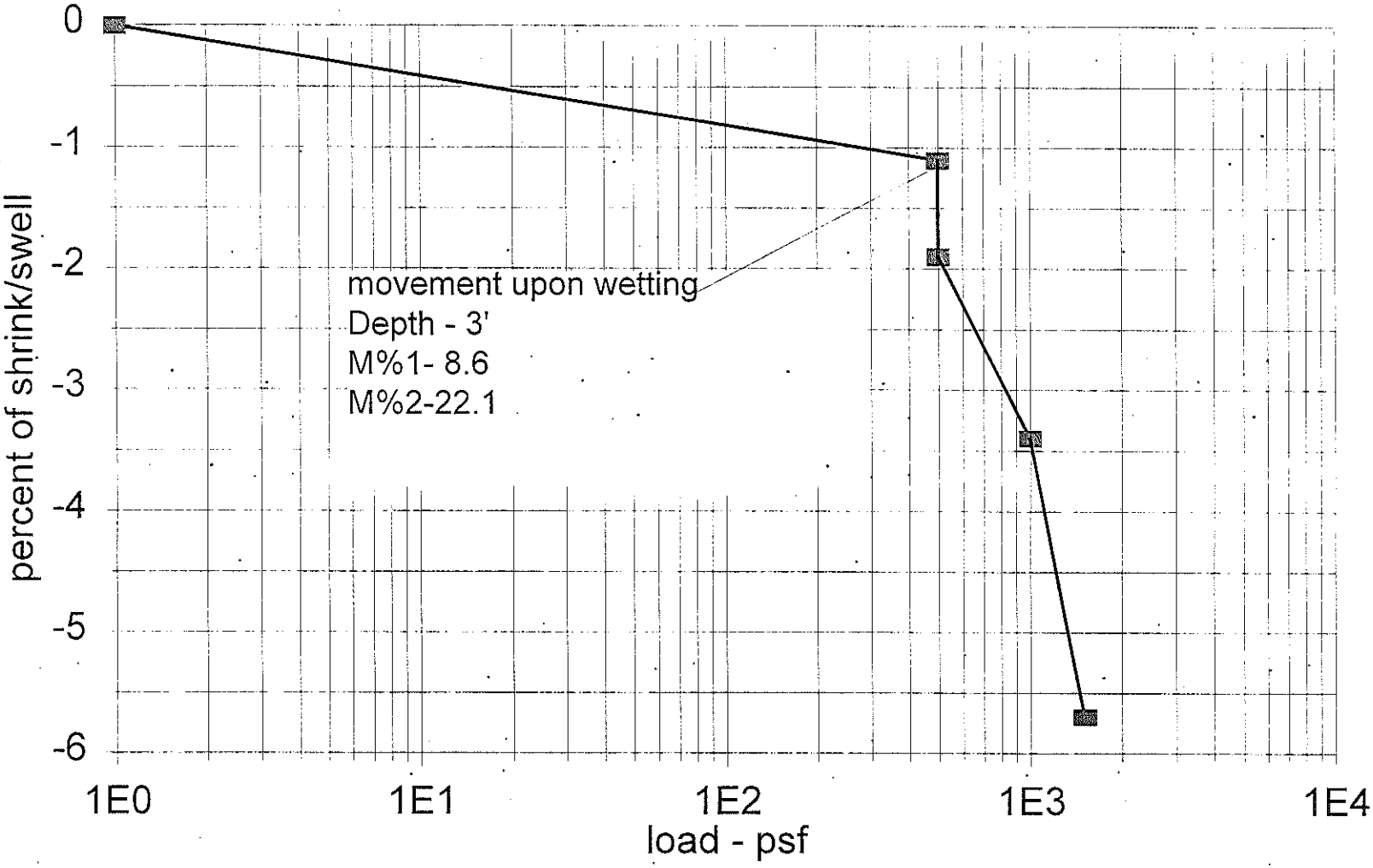


Geotrench #5

One Dimensional Swell-Consolidation

AIC
The Legends
Filing 3

dd -99.6

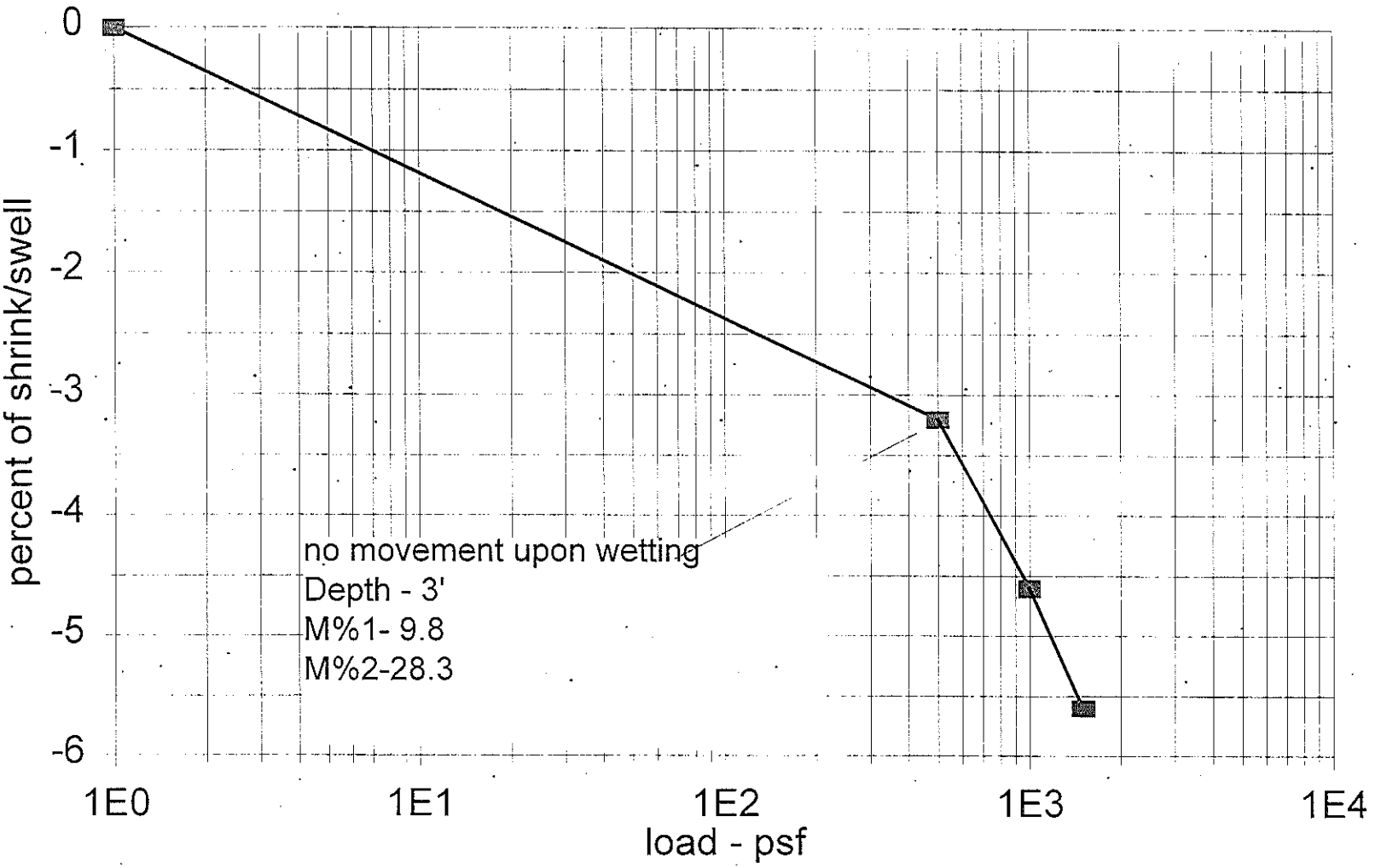


Geotrench #6

One Dimensional Swell-Consolidation

AIC
The Legends
Filing 3

dd -97.6



Geotrench #9

One Dimensional Swell-Consolidation

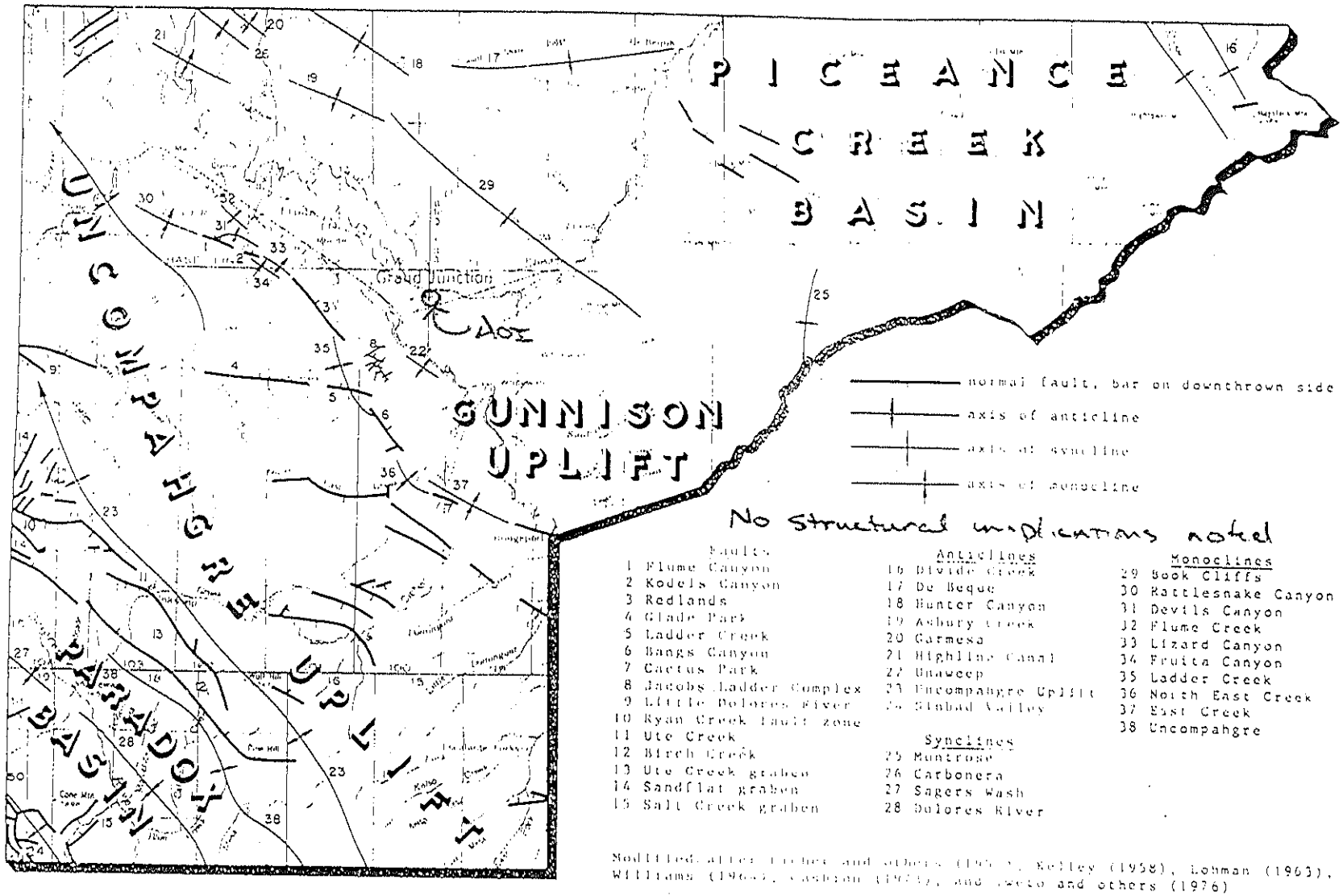
AIC
The Legends
Filing 3

dd - E6.28

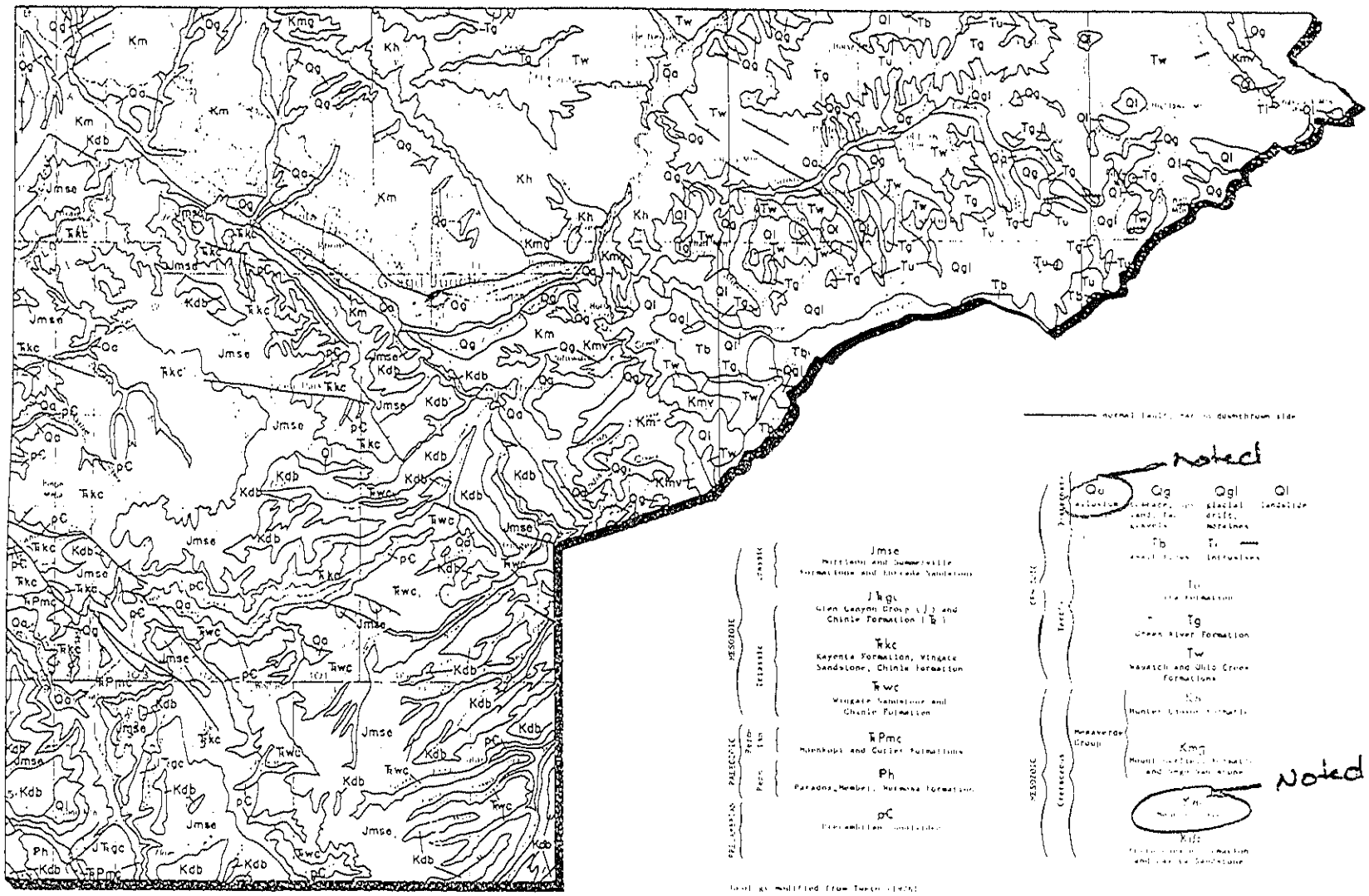
Location	Depth	Plastic Limit	Liquid Limit	Plastic Index
Lot 1 Blk 1	3'	22.35	34.22	11.87
Lot 2 Blk 1	3'	23.62	33.48	9.86
Lot 3 Blk 1	3'	24.78	32.03	7.25
Lot 4 Blk 1	8'	26.15	48.54	22.39
Lot 5 Blk 1	3'	28.07	46.49	18.42
Lot 6 Blk 1	8'	19.88	36.06	16.18
Lot 7 Blk 1	3'	18.99	27.2	8.21
Lot 9 Blk 1	3'	36.05	50.23	14.18
Lot 1 Blk 2	3'	20.62	30.74	10.12
Lot 1 Blk 3	3'	23.23	32.65	9.42
Lot 2 Blk 3	3'	23.36	32.17	8.81
Lot 4 Blk 3	3'	22.98	34.36	11.38
Lot 5 Blk 3	3'	21.29	30.67	9.38

The Legends
Geotechnical Study

In a records search at the City of Grand Junction it was found that the adjoining subdivision did not have a Geotechnical Study on file. Only the following letter from the Colorado Geological Survey was found in regards to "The Falls" subdivision. No definitive data was noted.

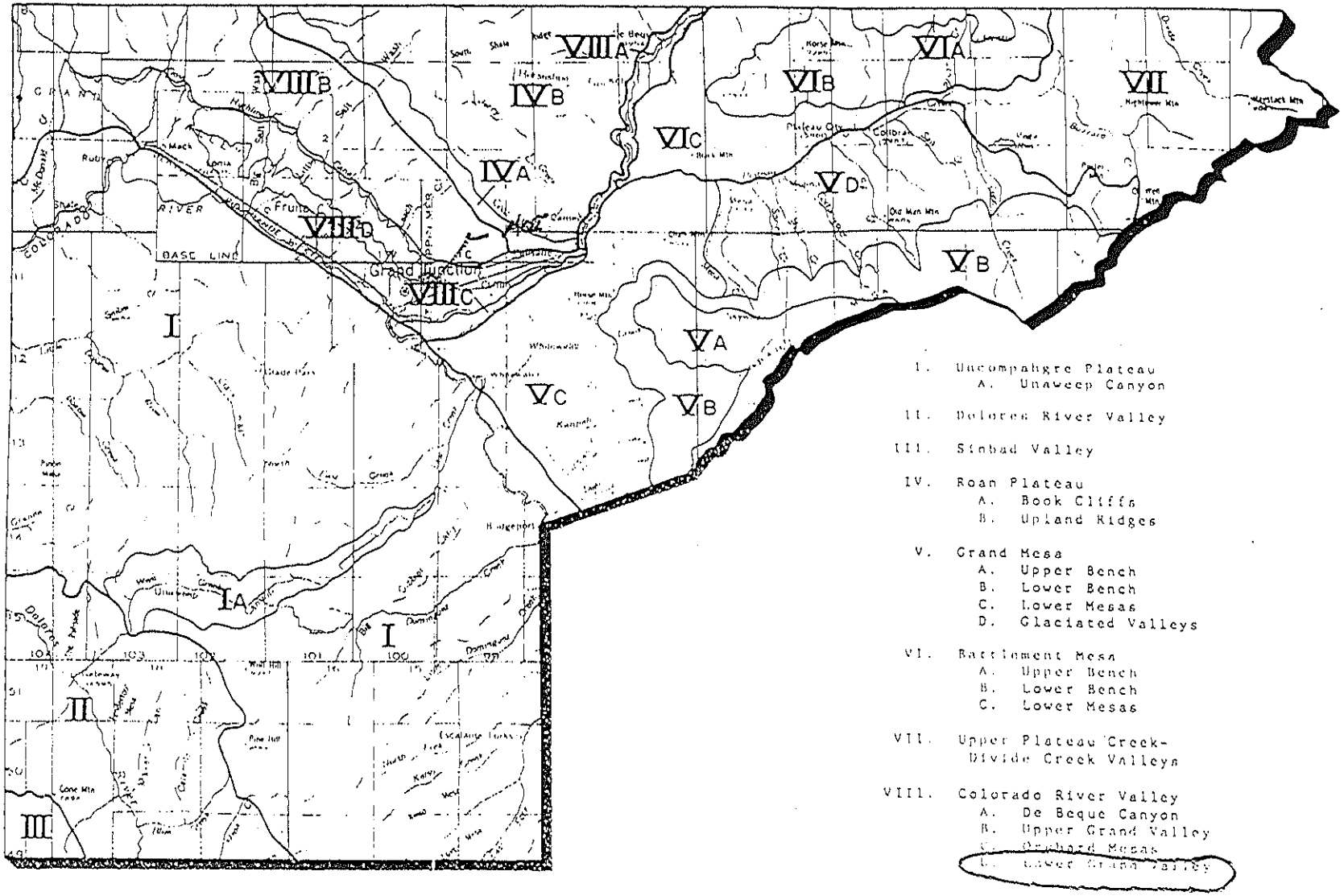


The Legends
Geotechnical Study - Structure Map



The Legends

Geotechnical Study - Geology Map



The Legends

Geotechnical Study - Physiography Map

STATE OF COLORADO

RICHARD D. LAMM
GOVERNOR

JOHN W. ROLD
Director

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES
715 STATE CENTENNIAL BUILDING – 1313 SHERMAN STREET
DENVER, COLORADO 80203 PHONE (303) 839-2611

NOV 28 1977

November 22, 1977

Ms. Conni McDonough
Mesa County Planning Department
P.O. Box 897
Grand Junction, Colorado 81501

Dear Ms. McDonough:

RE: C182-77, THE FALLS,
REZONE R-Z TO PD-8,
MESA COUNTY

We have reviewed the rezoning request and outline development plan on the above referenced subdivision. Geologic factors which should be carefully considered are compaction of fill materials, swelling soils, and soil erosion.

The primary geologic aspect which must be carefully controlled during construction is the placement and compaction of fill material. Although the fill areas generally are proposed as open space, some of the proposed structures may be located upon fill material. This fill should be properly compacted to insure the stability of the structures as well as open space areas. Additionally, structures may be subject to damage from expansive clay minerals in either the Mancos Shale bedrock or in the compacted fill. Both the expansive clays and fill compaction are foundation related problems. We strongly recommend a soils foundation investigation be conducted and that all cut and fill operations be supervised by a qualified soils engineer or engineering geologist.

Another factor which should be evaluated and mitigation measures developed is soil erosion. Erosion rates in semi-arid climates are high, particularly for sparsely vegetated slopes in the Mancos Shale. Revegetation of drainage ways and shale slopes will be difficult after the proposed cut and fill operations. We recommend that erosion control and revegetation measures be adopted for the easily erodable Mancos Shale and fill derived from the Mancos Shale.

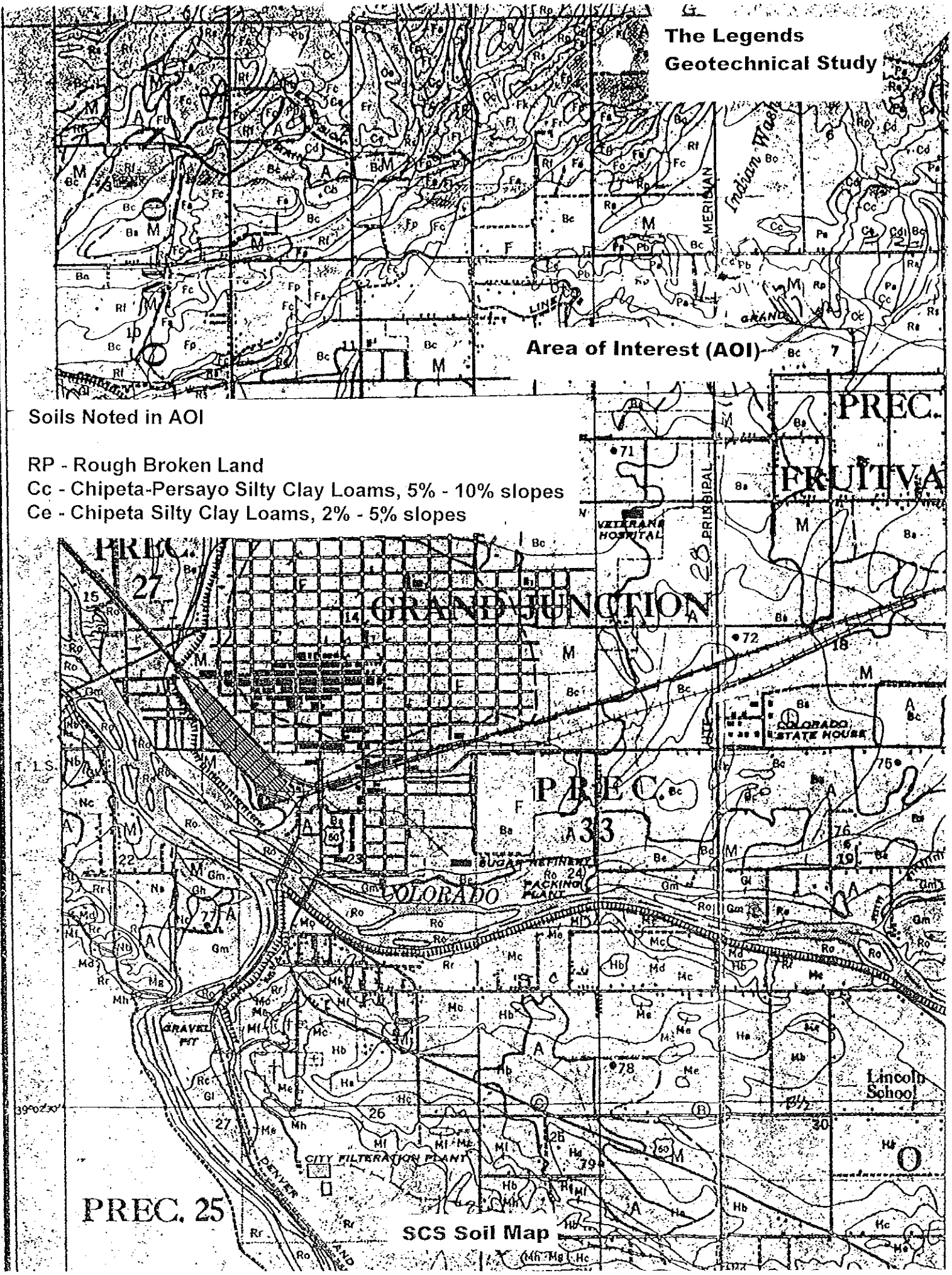
In summary, we suggest that the above factors be fully evaluated and included as a portion of the development plan. If we can be of further assistance in this review of the plan, please let us know.

Sincerely,

Walter R. Junge
Engineering Geologist

WRJ/vt
cc: Land Use Commission

The Legends
Geotechnical Study



Rough broken land, Chipeta and Persayo soil materials (Rp).—This inextensive land type consists mainly of bare Mancos shale. The rather steep areas northeast of Grand Junction consist mainly of bare Chipeta soil-forming material, whereas those north of Mack have a thin to moderately thick mantle of gravelly clay loam, Fruita soil material, overlying the Mancos shale.

Some areas of this land type that have a mantle of soil material could be used for irrigated pasture. Most of the acreage, however, is steep and consists of raw shale. This land type is periodically grazed by sheep, normally late in the fall. The sparse cover consisting of saltsage, saltbush, some shadscale and ryegrass, and other plants provides browse of low value.

Rough gullied land (Rs).—This land type is the product of erosion, gullying, and gully-bank caving of Billings soil material. The largest areas occur along East and West Salt Creeks, Big Salt Wash, and Mack Wash. The texture of the soil material varies; clay, clay loam, silty clay loam, fine sandy loam, gravel, and stones are represented.

The progress of erosion, gully, and caving is unusual (pl. 3, *A*). Erosion, facilitated by occasional mountain freshets and surface flow of irrigation waste water, continues until a gully has been cut down to the sandy substratum. The small continuous flow of irrigation waste water down the gully keeps the sandy substratum wet during the irrigation season. Some irrigation water applied on the fields adjoining the gully follows animal burrows or seeps down through the soil material until it reaches the sandy substratum. It then trickles out into the gully in small springlike veins and carries the saturated sandy material with it. Eventually, the high bank is undermined and topples down into the gully. The underground erosion and caving continually widen the gully. Some of the gully banks are already 50 to 400 yards apart. Unless waste water from irrigated land is disposed of through corrugated iron outlets, the cropland bordering the gullies gradually caves away. Sometimes it is necessary to abandon good cropland in order to stop this type of erosion.

Use and management.—A few small areas of Rough broken land might be made suitable for cropping if they were properly leveled, but the land is so rough that leveling normally would not be economically practical. The areas between wide gullies are rough, seepy, almost always high in salt content, unfit for irrigation, and consequently unsuitable for general field crops. Reclamation of these areas would require enormous expenditure.

Even if shallow, comparatively wide, straight ditches had been dug when the valley was first opened for irrigation, gully erosion could not have been prevented unless stone or concrete baffles were placed in the ditches approximately ⅛ to ¼ mile apart.

Areas of this land that livestock can reach are used primarily for grazing. The vegetation mainly consists of greasewood, scattered cottonwoods, tamarisk, inkweed, snakeweed, Mexican fireweed, smartweed, cattail, and saltgrass. Saltgrass is the most prevalent plant. The value of this land for browsing is low.

Thorou re fine sandy loam, 2 to 5 percent slopes (Tp).—This

igneous rocks but that also includes an admixture of material weathered from limestone and shale formations exposed by the Uncompahgre uplift. Ordinarily, the alluvial mantle ranges from 4 to 10 feet or more in thickness over the underlying sandstone or shale. Scattered sandstone and granite boulders are common in uncultivated areas that lie above the highest irrigation canal. The soil differs from those of the Mesa series in having a more reddish color and less distinct profile layers, and, except for a few areas bordering the Colorado River, in lacking gravel, cobbles, and stones in the lower subsoil.

The 10-inch surface soil, a light-brown to light reddish-brown fine sandy loam, contains considerable amounts of coarse irregularly shaped aggregates of granite not commonly found in other soil series of the area. This layer is soft when dry and very friable when moist. It has a low organic-matter content. The upper subsoil consists of light-brown to light reddish-brown fine sandy loam that contains a scattering of gravel-size granite and sandstone fragments. Below 20 to 24 inches, the material is slightly coarser and uniformly light brown. At depths below 50 inches the content of lime is noticeably greater; the lime appears as pink or pinkish-white threads and small spots.

The abundance of sandstone, granite, and quartz fragments varies from place to place, not only in the surface layer but also at different depths in the profile. The soil is calcareous throughout, but the lime can be seen only in the lower subsoil layers.

Use and management.—About 80 percent of this soil lying below the present irrigation canals is cultivated. This amounts to about 60 percent of the total acreage. An estimated 15 percent of the cultivated land is in orchard fruits, mainly peaches. The acreage in orchard crops is gradually increasing. Alfalfa, corn, beans, and small grains are the chief field crops. Potatoes, tomatoes, melons, and other truck crops are grown to some extent. Deep-rooted crops are well suited because drainage is generally good and the subsoil is very friable and permeable to plant roots. Yields compare favorably with those produced on Mesa and Fruita soils.

The water-holding capacity is moderate because of the high percentage of sandy material, especially in the lower subsoil. As for others of the Thoroughfare series, this soil requires more water for successful crop production than other soils in the Redlands.

It would cost too much, at least in most places, to bring water to the areas in the northwestern part of the Redlands and in other places lying above the higher irrigation canals. They afford scant grazing for sheep late in fall but are of little value for any other agricultural use.

Thoroughfare fine sandy loam, 0 to 2 percent slopes (Ta).—This soil is easily tilled and irrigated and generally favorable for agriculture. Except for its more gentle slope, it is very similar to Thoroughfare fine sandy loam, 2 to 5 percent slopes. It holds less water available for plants than Mesa clay loams.

Use and management.—Approximately 85 percent of this soil is under cultivation, and, of this, about 30 percent is in orchard fruits, mainly peaches. The rapidly permeable subsoil and favorable imate

Chipeta-Persayo shaly loams, 5 to 10 percent slopes (CB).—The more strongly sloping areas of Chipeta-Persayo shaly loams have the same soil characteristics that were described for Chipeta-Persayo shaly loams, 2 to 5 percent slopes. None of the complex is cultivated; it occurs in association with the complex having 2 to 5 percent slopes. The native cover consists of shadscale, a scattered growth of grasses, and some saltsage, rabbitbrush, and pricklypear cactus. The browse is better than on the associated undulating and sloping areas of Chipeta-Persayo silty clay loams.

Chipeta-Persayo silty clay loams, 5 to 10 percent slopes (CC).—This complex occupies a considerable acreage, mainly north of the Colorado River in the western half of the area. The soils are derived from material weathered from the thick Mancos shale formation. Except for their silty clay loam texture in the surface layer, the soils are very similar to those of the Chipeta-Persayo shaly loam complex on 5 to 10 percent slopes.

The Persayo soil in this complex contains somewhat more silt and fine sand and is slightly more permeable than the Persayo soil in the complex of Chipeta and Persayo shaly loams, but it is nonetheless highly erodible if cropped. In fact, the platy, compact, impervious shale under both soils of this complex permits so much erosion that only a sharp or choppy surface remains.

Use and management.—Because the surface of this complex is choppy and uneven, leveling for irrigation generally is not practical. Almost all of the complex therefore is used for periodic grazing. Even if the complex were leveled to permit growing of ordinary field crops, the soils would be so low in inherent fertility and so slowly permeable to plant roots that they would produce low yields.

Probably this complex is best used for periodic grazing. Some areas could be irrigated for pasture, but the difficulty of establishing a stand of grasses and the high erodibility of the soils keep the average stockraiser from attempting this. Moreover, a number of the larger areas and several of the smaller ones are on knobs scattered, for the most part, in the lower half of the valley and lie well above the level of the present irrigation system.

Fruita clay loam, 0 to 2 percent slopes (FE).—This fairly extensive soil occurs on old alluvial fans and in relatively low mesalike positions. The alluvial deposits are 4 to 10 feet thick and overlie Mancos shale. The alluvium is derived mainly from fine-grained sandstone but contains small quantities of material from shale and igneous rock.

The 8- to 10-inch surface soil is a slightly hard, calcareous clay loam, light brown to light reddish brown when dry and brown to reddish brown when moist. The upper subsoil is light-brown to light reddish-brown clay loam. At depths of 15 to 22 inches it grades into the lower subsoil, a very pale-brown, very strongly calcareous loam or clay loam that is mottled with soft, white accumulations of lime. Small fragments of sandstone and other rock occur in places.

The very gentle slopes favor irrigated crops. The position of the soil on comparatively narrow mesas facilitates underdrainage, and practically all the soil is free of harmful concentrations of salts. Like other soils of the area, this one has a low organic-matter content. When moist, the soil is friable throughout the profile. Internal drainage is medium. The moderate permeability favors successful growth of deep-rooted crops.

Use and management.—Nearly all of this soil is cultivated. The chief crops are pinto beans, alfalfa, corn, cantaloups, small grains, and truck crops. Yields generally are good. This would be a good soil for fruit growing, but it is subject to occasional low temperatures and frosts.

Ordinarily, alfalfa is left on the soil 4 or 5 years and then followed by corn, a small grain, and pinto beans. No set crop rotation is practiced. For alfalfa or beans, most farmers apply manure when available, or use superphosphate at the rate of 100 to 125 pounds an acre.

Fruita clay loam, 2 to 5 percent slopes (FF).—This soil has a profile almost identical to that of Fruita clay loam, 0 to 2 percent slopes, but its greater slope and more undulating surface make it less favorable for irrigation. Shale ordinarily occurs at depths of 3½ to 5 feet or more.

Use and management.—Although all of this soil could be cultivated, the areas now cropped represent about 88 percent of the total acreage. The chief crops are alfalfa, beans, small grains, and corn, which yield about the same as on Fruita clay loam, 0 to 2 percent slopes. Soil management is about the same, but more care is necessary to control erosion and to prevent the thinning of the soil mantle over the underlying shale. Farmers should be particularly careful to construct their small irrigation furrows at gradients that will assure the least amount of erosion.

Fruita clay loam, moderately deep, 0 to 2 percent slopes (FG).—This soil occurs in the more level parts of the area. It is located on mesalike tracts that have been more affected by geologic erosion than the larger mesas on which Fruita clay loam soils occur. Consequently, it has somewhat less depth to shale. The soil occurs as scattered narrow areas in association with Fruita clay loam, 0 to 2 percent slopes.

The surface soil and subsoil, similar to corresponding layers in Fruita clay loam, 0 to 2 percent slopes, rest on Mancos shale at depths ranging from 1½ to 4 feet. The soil is calcareous. In places it is somewhat mottled with white accumulations of lime or contains soft segregations of lime. The soil is moderately permeable but its moderate depth to shale limits the growth of deep-rooted crops and, in places, retards subsoil drainage. A few areas located about a quarter of a mile north of Loma are exceptionally shallow; the shale occurs at depths of 1 to 1½ feet.

Use and management.—About 80 percent of this soil is cultivated. Beans, alfalfa, corn, and small grains, listed in the approximate order of their importance, are the chief crops. The soil would not be well suited to orchard fruits, even if the climate were suitable. The very slow underdrainage and the very slow permeability of the shale beds are unfavorable. This soil is less productive than Fruita clay loam, 0 to 2 percent slopes, especially for deep-rooted crops. Also, more care is necessary to prevent erosion if the productivity of this soil is to be maintained.

Fruita clay loam, moderately deep, 2 to 5 percent slopes (FH).—Like the deeper Fruita soils, this soil is derived from alluvial material

LEGENDS

Chipeta silty clay loam, 0 to 2 percent slopes (CD).—The scattered areas of this soil normally border areas of Billings silty clay loams. It is a shallow soil developed in place from Mancos shale.

In areas not disturbed, the surface 2½ to 3 inches consists of gray or light-gray silty clay loam that has a slight crust but is otherwise moderately granular. Below 3 inches the material becomes increasingly hard and compact, and it is soon replaced by thin hard plates of dark-gray or gray shale that show little weathering below depths of 12 to 18 inches. Clusters of gypsum crystals are noticeable on the surface, and seams of gypsum occur throughout the unweathered shale. The entire soil profile is calcareous; the lime is well dispersed through the soil material.

Surface drainage is slow but adequate. Internal drainage and subdrainage are very slow; the hard parent shale obstructs the penetration of roots, air, and water.

The salt content is slight from the surface downward. Nevertheless, because water moves laterally over the shale, seepy or waterlogged areas with a high salt concentration frequently develop. In places, water from the upper irrigation canals seeps through crevices and produces waterlogged and saline areas at lower elevations.

Included with this soil are areas of Chipeta clay that together total about 120 acres. These occur ½ mile north, ½ mile south, and 1 mile west of Loma, and about 2½ miles northwest of Fruita. These included finer textured areas do not have so good tilth, workability, and internal drainage, but the difference is not enough to lower yields or to justify separate mapping.

Use and management.—About 25 percent of this soil is cultivated. Pinto beans, small grains, and sugar beets are grown but they produce low average yields. Some of the soil is in irrigated pasture. The grasses do not produce heavy stands, because the soil has low natural fertility. Generally this soil has to be irrigated more often than the deeper soils of groups 1 and 2. Probably those places underlain by hard shale would be benefited by subsoiling. Breaking up the shale should increase the available water-holding capacity, the spread of roots, and the average yields. The growing of sweetclover or other legumes, or the application of stable manure, is recommended to increase the content of organic matter.

Chipeta silty clay loam, 2 to 5 percent slopes (CE).—This soil has developed in place from Mancos shale. Before leveling, it has a somewhat irregular surface and includes a few small sharp rises and dips that have slopes in excess of 5 percent.

The 8- to 10-inch surface soil consists of a gray crumbly mass of thin slaty shale fragments. The subsoil and underlying layers of shale are hard, compact, and very slowly permeable to water and plant roots. The platy shale fragments in this soil become harder and more compact below depths of 12 to 15 inches and are eventually replaced by the shale rock.

This soil is calcareous from the surface downward. It is harder to till than most irrigated soils in the Grand Valley because it contains little or no organic matter and has been only slightly affected by weathering.

Use and management.—Most of this soil is grazed. Only about 25 percent is cultivated. The scant natural cover is largely saltsage and a small admixture of bunchgrass, pricklypear cactus, and other plants of low grazing value. Some farmers in the western part of the area graze sheep on this soil late in fall.

The areas now cultivated are planted mainly to small grains, sugar beets, and irrigated pasture. Because the soil has low fertility, crop yields are poor, or about the same as on Chipeta silty clay loam, 0 to 2 percent.

Erodibility, limited crop suitability, low productivity, and frequent out-of-the-way location, plus the cost of leveling, have discouraged farmers from trying to irrigate this soil. Most of the acreage now cultivated was moderately smooth to start with, so it required little expense for leveling.

Chipeta-Persayo shaly loams, 2 to 5 percent slopes (CA).—In this complex of Chipeta and Persayo shaly loams, the Chipeta soil is dominant. The Chipeta surface soil in uncultivated areas is a very pale-brown, pale-yellow, or light yellowish-brown, slightly hard, calcareous shaly loam or shaly fine sandy loam. This layer contains fragments of shale and sandstone that are about the size of fine gravel and mostly angular. The fragments from the fine sandy shale and silty shale are very hard. At depths of 10 inches or less, the surface soil is replaced by a light-gray to dark-gray calcareous silty clay loam that ranges from weak coarse platy to granular structure. Calcareous shale normally begins at depths of less than 20 inches.

The Persayo soil has a pale-yellow surface layer of calcareous silty clay loam. This layer grades into pale-yellow, hard shale of coarse platy structure.

Both soils of this complex have a surface soil derived from material left after weathering of the sandier layers in the Mancos shale formation. Where soils of this complex are associated with soils of the Fruita series, they have surface soils that contain semirounded and rounded sandstone pebbles. Here, the very shallow surface soils have developed in the remnant of an alluvial mantle.

Included with this complex are areas with slopes of 0 to 2 percent that together cover about 45 acres. Several of these occur 2½ miles north, 3½ miles north, and ½ mile south of Mack. Another area lies 3½ miles northwest of Grand Junction.

Use and management.—About 60 percent of this complex is cultivated. Tillage has mixed the surface layers with the underlying silty clay loams and formed a clay loam surface texture. This complex is not well suited to crops but it produces higher yields of shallow-rooted crops than either Chipeta silty clay loam, 2 to 5 percent slopes, or Persayo-Chipeta silty clay loams, 2 to 5 percent slopes.

Pinto beans, wheat, oats, barley, sugar beets, and sorghums are grown with better success on this complex than are other crops. Management that aids in increasing the content of organic matter is necessary if the present low productivity is to be increased. If barnyard manure is not available, the soils can be improved a great deal by growing sweetclover and turning it under as a green-manure crop. Subsoiling increases the water-holding capacity and permits deeper penetration of plant roots. Unless prices of farm crops are fairly high, it probably would be best to use this complex for irrigated pasture.