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Consulting Engineers and Geologists

Engineering Geology, Ground Water Hydrology
Seismotectonics and Earthquake Engineering,
Geotechnical Engineering,
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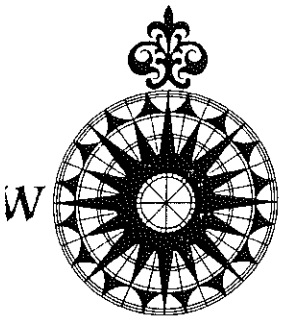

ENGINEERING GEOLOGIC EVALUATION BUFFALO MOUNTAIN RANCH PROJECT, SILVERTHORNE, SUMMIT COUNTY, COLORADO

Prepared for:

Cordillera
Attn: Mr. Jerry B. Landeck
P.O. Box 988
Edwards, CO 81632

March 24, 1999

Project No. 98299

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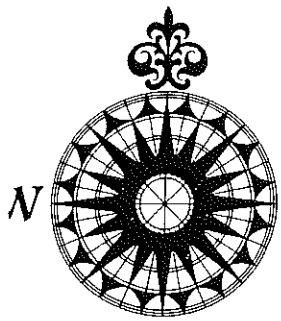
SUBJECT: Engineering Geologic Evaluation, Buffalo Mountain Ranch Project, Silverthorne, Summit County, Colorado. Project No. 98299.



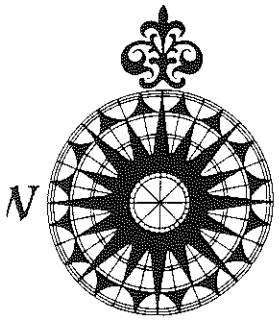
Gentlemen:

The attached report presents an engineering geologic evaluation for the Buffalo Mountain Ranch Project (Clark-Hyatt and Smith parcels) in Silverthorne, Summit County, Colorado. We understand that the parcels will be developed for low and high-density housing and limited commercial uses. The Clark-Hyatt parcel will include a golf course and infrastructure typically associated with a golf community. Previous geological and geotechnical studies indicate the parcels are underlain by the Cretaceous-age Pierre, Benton, Niobrara and Dakota formations, principally marine clay-shales with some sandstones (Dakota Group). These units, especially the clay-shales, are known to contain expansive materials and are prone to landsliding on steep, natural or man-made slopes. Several landslides are known to exist within the parcels. The presence of existing landslides and the long-term stability of man-made slopes will likely impose constraints on project planning, design and construction. The risk of future landslide movement can be reduced, but not eliminated, by avoidance and by appropriate planning, design and construction practices.

The objectives of our studies were: (1) to assess the principal geologic conditions across the proposed development; (2) to assess the probable impact of those conditions on residential, commercial, golf course, and infrastructure design and construction; (3) to recommend general procedures to avoid or reduce risks related to potential geologic hazards inherent to mountain property development; and (4) to offer recommendations for additional work to reduce uncertainties in interpretation and to provide general engineering criteria for project designs. Although particular attention was paid to delineation of geotechnical conditions and potential geologic hazards, this study was not intended to provide data for final design and construction.

Based on results of our reconnaissance-level engineering geologic studies and our experience with similar projects in mountainous areas of Colorado, we conclude that Buffalo Mountain Ranch can be developed for residential, commercial and recreational uses with certain constraints imposed by geotechnical conditions and existing geologic hazards. Geotechnical conditions appear to be

suitable for light frame construction in areas underlain by relatively thick (>10 feet) alluvium, alluvial terrace, glacial outwash, and alluvial fan deposits. The Benton, Niobrara, and Pierre formations and colluvial materials derived from these bedrock units may contain expansive clays, requiring special foundation treatment to prevent risk of structural movement in lightly-loaded structures. In some areas, swelling bedrock may be present at relatively shallow depths (<10 feet) below unconsolidated surficial deposits and could be intersected during overlot grading or by deeper structures. Existing landslides, earthflows and areas of surficial creep and slump indicate that slopes are locally unstable. Slopes outside of mapped landslide areas appear to be relatively stable in their natural, undisturbed state. Improper construction practices, however, including high steep cuts in bedrock and surficial deposits, large fills, addition of water to marginally stable slopes, and disturbance of the vegetative cover could result in slope failures.



In view of the general site conditions outlined above, we recommend foundation investigations at individual building sites to identify the possible presence of swelling bedrock and soils at foundation levels and to provide criteria to reduce the risk of damage from foundation movement.

Areas mapped as discrete landslides should be avoided, if possible, for construction of permanent structures and roadways. Fifty-foot setbacks should be maintained from known landslide scarps and toe areas as a precaution. For preliminary planning purposes, soil slopes should be cut no steeper than 3h:1v, and bedrock slopes no steeper than 2h:1v. Large cuts in bedrock, especially on north-facing slopes oriented adversely to bedrock dip, will require site-specific geological and geotechnical investigations to provide cut-slope design criteria.

Avoidance of landslide areas or minimum setbacks either may not be possible or practical in all situations. In these cases, we recommend site-specific engineering studies to assess the risks associated with specific construction plans and to provide methods to reduce the risk of slope failure. Care should be exercised in drainage and golf course irrigation plans to divert water away from landslide areas. If fairways, greens or tee boxes are planned for landslide areas, consideration should be given to surface and subsurface drainage to minimize infiltration of water into landslide masses. Similarly, grading in landslide areas should be minimized or designed to enhance slope stability, not degrade it.

Frequency of flooding and areas likely to be inundated along the Blue River and tributary drainages in the project area should be evaluated by a competent hydrologist. Recent alluvial fans should be avoided for permanent habitable structures. Similarly, permanent structures should be located away from rockfall hazard areas associated with outcrops of the Dakota Group and talus deposits in the southeast corner of the Clark-Hyatt parcel.

Information in this report is intended to provide an assessment of geological and geotechnical conditions for mountain property development; no other use is intended, implied, or authorized. The report is based on reconnaissance-level

geologic mapping, excavation of test pits, and our general understanding of geological processes in the project area, the proposed construction, and past experience with similar conditions. Variations can and do occur in geological materials, and departures from conditions portrayed in this report are possible. The conclusions and recommendations presented in this report are subject to the limitations and explanations contained herein. The economic and technical performance of the project cannot be guaranteed in any respect.

We have enjoyed working with you on this project. If you have any questions or if we can be of further assistance, please do not hesitate to call.

Very truly yours,

MICHAEL W. WEST & ASSOCIATES, INC.

By: Michael W. West, Ph.D., P.E.
President

Attachments

ENGINEERING GEOLOGIC EVALUATION, BUFFALO MOUNTAIN RANCH PROJECT, SILVERTHORNE, SUMMIT COUNTY, COLORADO

TABLE OF CONTENTS

ENGINEERING GEOLOGIC EVALUATION, BUFFALO MOUNTAIN RANCH PROJECT, SILVERTHORNE, SUMMIT COUNTY, COLORADO

1. INTRODUCTION

The following report presents an engineering geologic evaluation for the Buffalo Mountain Ranch Project in Silverthorne, Summit County, Colorado. The Project, as presently envisioned, includes two parcels: a larger parcel on the east valley slopes of the Blue River (Clark and Hyatt Ranches) and a smaller parcel in the valley bottom and lower slopes west of the Blue River (Smith Ranch) as shown on Figure 1. We understand that the Clark-Hyatt parcel will be developed for residential housing and will include a golf course and infrastructure typically associated with a golf community. The Smith Ranch parcel will be developed for higher density housing and will include a commercial office building near the southeast corner of the property.

Previous geological and geotechnical studies indicate the general project area is underlain by bedrock of the Cretaceous-age Pierre, Benton, Niobrara and Dakota formations, principally marine clay-shales with some sandstones (Dakota Group). These units are known to contain expansive clays and are prone to landsliding on steep, natural or man-made slopes. Several landslides are known to exist within the property. The presence of existing landslides and the long-term stability of man-made slopes will likely impose constraints on project planning, design, and construction. The risk of future landslide movement can be reduced, but not eliminated, by appropriate planning, design and construction practices.

Bedrock is locally mantled by variable thicknesses of unconsolidated surficial deposits, mainly of alluvial and alpine glacial origin. The valley floor and lower valley slopes along the Blue River are underlain by coarse sands and gravels deposited by glacial meltwater associated with tributaries draining the east flank of the Gore Range and the modern river flood plain.

1.1 OBJECTIVES

The objectives of our studies were: (1) to assess the principal geologic conditions across the proposed development; (2) to assess the probable impact of those conditions on residential, golf course, commercial, and infrastructure design and construction; (3) to recommend general procedures to avoid or reduce risks related to potential geologic hazards inherent to mountain property development; and (4) to offer recommendations for additional work to reduce uncertainties in interpretation and to provide general engineering criteria for project designs. Although particular attention was paid to delineation of geotechnical conditions and potential geologic hazards, this study was not intended to provide data for final design and construction.

1.2 SCOPE OF STUDIES

The scope of work summarized in this report is intended to meet the requirements of Colorado Revised Statutes (C.R.S.) 30-28-101 (Senate Bill 35, 1972) and C.R.S. 24-65.1-101 (House Bill 1041, 1974). Our studies included:

1. Review of applicable state and local government regulations, policies and guidelines regarding identification and mitigation of geologic hazards.

2. Research and review of unpublished consultants' reports and published geologic reports and maps in the files of local, state, and federal agencies, and local universities.

3. Interpretation of aerial photographs to identify bedrock units, surficial deposits, and existing geologic hazards.

4. Reconnaissance field geologic mapping of the project area and vicinity to confirm aerial photographic interpretations and to provide direct observations.

5. A field review with Cordillera and Redstone Development Services, Inc. personnel to present results of our studies and to provide information for the planning process.

6. Excavation of 23 test pits at the locations of key structures, road cut-slopes, and other areas of interest.

Figure 1 shows the locations of the Clark-Hyatt and Smith parcels with respect to the State of Colorado and the Town of Silverthorne. We explain geologic map units and symbols on Figure 2 and illustrate geologic conditions across the proposed development on maps and cross sections, Figures 3 and 5. Figures 6 through 28 present summary logs of test pits excavated on both parcels. We based subsurface interpretations on test pit data, exposures in road and stream cuts, and our general understanding of geologic and geomorphic processes in the project area. Test hole drilling is required to confirm subsurface interpretations and to provide specific data for engineering designs for specific structures and other features.

1.3 ACKNOWLEDGMENTS

Project information was provided by Mr. Jerry B. Landeck, Cordillera; Messrs. Andy Bush and John Prestwich, Redstone Development Services, Inc; Messrs. Jeff Vogel and Dick Marshall, dhm Design Group; and Mr. Tom Warnes, Gold Mountain Realty. Mr. Doug Law, Redstone; and Mr. Carl Borgstrom provided assistance with test pit excavation. A site reconnaissance on October 8, 1998, to review preliminary project plans included Messrs. Landeck, Bush, Prestwich; Alan Cunningham, Redstone; Arthur Hills and Christopher Wilczynski, Arthur Hills and Associates; John Exley, Zehren and Associates; and Michael W. West, Ph.D., P.E., and Juan Carlos Moya, Ph.D., Michael W. West & Associates, Inc.

We discussed requirements for geologic hazard studies with Mr. Michael Johnson, Planner with the Community Development Department, Town of Silverthorne; Mr. David Noe, Section Chief, Engineering Geology Division, Colorado Geological Survey and Mr. Jeff Hynes, Engineering Geologist, Colorado Geological Survey.

Field work was conducted under the general guidance of Dr. West. The project area was mapped and test pits were logged by Dr. Moya, project engineering geologist. and Mr. James D. Gill, P.E., project geotechnical engineer. Dr. West prepared the report with assistance from Dr. Moya and Mr. Gill.

2. SITE CONDITIONS

The proposed Buffalo Mountain Ranch Project is located in two separate parcels: one on the lower valley slopes on the east side of the Blue River Valley and the other on the valley floor and lower slopes west of the Blue River about one mile north of the Silverthorne business district, Summit County, Colorado (Figure 1). We describe, in the following sections, the general location and site conditions of the east parcel, known as the Clark-Hyatt Ranches, and of the west parcel, known as the Smith Ranch.

2.1 CLARK-HYATT RANCHES

The Clark-Hyatt parcel (Figure 1) occupies parts of Section 36, Township 4 South, Range 77 West; Section 1, Township 5 South, Range 78 West; and Section 6, Township 5 South, Range 77 West. Access to the site from Colorado 9 is provided by an unpaved road through a former sand and gravel mining operation about one mile north of Silverthorne or through an existing development on the south side of the property. Unimproved dirt roads and 4-wheel-drive trails provide limited vehicular access through the project area.

The Clark-Hyatt parcel spans a variety of topographic conditions ranging from the flood plain of the Blue River on the west side to relatively steep slopes on the lower west flank of the Williams Range, one of the principal physiographic elements of the Colorado Front Range. Elevations range from about 8660 feet along the floor of the Blue River to greater than 9700 feet in the higher terrain near the southeast corner of the property, total relief of about 1040 feet. The crest of the Williams Range on Ptarmigan Peak, about three miles to the northeast of the property, reaches an elevation of 12,498 feet. Higher elevations within the property afford spectacular views of the Tenmile Range to the southwest and the Blue River Valley and the Gore Range (Eagles Nest Wilderness) to the west.

The Williams Range in the vicinity of the Clark-Hyatt Ranches was not intensely glaciated. Glacial ice, if present at all, was confined to small, local areas and did not produce the degree of erosion and

deposition evident in the Gore Range across the Blue River valley to the west.

The Clark-Hyatt parcel spans, from north to south, two relatively broad, open valleys draining west into the Blue river. Higher, wooded terrain separates the two valleys through the central part of the parcel, and steeper slopes are present to the north, east, and southeast. Slopes to the east rise moderately-steeply toward the crest of the Williams Range. The property along the transition to the Blue River flood plain consists of a series of irregular bench-like surfaces related to down-cutting of the ancestral Blue River.

Vegetation across the property consists of aspens and conifers in the higher terrain and on sheltered north-facing slopes and native grasses and sagebrush across the broad valley bottoms and exposed lower slopes. Willows and other phreatophytes grow along intermittent drainages.

2.2 SMITH RANCH

The Smith Ranch parcel (Figure 1) lies mainly in the valley floor, lower terraces and the lowermost valley slopes on the west side of the Blue River in Section 2, Township 5 South, Range 78 West. Access to the property is from Colorado 9 via Ruby Ranch Road..

The Blue River through the project area has carved a valley ranging from about 1400 to 3600 feet wide. The flood plain is bounded on the west side by a series of relatively flat, bench-like surfaces associated with ancestral levels of the Blue River and glacial outwash (meltwater) deposits derived from drainages on the east flank of the Gore Range. The Gore Range about three miles west of the Smith Ranch rises abruptly to elevations of 13,109 feet at the summit of Red Peak and 12,777 feet on Buffalo Mountain, the project namesake. Intense alpine glaciation in the Gore Range produced classic U-shaped valleys, jagged alpine topography along the range crest, and lower slopes mantled by thick glacial tills (unsorted ice-deposited material) and outwash (melt-water-deposited) sands and gravels.

Except for the southwest corner, the Smith Ranch parcel spans three relatively flat, gently eastward-sloping topographic surfaces associated with glacial outwash deposition from the Willow Creek drainage and erosional and depositional processes associated with the Blue River. The three topographic surfaces are separated by low escarpments, running generally north-south in the eastern quarter of the parcel. Elevations range from less than 8700 feet on the lower surface, from 8700 to 8710 feet on the intermediate surface, and from 8720 to 8770+ feet on the upper surface. In the southwest corner, the property encompasses moderately steeper slopes rising to elevations of from 8770 to 8855 feet. Total relief across the Smith Ranch parcel is about 155 feet.

Vegetation consists of native grasses and sagebrush across the terrace surfaces and exposed lower slopes and aspens and conifers on sheltered north-facing slopes in the southwest corner.

3. PROPOSED CONSTRUCTION

As presently envisioned, the Buffalo Mountain Ranch Project will include a golf course and appurtenant facilities; single-family, low-density housing; higher density, multifamily housing; limited commercial development; and supporting infrastructure. We discuss conceptual development plans for the Clark-Hyatt and the Smith Ranch parcels in the following sections.

3.1 CLARK-HYATT RANCHES

As presently envisioned, the Clark-Hyatt parcel will include an eighteen hole golf course, driving range and practice greens, clubhouse, residential areas, and related access roads. We were provided preliminary golf routing, access road alignments, and clubhouse locations; however, details related to residential housing, including specific building sites, grading plans and foundation loads, were not available at the time of our study. We assumed for the purposes of this study that development will be similar to other mountain residential golf properties and will include low and moderate density housing and recreational facilities, using lightly-loaded frame construction.

3.2 SMITH RANCH

The Smith Ranch parcel will include higher density, multifamily housing across the lower topographic surfaces and low-density single family housing in the higher terrain in the southwest corner of the property. A two-story commercial office building is planned for the southeast corner of the property near the intersection of Ruby Ranch Road and Colorado 9. We were provided preliminary access road alignments and building sites. We assumed for the purposes of this study that development will be similar to other residential and commercial properties using lightly-loaded frame construction.

4. GEOLOGICAL AND GEOTECHNICAL INVESTIGATIONS

Geological and geotechnical investigations included reconnaissance geologic mapping of the Clark-Hyatt and Smith Ranch parcels and immediate vicinity, excavation of thirteen test pits at selected sites on the Clark-Hyatt parcel and ten test pits on the Smith Ranch parcel, and limited laboratory testing of selected samples. These investigations are discussed in greater detail in the following sections.

4.1 GEOLOGIC MAPPING

We performed geologic mapping on black-and-white (Clark-Hyatt) and natural color (Smith), stereoscopic aerial photographs at approximate scale of 1:9000 and topographic base maps at a scale of 1:2400 (1 inch = 200 feet) prepared by Redstone Development Services and dhm Design Group. Geologic interpretations derived from the aerial photographs were compiled and transferred to base maps of the respective parcels. Geologic data for the Clark-Hyatt parcel were subsequently digitized and added as a layer to AUTOCAD base mapping provided by Redstone Development Services, Inc. Topography and cultural features for the Smith parcel were digitized from maps provided by dhm Design Group and later combined with geologic mapping. Geologic mapping in AUTOCAD format has been provided separately to Redstone as part of this project. Bedrock and surficial geologic mapping of the Clark-Hyatt and Smith parcels is included in this report as Figures 3 and 5. Map units and symbols are explained on Figure 2, preceding the maps.

4.2 SUBSURFACE INVESTIGATIONS

Based on our interpretation of bedrock and surficial geologic conditions, we excavated thirteen (13) test pits on the Clark-Hyatt parcel (Figures 6 - 18) and ten (10) test pits on the Smith parcel (Figures 19 - 28 to depths ranging from 5.0 to 10.0 feet at the locations shown on Figures 3 and 5, respectively. Test pits were excavated using a

backhoe and logged at the time of excavation by our project engineering geologist. Samples of selected materials encountered in the test pits were bagged and labeled and returned to our office for visual classification and index property laboratory testing.

4.3 LABORATORY TESTING

At this preliminary stage of study, we limited laboratory testing to gradations and Atterberg limits of samples recovered from test pits believed to be representative of major, widespread geologic units across the proposed development. We present laboratory test data in the Appendix.

5. PROJECT GEOLOGY

We describe the geology of the Buffalo Mountain Ranch Project in the following sections, including bedrock stratigraphy, bedrock structure, and unconsolidated surficial deposits mantling bedrock. Significant properties of bedrock and unconsolidated, surficial geologic units are tabulated on Figure 2, and laboratory test results are appended.

5.1 BEDROCK STRATIGRAPHY

The Clark-Hyatt Ranches and Smith Ranch parcels are underlain by a thick sequence of predominantly marine claystones shales, siltstones, and sandstones ranging in age from early to late Cretaceous (104 to 66.4 million years old). Stratigraphic terminology and predominant rock types are summarized in descending stratigraphic order in the following table:

TABLE I
BEDROCK STRATIGRAPHY

FORMATION	AGE	THICKNESS (Feet)	LITHOLOGY
Pierre Shale (lower shale member)	Late Cretaceous 97.5-66.4	>2690	Dark-gray, brownish gray, and black marine clay-shale; indistinct bedding in fresh outcrops; fissile bedding apparent in weathered outcrops; contact with underlying Niobrara is indistinct.
Niobrara Formation	Late Cretaceous 97.5-66.4	470-486	Upper calcareous shale member (Smoky Hill Shale) consists of gray, fissile, platy, calcareous shale and shaly limestone; more shaly in upper part.

			Lower member (Fort Hays Limestone) consists of gray blocky limestone.
Benton Shale	Late Cretaceous 97.5-66.4*	310-360	Mainly black to dark gray shales with interbedded limestones and sandstones near the top of the unit. Benton Shale does not outcrop but is inferred to underlie colluvium in the southeastern part of the project area.
Dakota Group	Early Cretaceous 144-97.5*	±222	Includes and upper quartzite unit, a middle shale unit, and a lower quartzite unit. Upper quartzite is light gray, cross-bedded with interbedded carbonaceous shale. Middle unit is dark gray to black carbonaceous shale interbedded with gray to light gray quartzite. Lower unit is massive, medium-grained, grayish-white quartzite with thin dark gray shale interbeds.
Morrison Formation	Jurassic 205-144*	180-260	Light gray and light greenish gray, locally calcareous claystone; maroon claystone near top; lower half of unit contains light yellow to white medium-grained sandstone beds.

* Millions of years

The Jurassic age (205-144 million years old) Morrison Formation, locally present in the Dillon-Silverthorne area, underlies the Dakota Group, but is not known to outcrop within either the Clark-Hyatt or Smith Ranch parcels. The Morrison Formation, however, is depicted at depth on Cross Section, B-B', Figure 4.

5.2 BEDROCK STRUCTURE

Sedimentary bedrock underlying the Buffalo Mountain Ranch Project occupies a narrow, north-trending structural basin. This structural basin, referred to as Middle Park, is bounded on the east by the Williams Range thrust fault which displaces older Precambrian (>570 million years old) crystalline (metamorphic and igneous) rocks over younger (144-66.4 million years old) marine and coastal-margin sedimentary rocks described in Table I. The Williams Range fault is a major, low-angle (>45°) tectonic structure bounding the west flank of the Front Range uplift of the Southern Rocky Mountains. Kellogg (1997) maps the trace of the Williams Range fault about 0.5 miles east of Buffalo Mountain Ranch and several hundred feet higher on the flank of the Williams Range.

The west side of the Middle Park structural basin is defined by the Frontal fault of the Gore Range (also known as the Blue River fault) which juxtaposes Precambrian crystalline rocks against Jurassic to Cretaceous sediments along a sub-vertical zone of dislocation. The Frontal fault is responsible for the steep, abrupt topographic escarpment along the east flank of the Gore Range visible from the proposed development.

In general, sedimentary bedrock across the project area strikes about N30° E to almost due east and dips to the north at 13° to 20°. Near the southeast corner of the project area, bedrock of the Dakota Group has been folded into an upwarp (anticline) trending N30°W. Dakota bedrock on the southwest flank of the upwarp strikes N50°W and dips to the southwest at angles up to 14°. Several normal faults cut lower Pierre Shale, Dakota Group and Morrison Formation bedrock southeast of the Buffalo Mountain Ranch property. In our mapping, we noted no faults or other significant structural complexities (folds) across the Buffalo Mountain Ranch property. However, it appears plausible that at least one high-angle normal fault displaces Dakota Group sandstones and inferred underlying Morrison Formation on the east against the Niobrara Formation on the west as depicted on cross section B-B' (Figure 4). The actual fault trace, if present, is covered by unconsolidated, surficial deposits. Poor bedrock exposures and the generally thick cover of surficial deposits may mask other faults and folds across the project area.

5.3 SURFICIAL DEPOSITS

Bedrock across the proposed development, except for erosion-resistant outcrops of Dakota quartzites and isolated outcrops of other bedrock units on slopes, is mantled by varying thicknesses of unconsolidated surficial deposits of Quaternary age (less than 1.9 million years old). These deposits include modern alluvium, older terrace alluvium, and glacial outwash along the flood plain of the Blue River and its tributaries; alluvial fans; landslides, earthflows, and areas of surficial creep and slump; talus; colluvium derived from weathering and erosion of underlying bedrock units; and mixed colluvium and older gravel deposits of uncertain origin. We discuss each of these units in the following sections.

5.3.1 Alluvium (Qal, Qal-t,)

Modern alluvium (stream-deposited material) is confined to the flood plain of the Blue River and small tributaries draining the project area. In general, these deposits consist of medium-dense to dense, sands and gravels with scattered cobbles and boulders locally interbedded with lenses of silt and clay. Organic-rich soils are present especially along the channels of small tributary drainages within the Buffalo Mountain Ranch property. In general, the alluvial deposits exhibit lenticular bedding, are moderately well-sorted, and moderately-well- to well-stratified. Alluvium deposited in the flood plain of the Blue River along the western side of the property is mantled by and interfingers with alluvial fans deposited at the mouths of tributary drainages and colluvium derived from the adjacent steep valley slopes.

Older alluvium associated with a higher level of the Blue River mantles a low topographic (terrace) surface in the eastern quarter of the Smith Ranch parcel. In general, these deposits are similar to modern alluvium in the flood plain of the Blue River and consist of medium dense to dense, cobbly sands and gravels with scattered boulders. The sands and gravels are locally capped by several feet of silty, high plasticity clay derived either from overbank flooding or colluviation from nearby slopes.

5.3.2 Alluvial Fans (Qaf)

Alluvial fans of various ages and elevations cover large areas of Buffalo Mountain Ranch. A well-defined recent alluvial fan (Qaf-1), associated with a tributary of the Blue River, is present in the north-west part of the property. In this area, the abrupt decrease in stream gradient from the tributary drainage to the river flood plain caused the bed and suspended load to be deposited at the tributary mouth in a fan-shaped deposit consisting of sands, gravels, and cobbles. Due to the rapidity of fan deposition and generally short transport distances, recent alluvial fan deposits (Qaf-1) tend to be less dense and less well-sorted and stratified than flood plain alluvium. In some cases, alluvial fan deposits may be loose to very loose and subject to large settlements on wetting and/or imposition of loads associated with structures.

Large areas of Buffalo Mountain Ranch, especially in the northern third appear to be covered by higher, older alluvial fan deposits consisting predominantly of gravelly to cobbly, sandy to silty clays. We identified older alluvial fan deposits mainly on the basis of topographic position relative to the elevations of modern streams. The ages of alluvial fans increase with elevation above modern stream level and are indicated by increasing numbers associated with the map symbol (i.e. Qaf-1 is youngest; Qaf-5 is oldest). These deposits, characterized by the presence of alluvial gravels and cobbles, form a thin veneer over bedrock and grade into colluvium and residual soils derived from the underlying bedrock units. Older, inactive alluvial fans (Qaf-2 to 5) at higher elevations are believed to be generally more dense and less prone to settlement/collapse than recent, active alluvial fans (Qaf-1).

5.3.3 Glacial Outwash (Qgo)

The upper and intermediate reaches of the North and South Willow Creek drainages on the east flank of the Gore Range held alpine valley glaciers until about 10,000 years ago. Meltwater from these glaciers deposited sandy to silty, locally cobbly and bouldery gravels at the mouth of the Willow Creek drainage in the west three-quarters of the Smith Ranch parcel (Figure 5). These deposits are generally medium dense to dense, poorly sorted, and variably stratified.

5.3.4 Landslides (Qls-b, Qls-ef, Qls-cs)

Bedrock (Benton Shale, Niobrara Formation, and Pierre Shale) underlying Buffalo Mountain Ranch is composed largely of marine clay-shales. Clay-shales are weak rocks and prone to landsliding on moderate to steep slopes, especially in the presence of ground water. Several existing landslides are present within the Buffalo Mountain Ranch property and slopes that appear stable in their natural, undisturbed state may be destabilized by construction activity associated with development. Given the generally weak nature of bedrock and overlying surficial deposits and locally steep slopes, slope stability will be a principal concern in development of Buffalo Mountain Ranch.

In our geologic mapping, we identified two principal types of landslides within the project area and additional areas that are undergoing surficial creep and slump, primarily in unconsolidated deposits overlying bedrock. Large, rotational and translational(?) block landslides are present in the northern third of the Clark-Hyatt parcel. These landslides, which involve deep-seated failure in underlying bedrock, appear to be associated with erosion of valley slopes by the Blue River and the tributary drainage forming the broad valley in the northern third of the property. A large landslide complex, mainly in the lower Pierre Shale, was apparently triggered by erosion and undercutting of the valley slope by the Blue River in the recent geologic past. This landslide complex is partially occupied by an existing subdivision north of Buffalo Mountain Ranch. Part of this large landslide complex extends into the northwest corner of the project area. We consider this area to represent a high risk of future slope instability despite the presence of an existing development within the main body of the landslide complex.

A second large landslide complex is located south of the small tributary draining the northern third of the Clark-Hyatt parcel. This landslide, probably a deep-seated failure in the Niobrara Formation, shows classic landslide topography (hummocky topography, scarps, back-tilted blocks, closed depressions) and has been active in the past few hundred to few thousand years. Niobrara Formation bedrock in the area of this landslide strikes east-northeast and dips to the northwest at about 16°. The direction of landslide movement (northwest) corresponds approximately to the bedrock dip direction, indicating this landslide is partially bedding plane-controlled and related to erosion

and undercutting of slopes by the Blue River and the smaller tributary north of the landslide. The relatively shallow dip of bedrock in this area, about 16°, indicates that potentially weak beds, probably plastic clays within the Niobrara Formation, contributed to this landslide.

A large, active earthflow is present in the east central part of the Clark-Hyatt. parcel. The earthflow is characterized by a slowly moving, lobate toe which is actively toppling aspen trees and overriding the ground surface. Several small active slumps are present within the overall earthflow mass. The source of the earthflow is in higher terrain to the east. Ground water is considered to be a critical factor in this earthflow. Increase of ground water levels in this earthflow due to natural precipitation or from man-made sources will likely accelerate movement. Based on disruption of soils at the earthflow toe and disturbance of trees, we estimate current earthflow movement to be in the range of several inches per year.

In addition to the large landslides described above, we mapped several areas of surficial creep and slump and a number of small slumps and landslides. Surficial creep and slump probably occurs in unconsolidated deposits, especially colluvium overlying weathered bedrock and perhaps in weathered bedrock itself. The critical factor appears to be the presence of elevated soil moisture in clayey colluvial soils on steep slopes, especially north-facing slopes that naturally retain soil moisture. The strength of clayey soils is inversely proportional to soil moisture. As soil moisture increases, strength is reduced and surficial creep and slump is more likely to occur.

5.3.5 Talus Deposits (Qt)

Erosion-resistant Dakota Group quartzites outcrop on the ridge crest in the southeast corner of Buffalo Mountain Ranch. Weathering, erosion, and undercutting of resistant outcrops produce angular gravel, cobble and boulder-size material that falls from outcrops and accumulates below the outcrop at or near the angle-of-repose. The presence of talus generally indicates an active rockfall hazard.

5.3.6 Colluvium (Qc, Qc/Kd, Qc/Kn, Qc/Kp, Qc/Kdbn)

Colluvial deposits form as the result of in-place weathering of the underlying bedrock units. The weathered material is transported downslope by slopewash and gravitational creep on moderate to steep slopes. Thick colluvial deposits typically accumulate at the base of slopes; thinner colluvial deposits are usually present on the upper reaches of slopes and across ridge crests.

In general, colluvial deposits reflect the lithologies of the underlying bedrock units. Because large areas are underlain by marine clay-shales, colluvium across most of the project area consists of sandy to silty clays with scattered gravels and cobbles derived from nearby alluvial fan deposits, glacial deposits, and perhaps poorly preserved alluvial terraces. Colluvium derived from the Dakota Group ranges from gravelly, silty to clayey sand to silty to clayey, sandy gravels.

5.3.7 Colluvium and Older Gravel Deposits (Qc-g, Qc-g/Kn)

Large areas of Buffalo Mountain Ranch are covered by colluvium mixed with gravels and cobbles probably derived from alluvial fans, eroded river terraces, and possibly glacial tills and outwash. Kellogg (1997) maps older outwash gravels and *"diamicton"* mantling higher terrain in the north central part of the Clark-Hyatt parcel near the proposed clubhouse. Kellogg (1997) states, however, that the source of the gravels and association with a discrete geomorphic surface are unclear. The term *"diamicton"* indicates a mixed deposit of unknown origin. Because of uncertainty in the origin of certain gravelly cobbly surficial units, especially in the northern half of the Clark-Hyatt parcel and the lack of clear geomorphic expression, we mapped these areas using a map symbol combining colluvium and older gravel deposits (Qc-g). In addition to alluvial fan deposits, this unit may contain gravels and cobbles derived from eroded river and outwash terraces and glacial tills. We expect the thickness of these deposits to be highly variable, ranging from a thin veneer on steeper slopes to ten feet or more on gentle slopes and on indistinct geomorphic surfaces.

5.4 GROUND WATER CONDITIONS

Little reliable data is available on ground water conditions across the Buffalo Mountain Ranch property. We infer, however, that perched ground water conditions may be present across large areas of the property, especially along the broad valley floors in the north and southern parts of the project area. Perched ground water conditions typically develop where bedrock is relatively impervious, as in the case of clay-shales, and mantled by significant thicknesses of more pervious surficial deposits. Accordingly, we expect that ground water may collect at shallow depths on the top of relatively impervious, weathered bedrock. Ground water levels may fluctuate dramatically under these circumstances, particularly with season. Higher ground water levels are likely to occur in spring and summer months, lower ground water levels in the fall and winter.

Perched ground water conditions are more likely to develop, in our opinion, across valley floors and on gentler slopes regardless of elevation. Perched ground water is less likely to be present on steeper south-facing slopes, but may be present on steep, north-facing slopes. Ground water contributes to surficial creep and slump and to deeper-seated landslides on north-facing slopes.

Ground water also occurs in alluvium, alluvial terrace deposits, and glacial outwash along drainages tributary to the Blue River and in the Blue River flood plain. We noted a spring, developed for livestock watering purpose, associated with alluvium along a drainage in the central part of the Clark-Hyatt parcel. Marshy areas and phreatophytes are locally present along stream channels, indicating ground water underflow in alluvium. Gravel pits along the Blue River flood plain have been excavated below the alluvial ground water table resulting in creation of several large lakes.

Bedrock across the project area, is not likely to contain significant amounts of developable ground water. Wells drilled into clay shale bedrock may produce small amounts (<1-2 gpm) of generally poor quality water. Deeper wells drilled into the Dakota Group may produce larger amounts of ground water, but the actual potential is unknown.

6. GEOLOGICAL/GEOTECHNICAL DESIGN CONSIDERATIONS

Geologic conditions across the proposed development will impose constraints on project planning, design, and construction. Special care should be exercised to reduce risks posed by swelling soils and bedrock, locally high ground water conditions, existing landslides and man-induced slope failures, debris flows, rockfalls, flooding, avalanche activity, and other geologic hazards.

6.1 FOUNDATION CONDITIONS

Marine clay-shale bedrock of the Benton, Niobrara, and Pierre Formations are known to contain highly expansive clays that can damage lightly-loaded structures. Colluvial soils derived from these bedrock units are also likely to be expansive when wetted. The Pierre Shale, in particular, contains thin beds of almost pure bentonite (smectitic clay) derived from weathering of airfall volcanic ash. Along the east side of the Front Range in Jefferson and Douglas counties, these highly swelling beds have resulted in severe damage to lightly loaded residential and commercial structures. The problem has been compounded by steep dips in bedrock along the Front Range which produces high differential swells across upturned, steeply-dipping beds. Bedrock dips across most of Buffalo Mountain Ranch are gentle to moderate (13° to 20°), reducing the risk of differential swell associated with more steeply-dipping beds. Nevertheless, the potential for swelling bedrock and associated soils and damage to lightly loaded structures in areas underlain by the Benton, Niobrara, and Pierre formations is real and should be accounted for in foundation designs. Swelling soils are less likely to be present in areas underlain by the Dakota Group and associated colluvial soils.

We recommend foundation investigations at individual building sites to identify the possible presence of swelling bedrock and soils at foundation levels and to provide design criteria to resist the risk of foundation damage from swelling bedrock and soils. In general, drilled pier and grade beam foundations or post-tensioned slab foundations are appropriate for areas underlain by swelling bedrock and soils. Spread footing foundations may be used in areas underlain by thick,

sand and gravel deposits associated with modern alluvium along the flood plain of the Blue River, older alluvial terrace deposits, glacial outwash, alluvial fans, and older gravel deposits. More recent fan deposits (Qaf-1) may be loose to very loose and could settle under imposed foundation loads or when wetted.

Perched ground water conditions are likely to be present across much of Buffalo Ranch, especially on lower, more gentle slopes overlain by alluvium, alluvial terrace, glacial outwash, and alluvial fan deposits. Accordingly, ground water levels are likely to fluctuate dramatically with season, with highest ground water levels occurring in spring and summer months. North-facing slopes typically retain water, and the presence of aspen and other phreatophytes indicate ground water levels are high, at least during the spring-summer growing season. High seasonal ground water levels should be accounted for in siting and design of structures.

6.2 SLOPE STABILITY

Existing landslides and potential man-induced slope failures, in our opinion, will be significant considerations in development of Buffalo Mountain Ranch. Areas mapped as discrete landslides (Qls-b and Qls-ef, and smaller landslides showing direction of movement on the Geologic Map, Figures 3 and 5) should be avoided, if possible, for construction of permanent structures and roadways. These areas represent a high risk of future landslide movement especially if disturbed or modified by construction. Stable areas adjacent to mapped landslides, especially slopes immediately above and below, may be destabilized by continuing or reactivated slide movement. In general, we recommend 50-foot setbacks from known landslide scarps and toe areas as a precaution. For preliminary planning purposes, we recommend that soil slopes be cut at no steeper than 3h:1v, and bedrock slopes no steeper than 2h:1v. Given apparent bedrock strike and dip (northeast to east, 13°-20° north) over most of the development, bedrock instability will most likely occur on north-facing slopes.

Avoidance of landslide areas or minimum setbacks may not be possible or practical in all situations. In these cases, we recommend site-specific engineering studies to assess the risk associated with specific

construction plans and methods to reduce the risk of slope failure. Mitigation may include complete removal of the landslide by excavation, surface and subsurface drainage, retainage of the landslide by structural walls, earth or rock buttresses, and/or soil nailing among other possible methods.

Care should be exercised in drainage and golf course irrigation plans to divert water away from landslide areas. If fairways, greens or tee boxes are planned for landslide areas, consideration should be given to surface and subsurface drainage to minimize infiltration of water into landslide masses. Similarly, grading in landslide areas should be minimized or designed to enhance slope stability, not degrade it. Some movement in golf course features may be tolerable and treated as a maintenance issue.

Slopes outside of mapped landslide areas appear to be relatively stable in their natural undisturbed state. Improper construction practices, however, including high steep cuts in bedrock and surficial deposits, large fills, addition of water to marginally stable slopes, and disturbance of the vegetative cover could result in slope failure.

6.3 FLOODING AND DEBRIS FLOW ACTIVITY

Flooding along the main channel of the Blue River and perennial and intermittent tributaries across the project area can be expected during the life of the project. The proximity of Dillon Dam to the project area may substantially lessen the risk of flooding along the Blue River. We recommend, however, that frequency of flooding and areas likely to be inundated should be evaluated by a competent hydrologist.

Recent alluvial fans (Qaf-1) may be subject to episodic debris flow activity and flooding. Recent experience in the Vail area and in the Big Thompson Canyon flood (August 1, 1976) has shown that alluvial fans associated with perennial and intermittent stream drainages, especially below steep slopes, may be at high risk due to debris flow activity and episodic flooding. We recommend avoidance of these areas for permanent habitable structures. Channelization of debris flow paths and barriers might be considered as an alternative to

avoidance; however, such schemes are expensive and may be only marginally effective.

6.4 ROCKFALLS

Rockfall hazards are associated with outcrop of Dakota Group quartzites and talus deposits in the southeast corner of the property. Permanent structures should be located away from rockfall hazard areas. Detailed analysis of rockfall hazards and mitigation techniques, however, are beyond the scope of this report. Typically, rockfall hazards are evaluated by computerized methods to determine rockfall runout, given slope angle and size, weight and shape of rocks likely to fall.

6.5 MISCELLANEOUS CONSIDERATIONS

Clay-shale bedrock commonly contains radioactive minerals that on decay may produce radon gas. The presence of radon gas in dwellings has been identified as a potential health risk. The evaluation of risk due to the natural occurrence of radon gas at this stage of investigation is beyond the scope of this report. In general, we believe the risk across Buffalo Mountain Ranch is not unusually high and can be mitigated by monitoring and ventilation, if required, of structure basements and crawl spaces. Additional consideration should be given to this potential problem once building sites have been selected.

Earthquake risk in the project area is considered low. The property is located in Seismic Zone 1 characterized by earthquakes of Modified Mercalli Intensity VI or smaller and minor damage. No active faults have been identified in the project area.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

Based on results of our reconnaissance-level engineering geologic studies and our experience with similar in mountainous areas of Colorado, we conclude:

1. Buffalo Mountain Ranch can be developed as a residential golf community with certain constraints imposed by geotechnical conditions and existing geologic hazards.

2. Geotechnical conditions appear to be suitable for light frame construction in areas underlain by relatively thick (>10 feet) alluvium and alluvial fan deposits. The Benton, Niobrara, and Pierre formations and colluvial materials derived from these bedrock units may contain expansive clays, requiring special foundation treatment to prevent risk of structural movement in lightly-loaded structures. In some areas, expansive bedrock may be present at relatively shallow depths (<10 feet) below unconsolidated surficial deposits and could be intersected during overlot grading or by deeper structures.

3. Existing landslides, earthflows and areas of surficial creep and slump indicate that slopes are locally unstable in their natural undisturbed states.

4. Slopes outside of mapped landslide areas appear to be relatively stable in their natural undisturbed state. Improper construction practices, however, including high steep cuts in bedrock and surficial deposits, large fills, addition of water to marginally stable slopes, and disturbance of the vegetative cover could result in slope failure.

7.2 RECOMMENDATIONS

In view of the general conclusions outlined above, we recommend:

1. Foundation investigations at individual building sites to identify the possible presence of swelling bedrock and soils at foundation levels and to provide criteria for designs to resist the risk of foundation damage from swelling bedrock and soils.

2. Areas mapped as discrete landslides should be avoided, if possible, for construction of permanent structures and roadways. Fifty-foot setbacks should be maintained from known landslide scarps and toe areas as a precaution. For preliminary planning purposes, soil slopes should be cut no steeper than 3h:1v, and bedrock slopes no steeper than 2h:1v. Large cuts in bedrock, especially on north-facing slopes will require site-specific geological and geotechnical investigations to provide cut-slope design criteria.

3. Avoidance of landslide areas or minimum setbacks may not be possible or practical in all situations. In these cases, we recommend site-specific engineering studies to assess the risk associated with specific construction plans and methods to reduce the risk of slope failure.

4. Care should be exercised in drainage and golf course irrigation plans to divert water away from landslide areas. If fairways, greens or tee boxes are planned for landslide areas, consideration should be given to surface and subsurface drainage to minimize infiltration of water into landslide masses. Similarly, grading in landslide areas should be minimized or designed to enhance slope stability, not degrade it.

5. Frequency of flooding and areas likely to be inundated along the Blue River and tributary drainages in the project area should be evaluated by a competent hydrologist. Recent alluvial fans (Qaf-1) should be avoided for permanent habitable structures.

6. Permanent structures should be located away from rockfall hazard areas associated with outcrops of the Dakota Group and talus deposits in the southeast corner of the Clark-Hyatt parcel.

8. GENERAL INFORMATION

Information in this report is intended to provide an assessment of geological and geotechnical conditions for mountain property development; no other use is intended or authorized. The report is based on reconnaissance-level geologic mapping, excavation of test pits, and our general understanding of geological processes in the project area, the proposed construction, and past experience with similar conditions. Variations can and do occur in geological materials, and departures from conditions portrayed in this report are possible. The conclusions and recommendations presented in this report are subject to the limitations and explanations contained herein. The economic and technical performance of the project cannot be guaranteed in any respect.

MICHAEL W. WEST & ASSOCIATES, INC.

By: Michael W. West, Ph.D., P.E.
President

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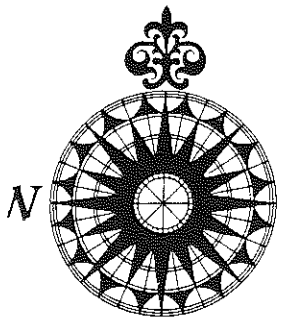
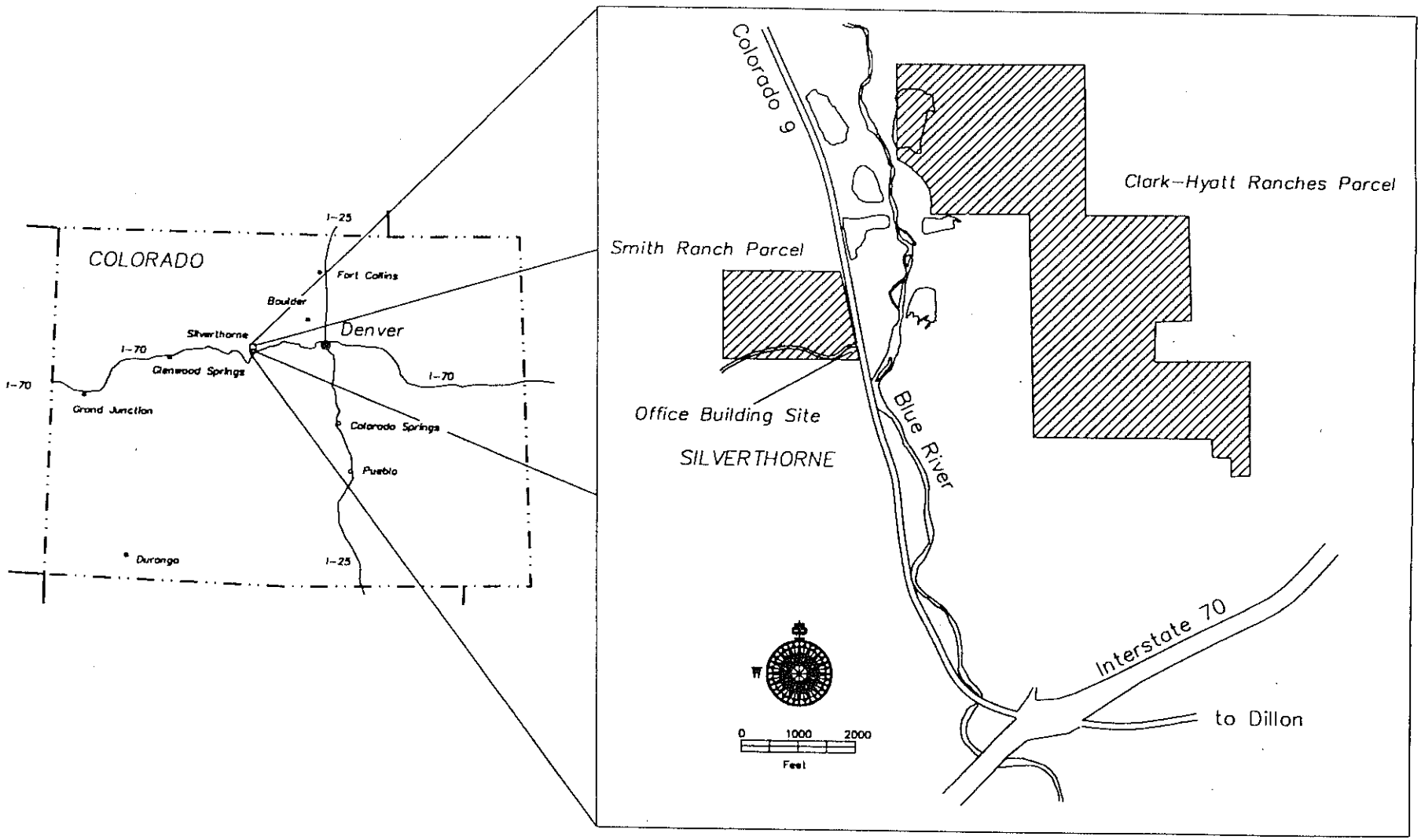


FIGURES



MICHAEL W. WEST & ASSOCIATES, INC.	Location Map, Clark-Hyatt and Smith Ranches Parcels Summit County, Colorado	BY: M.W. West PROJ: 98299 FIGURE: 1

EXPLANATION – GEOLOGIC MAPS AND GEOLOGIC CROSS SECTIONS

Qal ALLUVIUM – Sands and gravels with scattered cobbles and boulders; medium dense to dense; lenses of silt and clay; lenticular bedding; moderately-well to well-stratified.

Qal-m MARSH ALLUVIUM –Similar to alluvium (Qal) but contains organic soils and vegetative debris.

Qal-t TERRACE ALLUVIUM –Sand and gravels, cobbly and bouldery; medium dense to dense; locally capped by silty, high plasticity clay; lenticalr bedding; moderately-well to well-stratified.

Qaf ALLUVIAL FANS – Sands, gravels, and cobbles, variable density, loose to dense; lenticular; poorly sorted; moderately-well to poorly stratified; recent fan deposits (Qaf-1) may be prone to settlement or collapse.

Qgo GLACIAL OUTWASH – Gravels, sandy to silty; cobbly to bouldery, medium dense to dense; contains lenses of clay derived from colluvium near valley slopes; poorly sorted; variably stratified.

Qls-b BLOCK LANDSLIDE – Rotational and translational(?) landslides involving probable deep-seated failure of bedrock; moderate to high risk of future instability.

Qls-ef EARTHFLOW – Active earthflow; slowly moving (inches per year); overriding , lobate toe; actively toppling trees.

Qls-cs SURFICIAL CREEP AND SLUMP – Movement in unconsolidated surficial deposits and weathered bedrock primarily on steep, north-facing slopes.

Qt TALUS – Angular gravel, cobble, and boulder-size material deposited by rockfalls; resides at or near angle of repose.

Qc-g COLLUVIUM AND OLDER GRAVEL DEPOSITS (UNDIVIDED) – Sandy, gravelly and cobbly clays to clayey sands and gravels with scattered cobbles, non-sorted; non-stratified; precise origin unknown.

Qc/Kp COLLUVIUM MANTLING PIERRE SHALE – Sandy to silty clays with scattred gravels and cobbles; non-sorted and non-stratified.

Qc/Kn COLLUVIUM MANTLING NIOBRARA FORMATION – Mainly sandy clays and silts with scattered gravels and cobbles; non-sorted; non-stratified.

Qc/Kdbn COLLUVIUM MANTLING DAKOTA, BENTON & NIOBRARA FORMATIONS (UNDIVIDED) – Sandy to silty clays, sandy clays, clayey silts, clayey to silty sands with scattered gravels and cobbles; non-sorted; non-stratified.

Qc/Kd COLLUVIUM MANTLING DAKOTA GROUP – Clayey, silty sands to sandy clays with scatttered gravels and cobbles; non-sorted; non-stratified.

Kpl LOWER PIERRE SHALE – Marine clay-shale, thinly-bedded to fissile; variable joint spacing; contains expansive clays and discrete highly expansive beds derived from volcanic ash; prone to landsliding.

Kn NIOBRARA FORMATION – Calcareous shales and shaly limestone in upper part; blocky gray limestone in lower part; shales are very thin-bedded to fissile; variable joint spacing; contact with Pierre Shale is indistinct.

Kb BENTON SHALE – Block to dark gray shales with interbedded sandstones and limestones near top; unit apparently does not outcrop in project area but is inferred to underlie colluvium in southeast part of project area.

Kd DAKOTA GROUP – Upper quartzite, middle shale and lower quartzite units; upper quartzite is cross-bedded and contains carbonaceous shale; middle shale is carbonaceous with interbeds of quartzite; lower medium-grained quartzite contains thin shale interbeds; variable bedding and joint spacing.

Jm MORRISON FORMATION – Calcareous claystones with medium-grained sandstones in lower part; does not outcrop in project area.

Geologic contact; approximately located; queried where uncertain.

Fault; approximately located; queried where uncertain.

Landslide showing scarp and direction of movement.

TP-6 Test pit location and number.

Location and view direction of geologic cross section.

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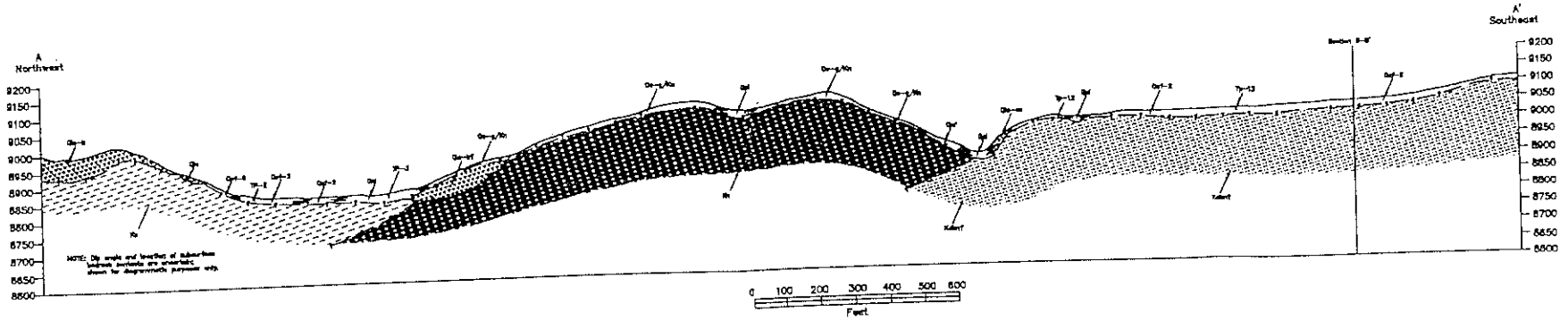
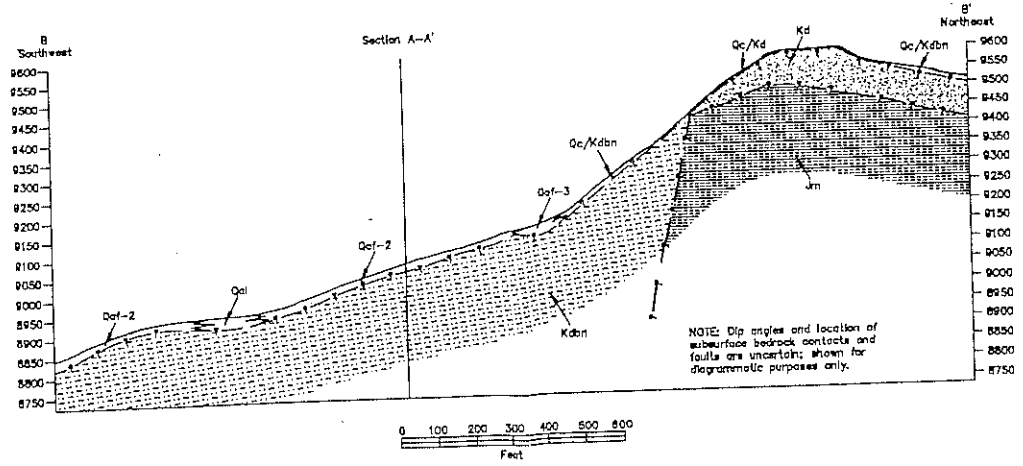
Explanation for Geologic Maps and Geologic Cross Sections
Buffalo Mountain Ranch

BY: J. Moya and M. West

PROJ: 98299 FIGURE: 2



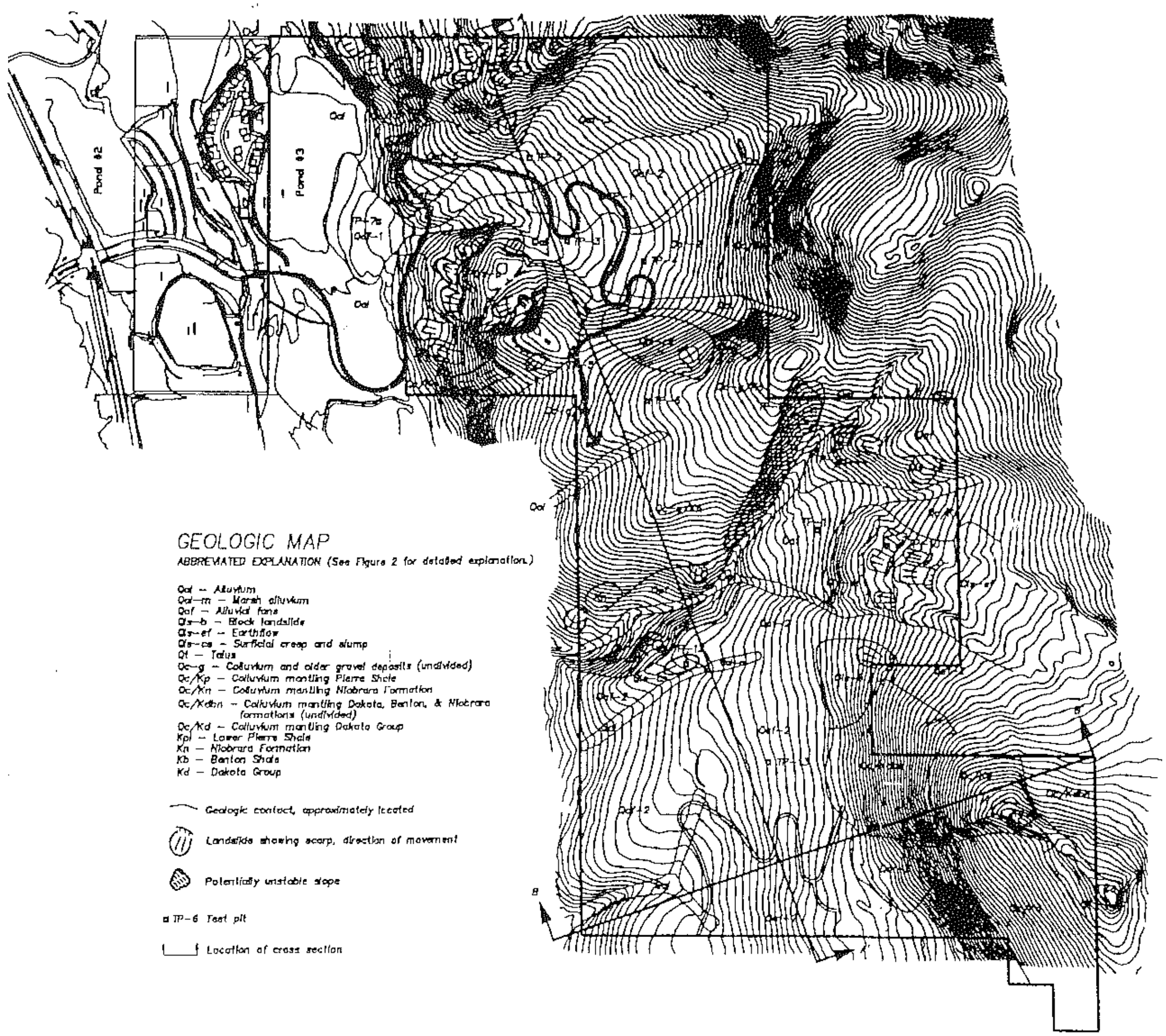


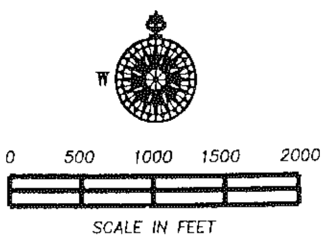
MICHAEL W. WEST
& ASSOCIATES, INC.

Geologic Cross Sections
A–A' and B–B'
Clark–Hya[illegible]arcel

BY: J.C. Moya & M.W. West

PROJ: 98299 FIGU[illegible]E: 4





GEOLOGIC MAP

ABBREVIATED EXPLANATION (See Figure 2 for detailed explanation.)

Qal – Alluvium
Qal–m – Marsh alluvium
Qaf – Alluvial fans
Qls–b – Block landslide
Qls–ef – Earthflow
Qls–cs – Surficial creep and slump
Qt – Talus
Qc–g – Colluvium and older gravel deposits (undivided)
Qc/Kp – Colluvium mantling Pierre Shale
Qc/Kn – Colluvium mantling Niobrara Formation
Qc/Kdbn – Colluvium mantling Dakota, Benton, & Niobrara formations (undivided)
Qc/Kd – Colluvium mantling Dakota Group
Kpl – Lower Pierre Shale
Kn – Niobrara Formation
Kb – Benton Shale
Kd – Dakota Group

Geologic contact, approximately located

Landslide showing scarp, direction of movement

Potentially unstable slope

TP-6 Test pit

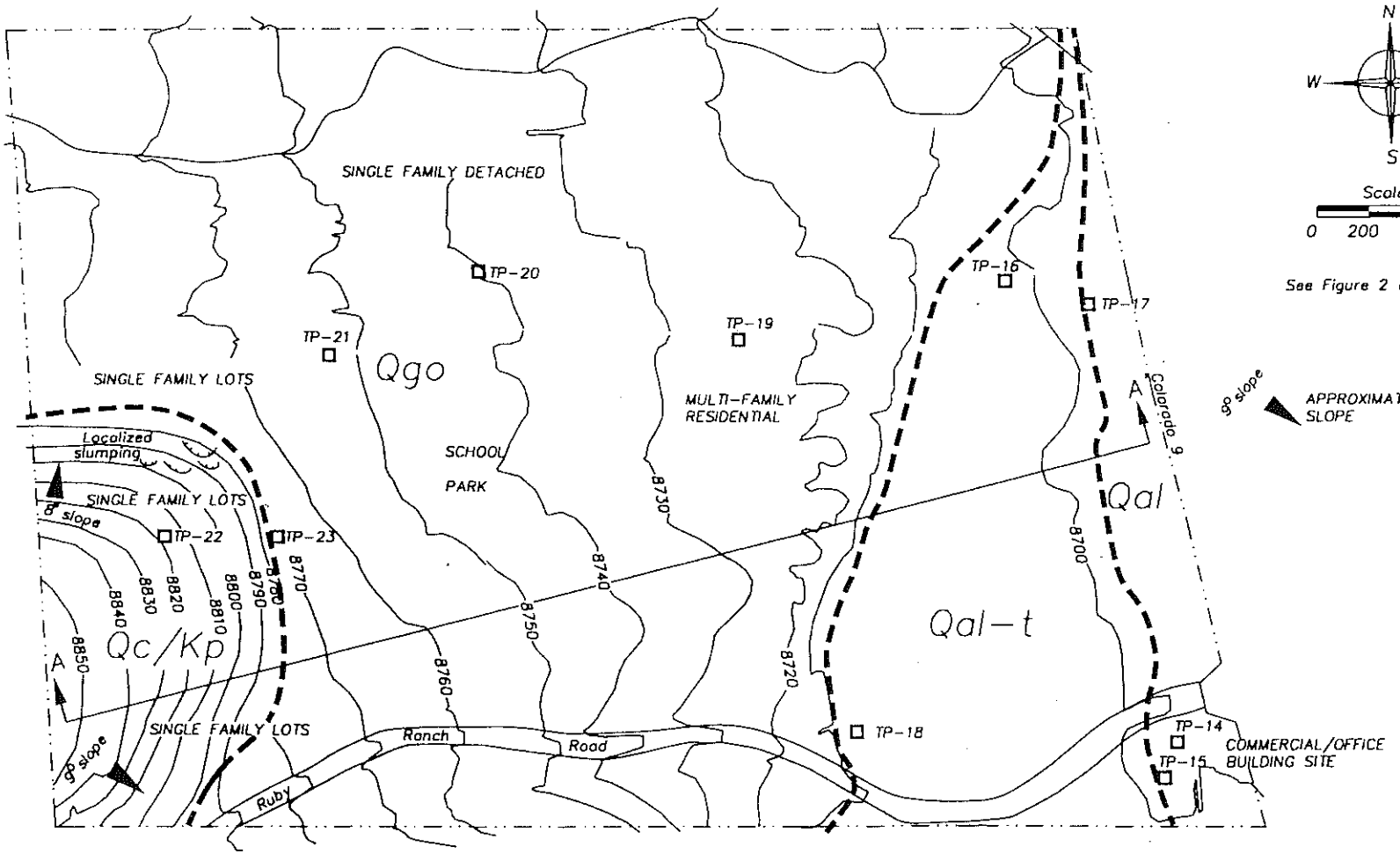
Location of cross section

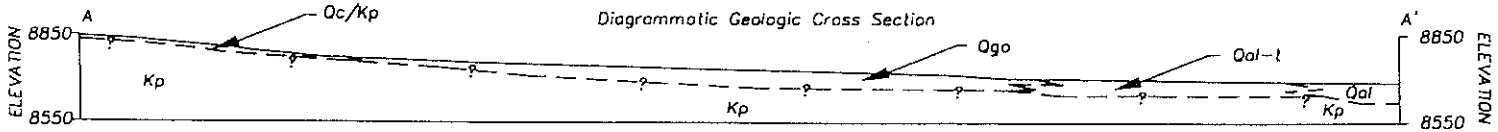
MICHAEL W. WEST
& ASSOCIATES, INC.

Geologic Map,
CLark–H[illegible]tt Parcel,
Summit County, Colorado

BY: J.C. Moya

PROJ: 98299 FIGURE 3





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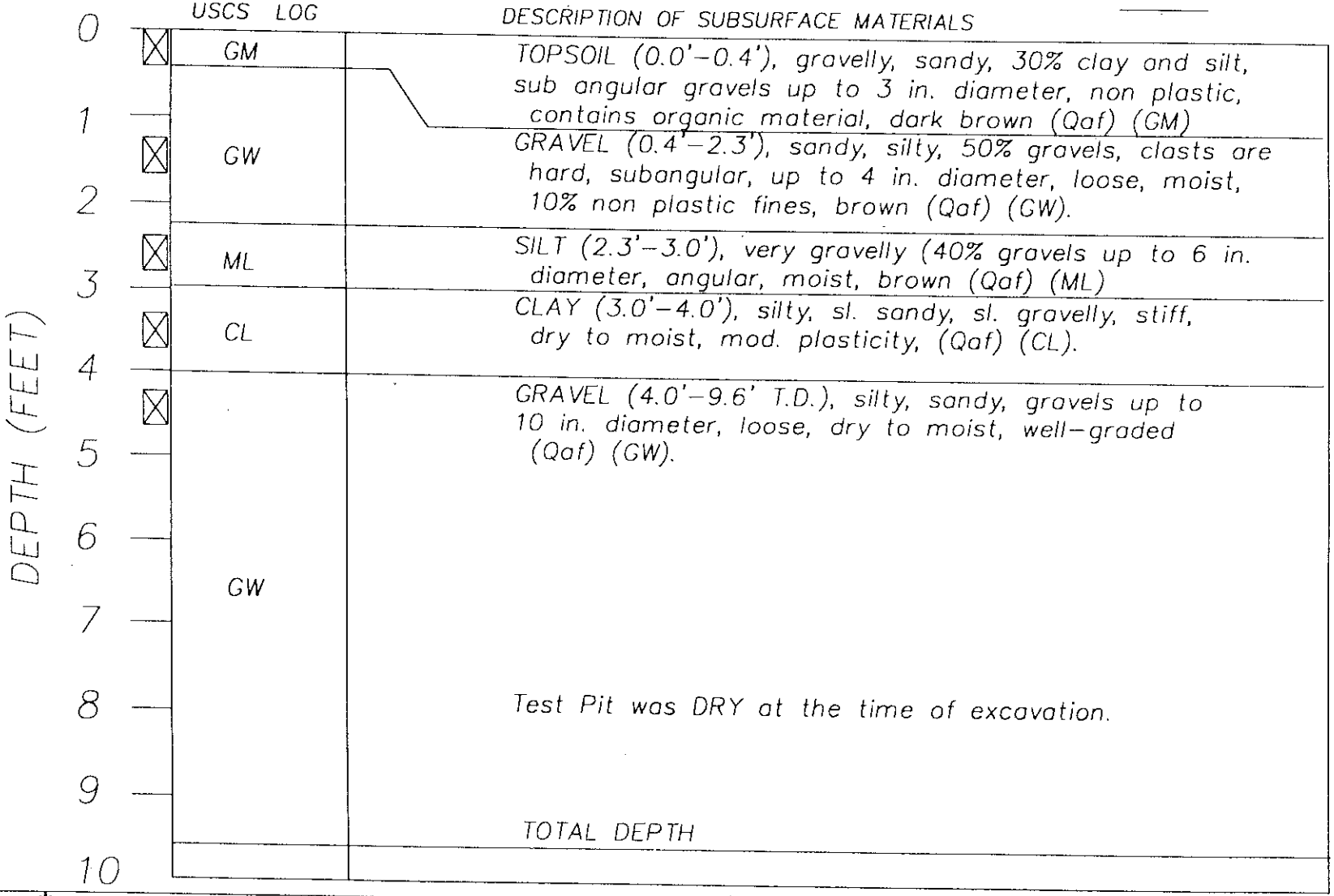
Geologic Map and Geologic Cross Section A–A'
Smith Ranch Parcel

BY: J.C. Moya

PROJ: 98299 FIGURE: 5

GEOLOGIC LOG OF TEST PIT NUMBER TP-1



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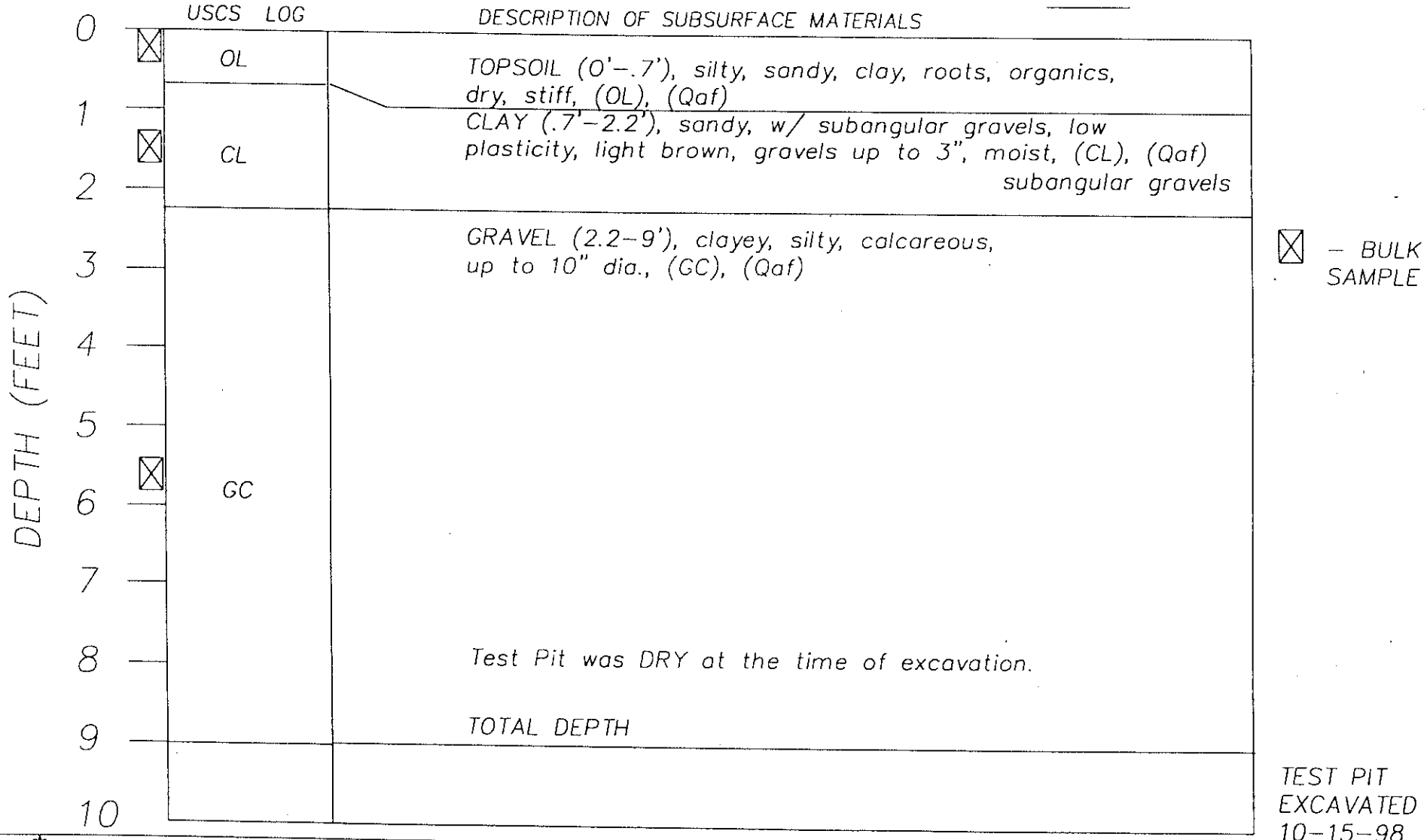
BUFFALO MOUNTAIN RANCH
CLARK–HYATT PARCEL
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE:

GEOLOGIC LOG OF TEST PIT NUMBER TP-2



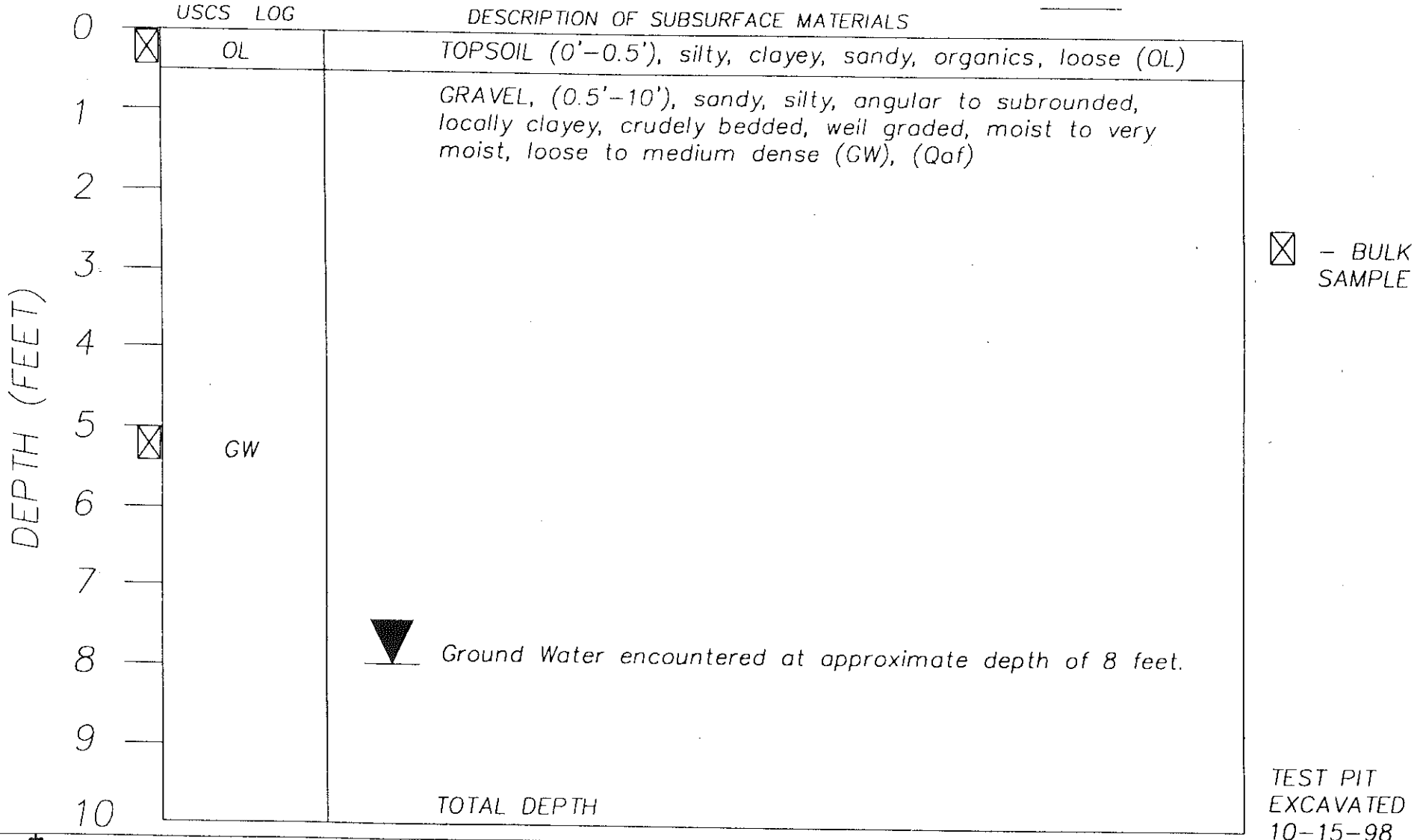
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH
CLARK–HYATT PARCEL
LOG OF TEST PIT

BY: JCM DECEMBER 1998

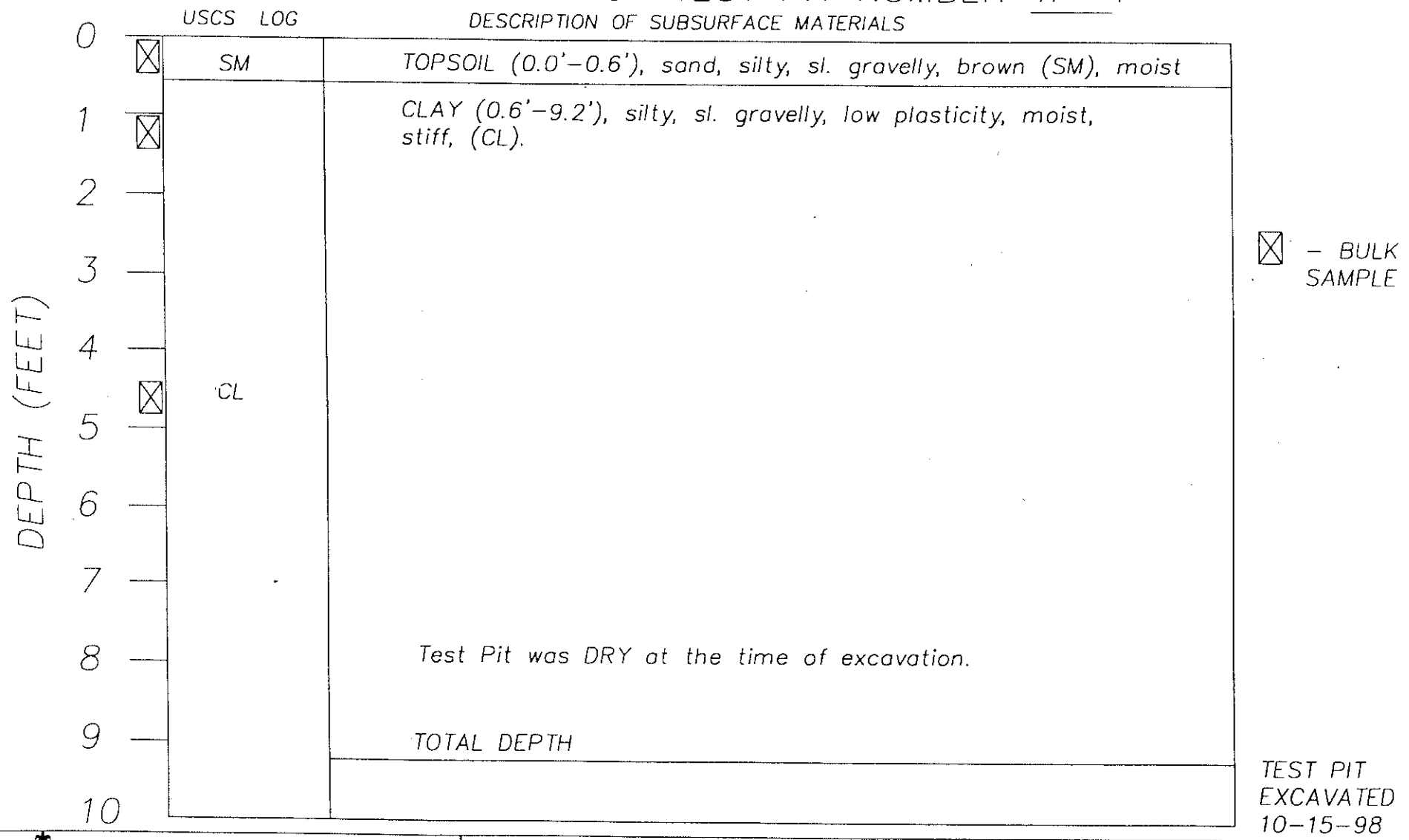
PROJ: 98299 FIGURE: 7

GEOLOGIC LOG OF TEST PIT NUMBER TP-3



MICHAEL W. WEST & ASSOCIATES, INC.	BUFFALO MOUNTAIN RANCH CLARK-HYATT PARCEL LOG OF TEST PIT	BY: JCM DECEMBER 1998 PROJ: 98299 FIGURE: ?

GEOLOGIC LOG OF TEST PIT NUMBER TP-4



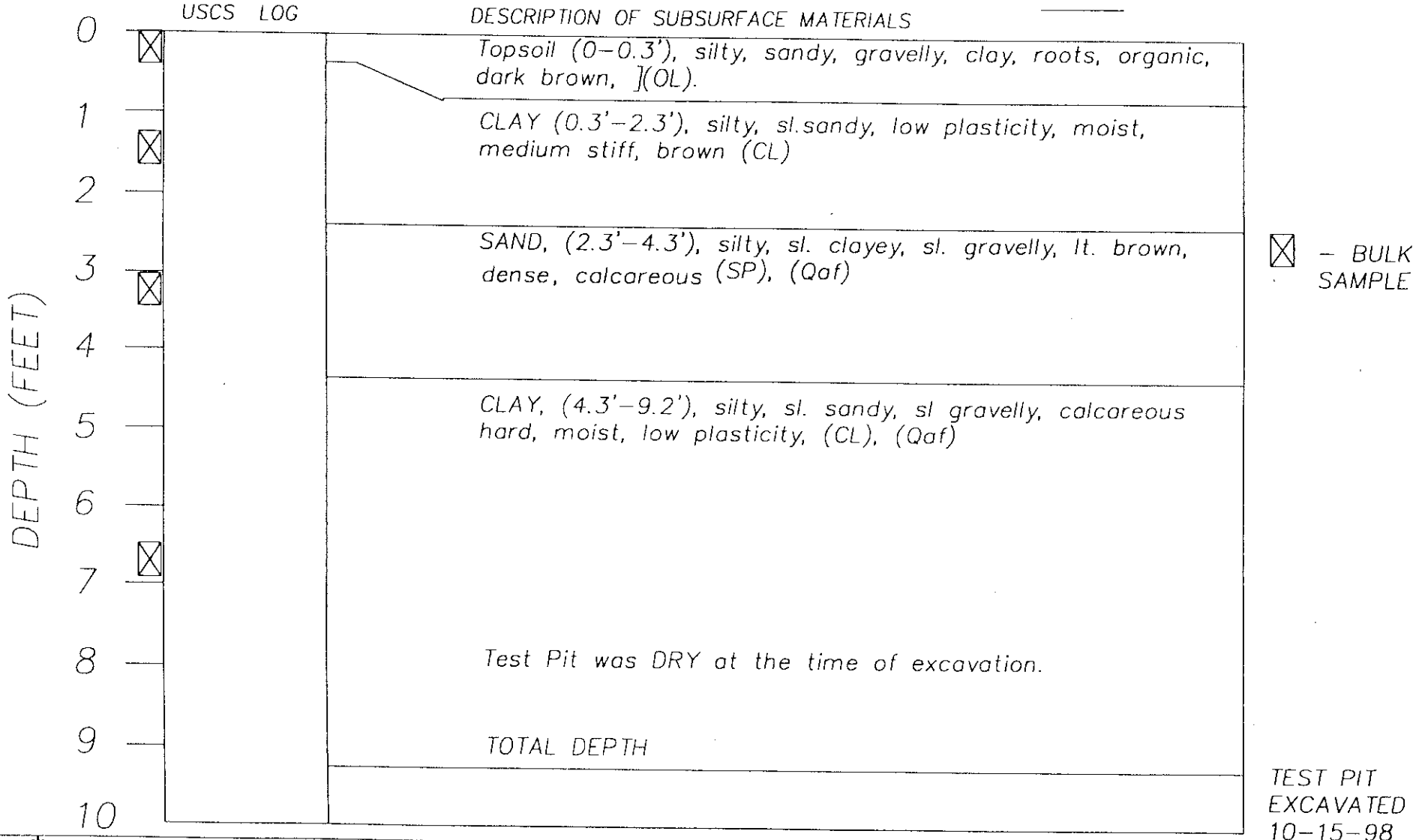
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH
CLARK-HYATT PARCEL
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 9

GEOLOGIC LOG OF TEST PIT NUMBER TP-5



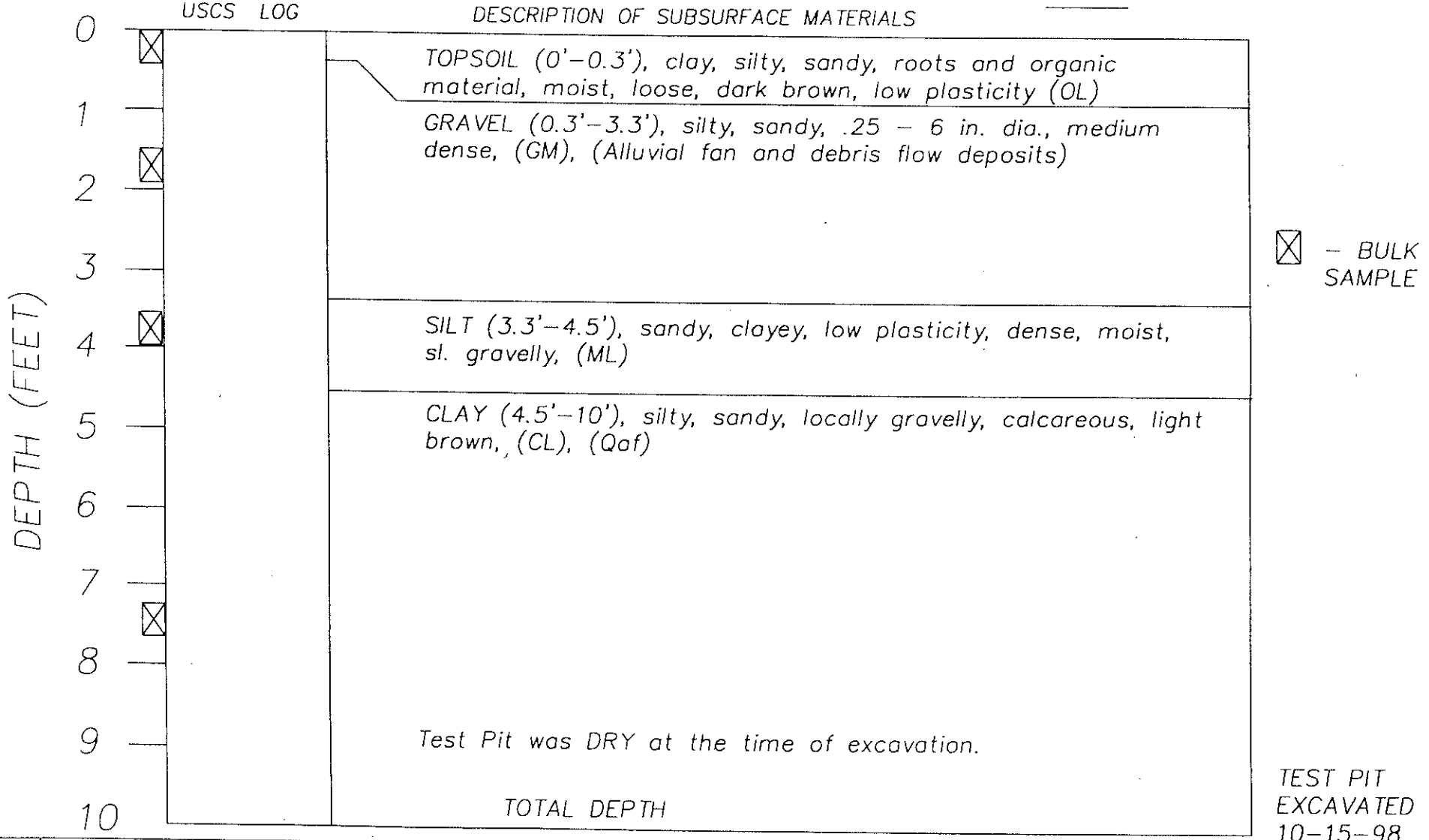
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH
CLARK–HYATT PARCEL
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 7

GEOLOGIC LOG OF TEST PIT NUMBER TP-6



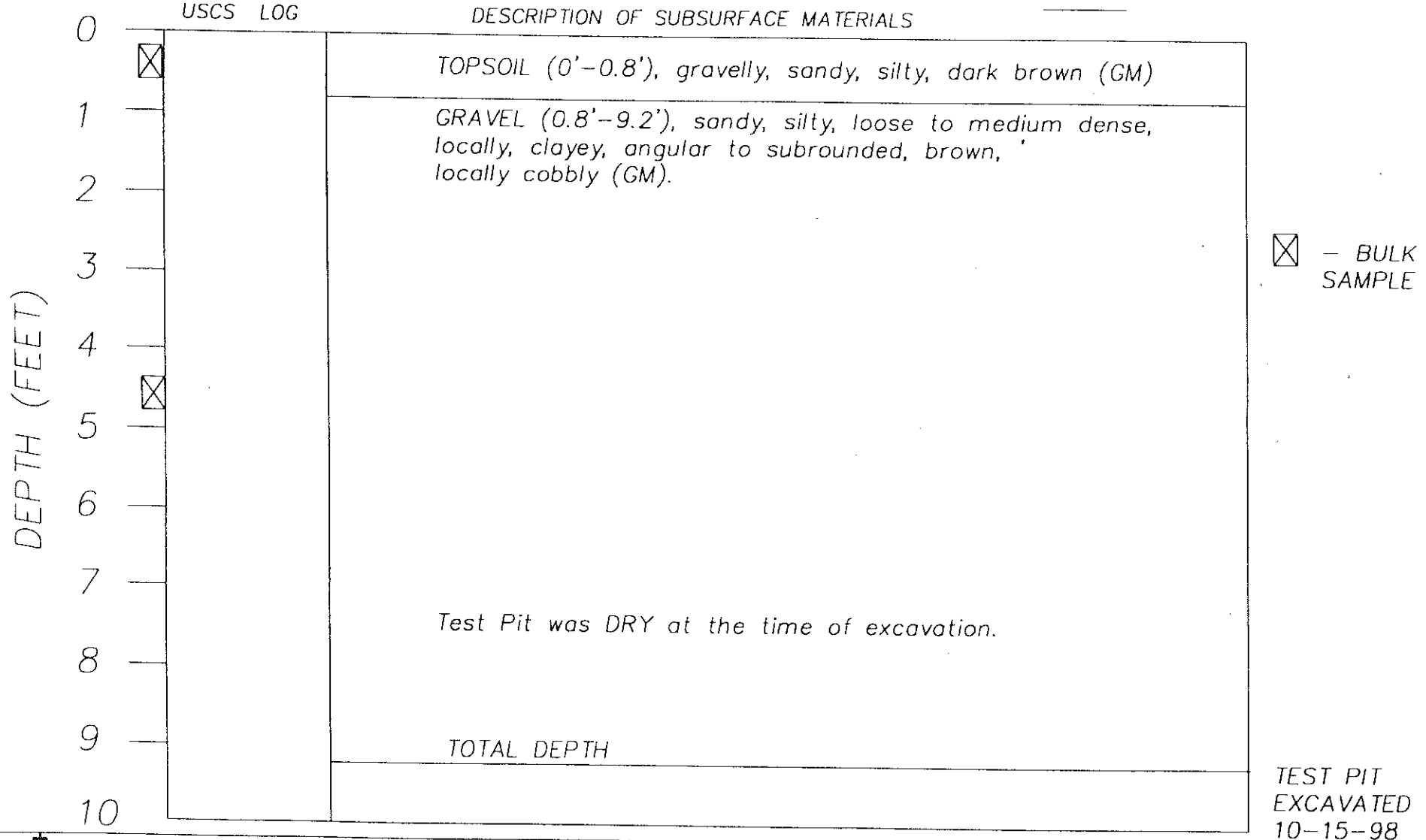
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH
CLARK–HYATT PARCEL
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 11

GEOLOGIC LOG OF TEST PIT NUMBER TP-7



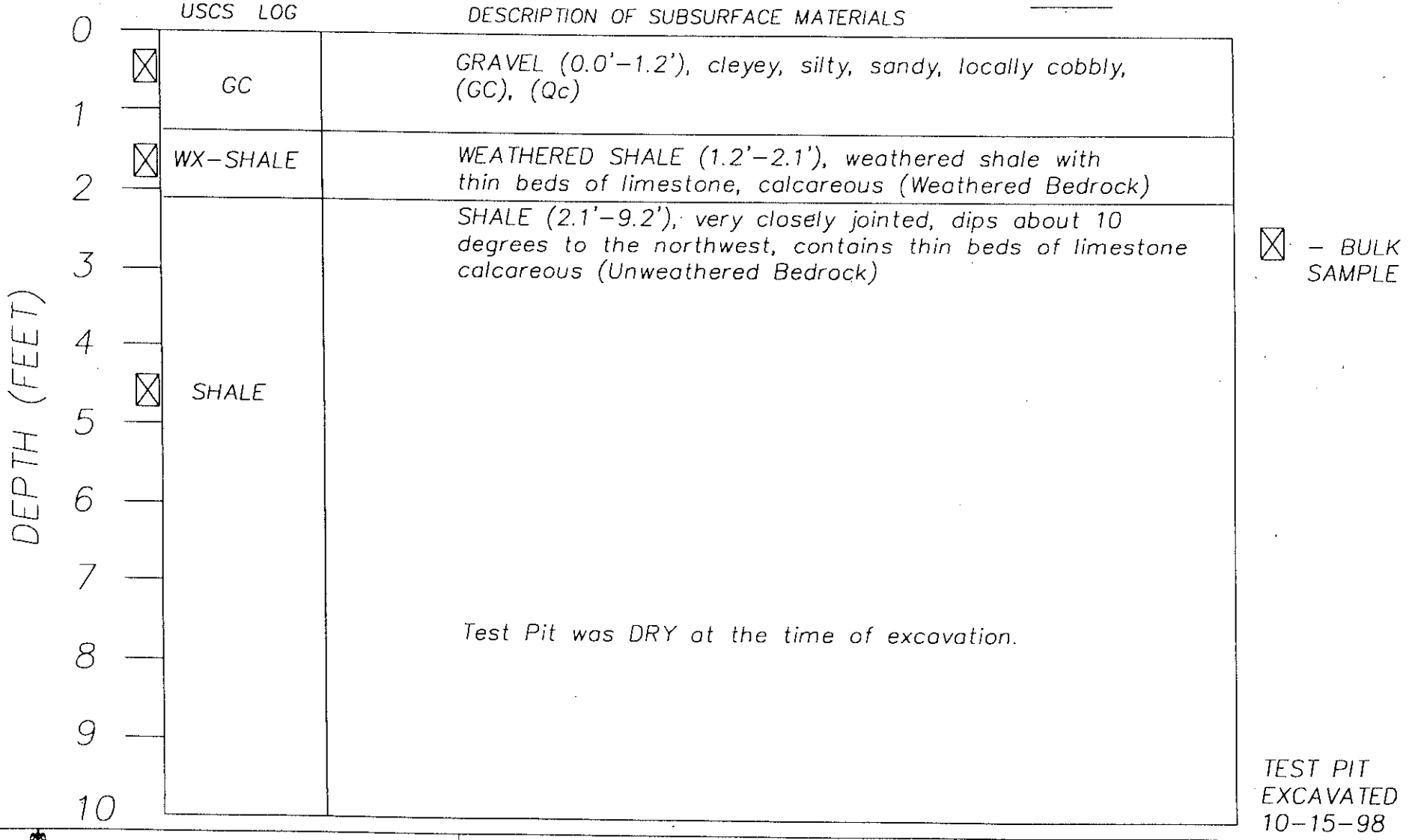
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH
CLARK-HYATT PARCEL
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 12

GEOLOGIC LOG OF TEST PIT NUMBER TP-8



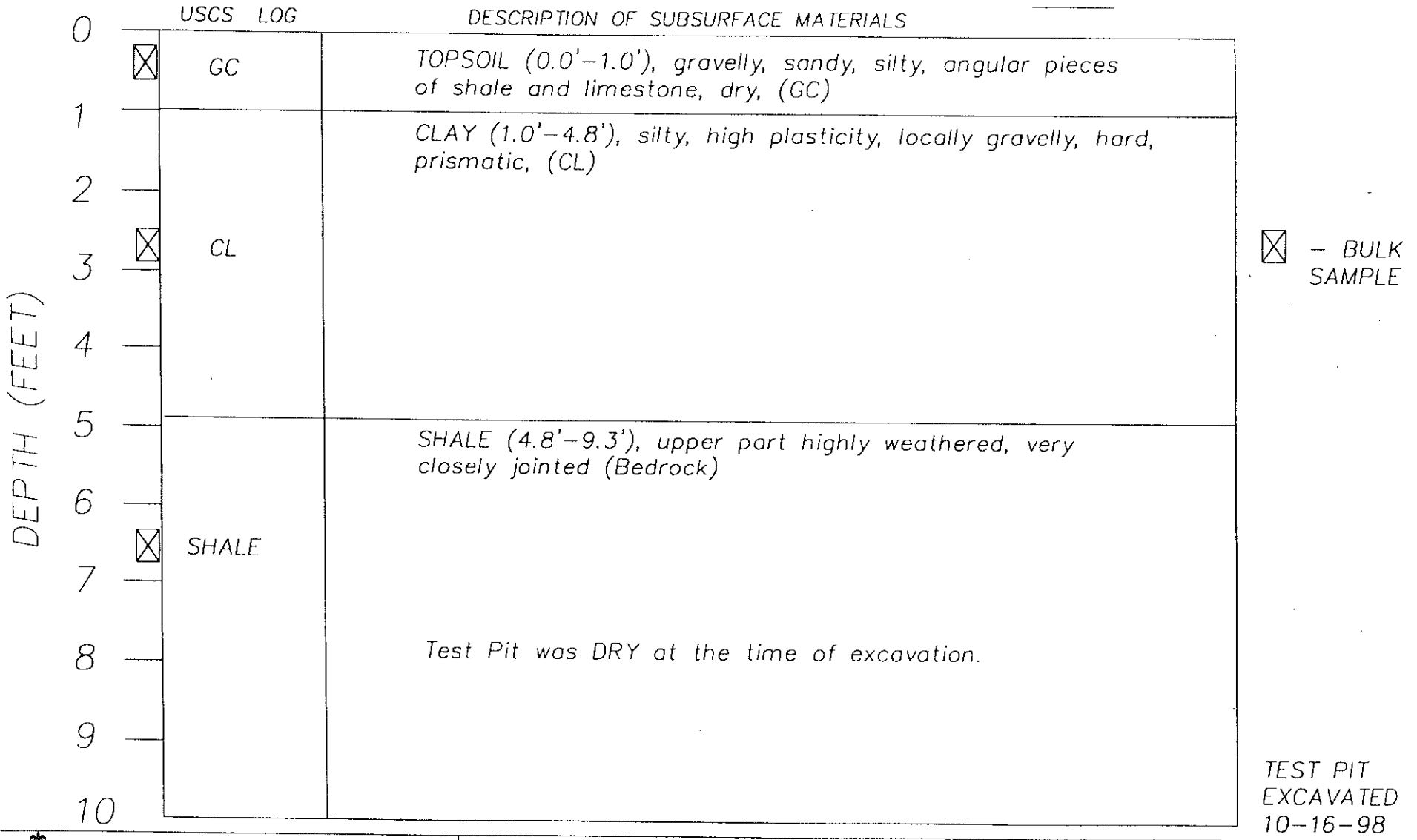
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH
CLARK–HYATT PARCEL
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 13

GEOLOGIC LOG OF TEST PIT NUMBER TP-9



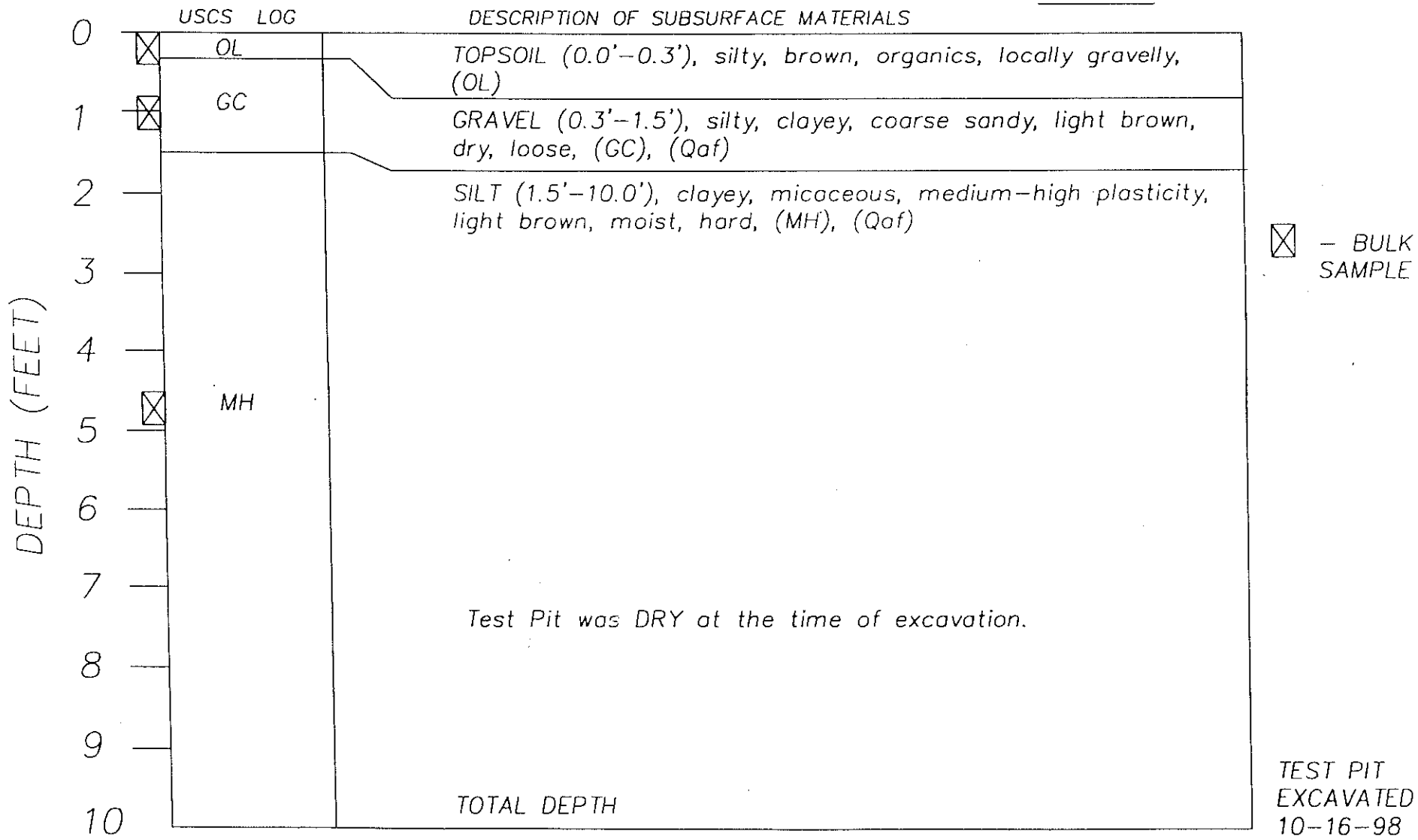
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH
CLARK–HYATT PARCEL
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 4

GEOLOGIC LOG OF TEST PIT NUMBER TP-10



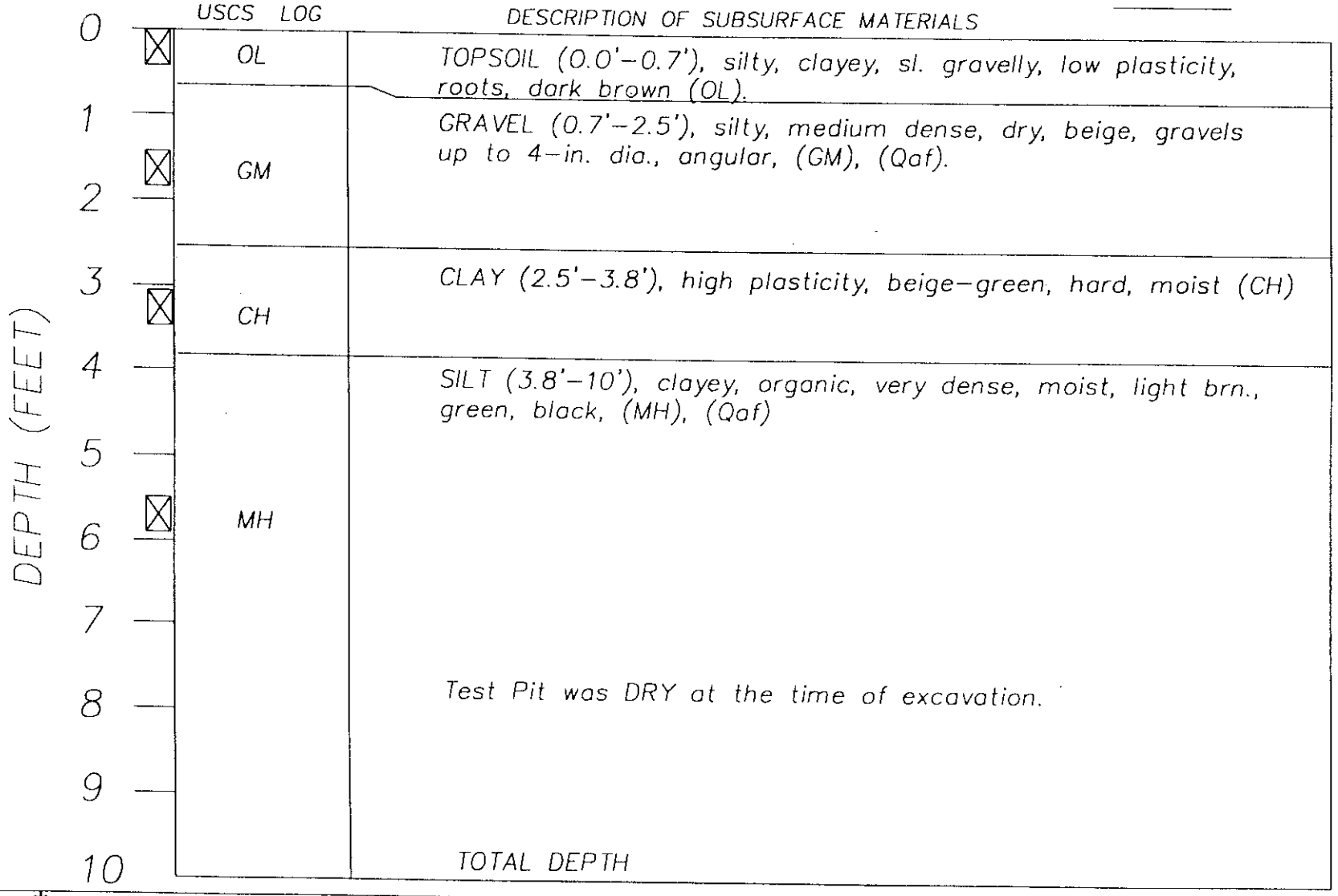
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH
CLARK–HYATT PARCEL
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 15

GEOLOGIC LOG OF TEST PIT NUMBER TP-11



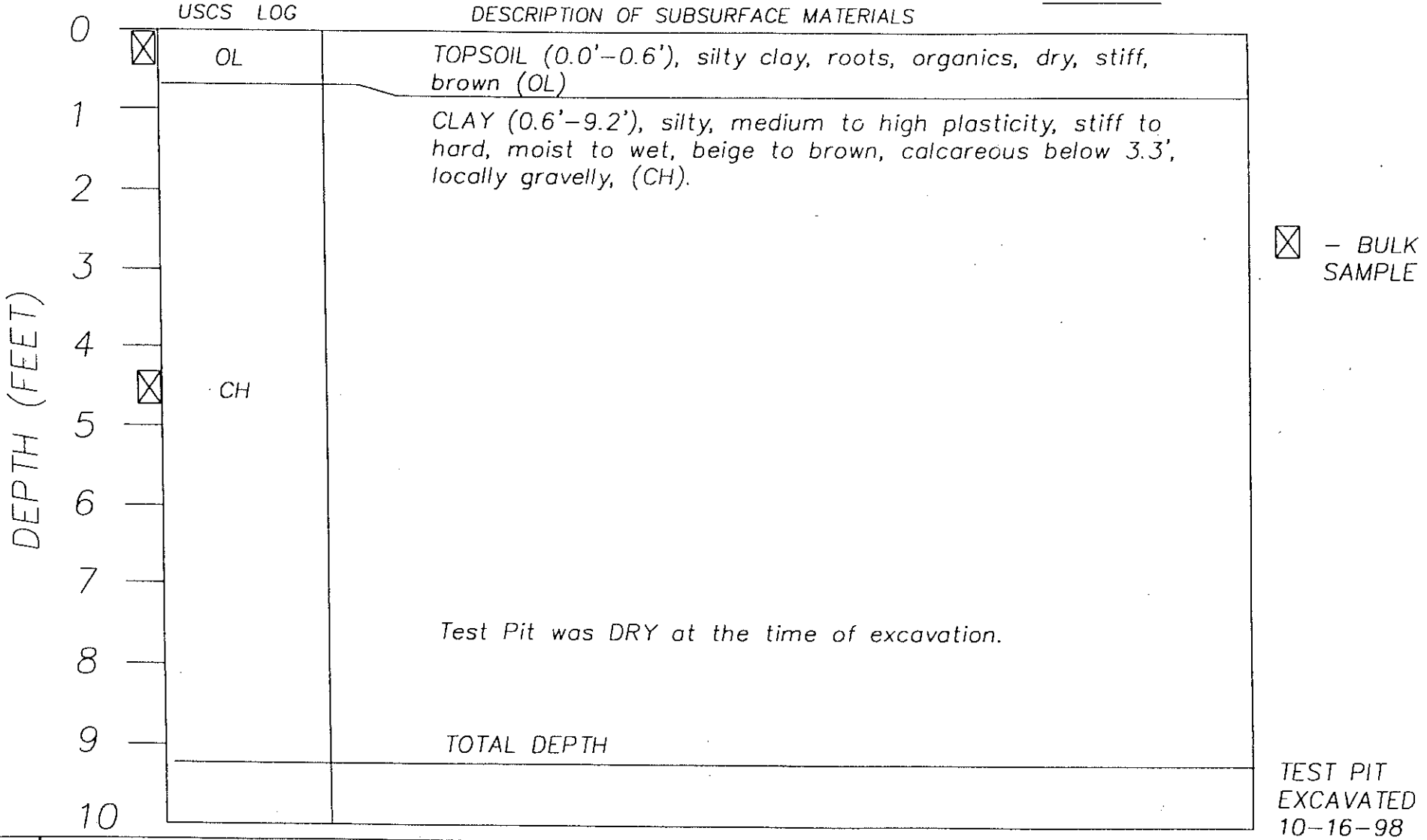
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH
CLARK–HYATT PARCEL
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 16

GEOLOGIC LOG OF TEST PIT NUMBER TP-13



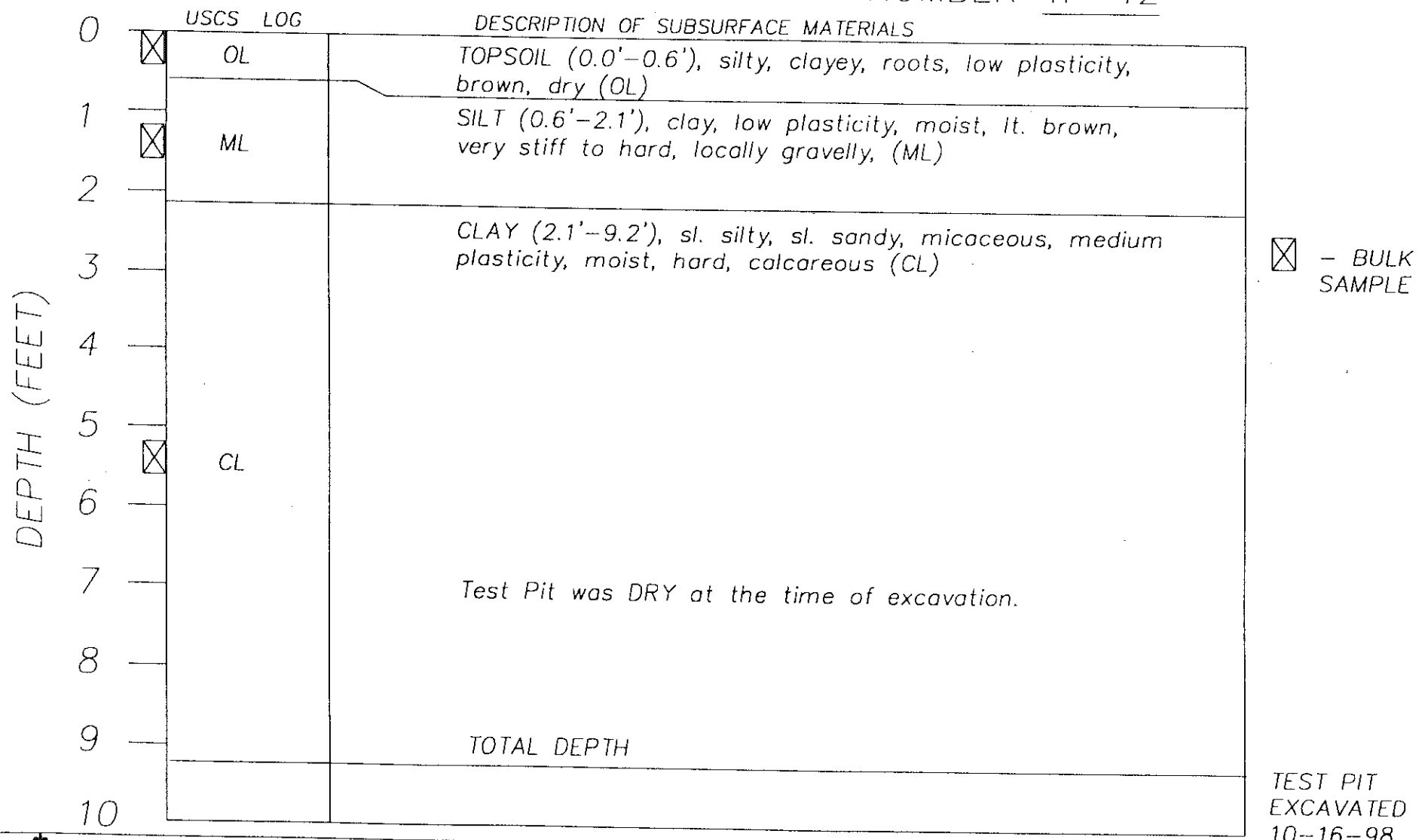
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH
CLARK–HYATT PARCEL
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 18

GEOLOGIC LOG OF TEST PIT NUMBER TP-12



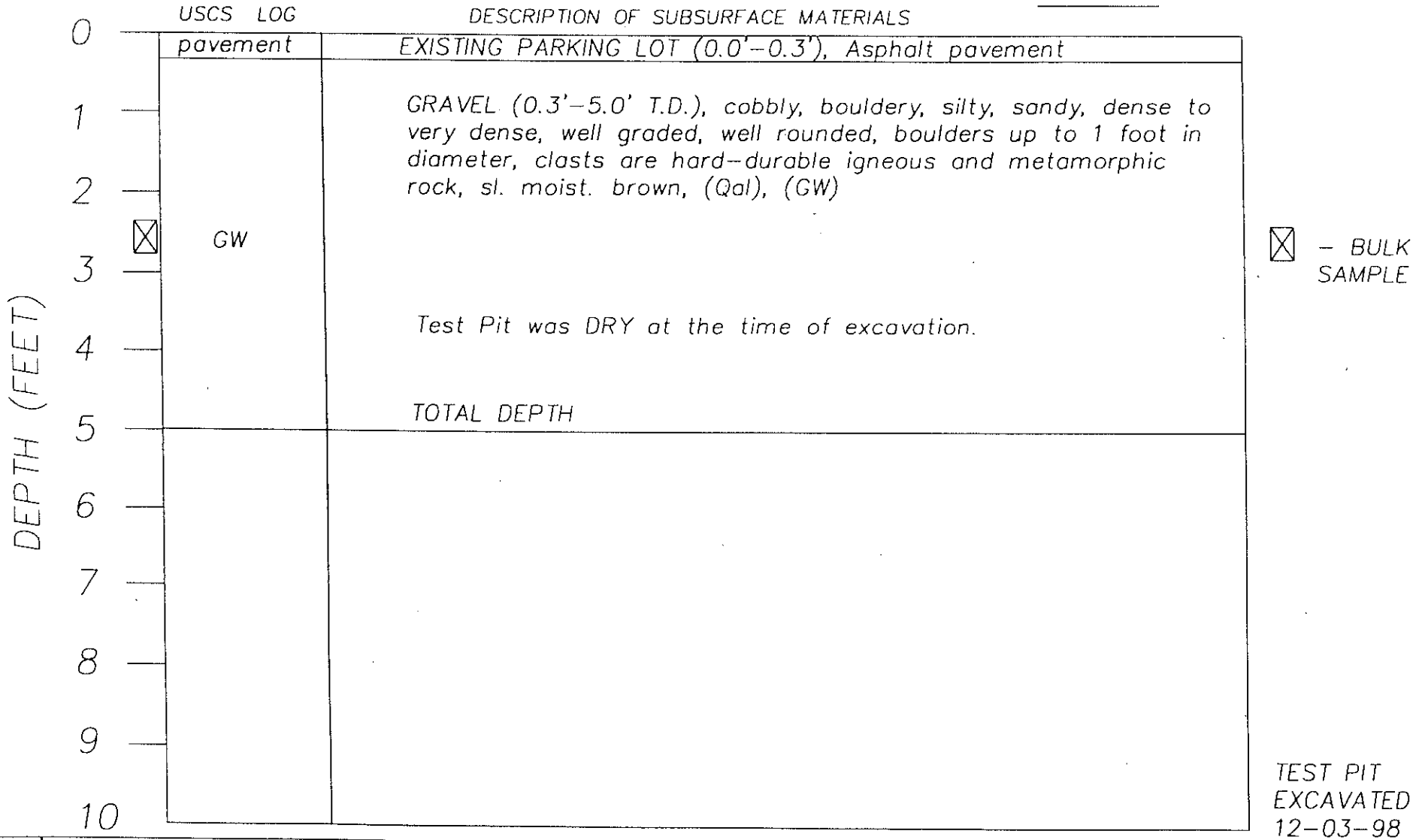
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH
CLARK–HYATT PARCEL
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 7

GEOLOGIC LOG OF TEST PIT NUMBER TP-14



MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH (SMITH)
COMMERCIAL BUILDING SITE
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 19

GEOLOGIC LOG OF TEST PIT NUMBER TP-15

DEPTH (FEET)

	USCS LOG	DESCRIPTION OF SUBSURFACE MATERIALS
0	pavement	EXISTING PARKING LOT (0.0'-0.4'), Asphalt pavement
1	GW	GRAVEL (0.4'-5.0' T.D.), cobbly, bouldery, silty, sandy, dense to very dense, well graded, well rounded, boulders up to 1 foot in diameter, clasts are hard-durable igneous and metamorphic rock, sl. moist. brown, (Qal), (GW)
2		
3		Test Pit was DRY at the time of excavation.
4		
5		TOTAL DEPTH
6		
7		
8		
9		
10		

☒ - BULK SAMPLE

TEST PIT EXCAVATED 12-03-98

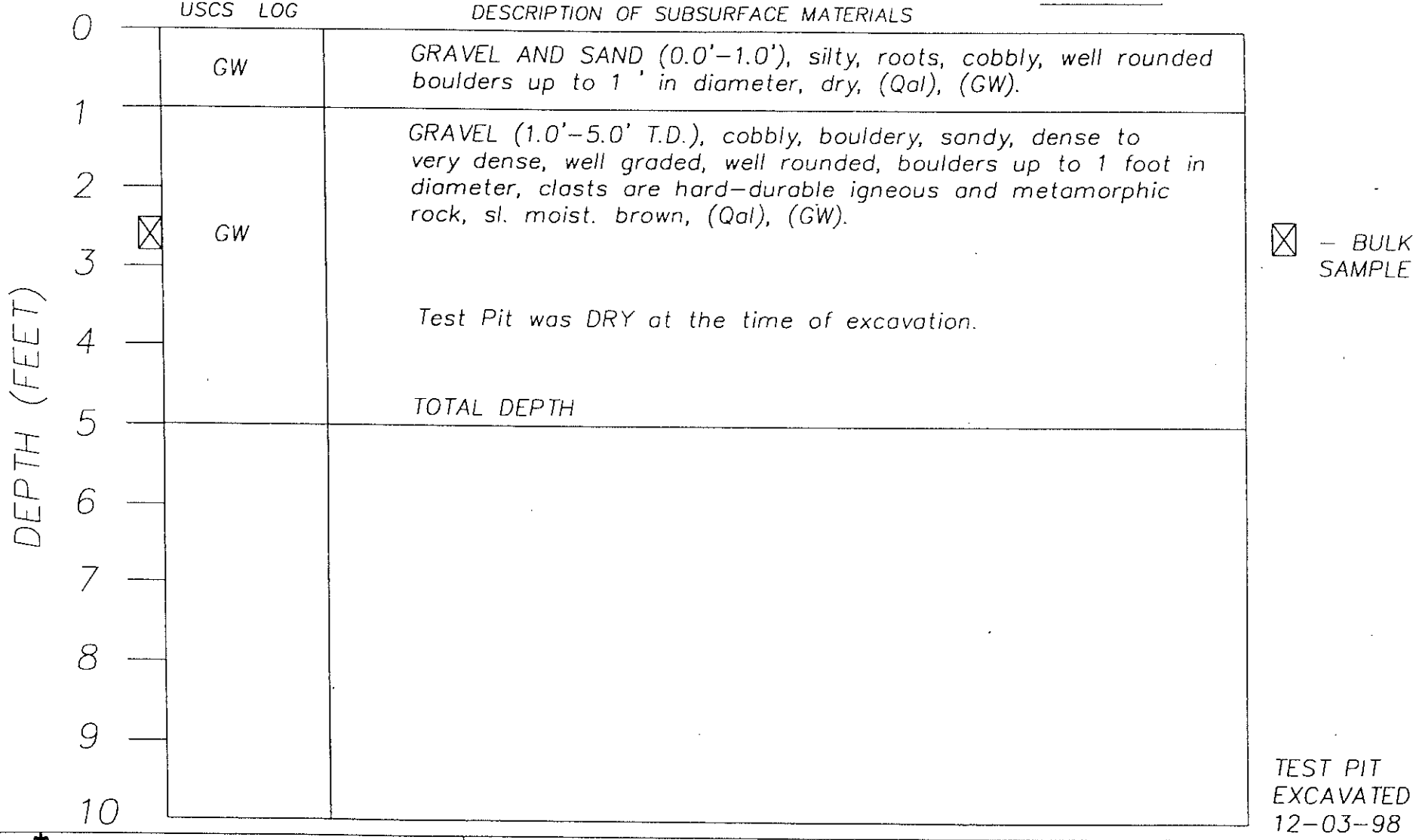
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH (SMITH)
COMMERCIAL BUILDING SITE
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 20

GEOLOGIC LOG OF TEST PIT NUMBER TP-16



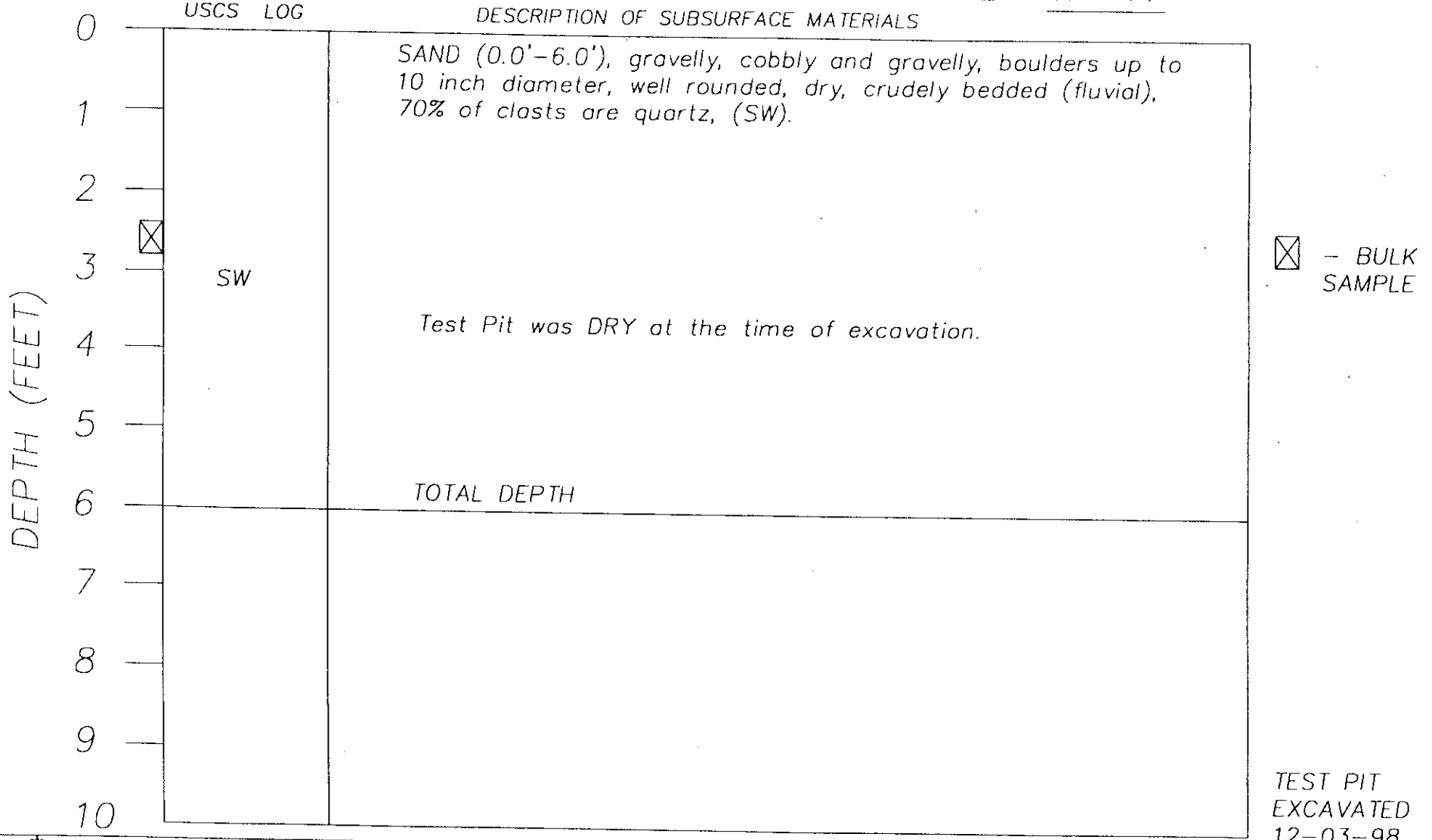
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH (SMITH)
RESIDENTIAL AREA
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 21

GEOLOGIC LOG OF TEST PIT NUMBER TP-17



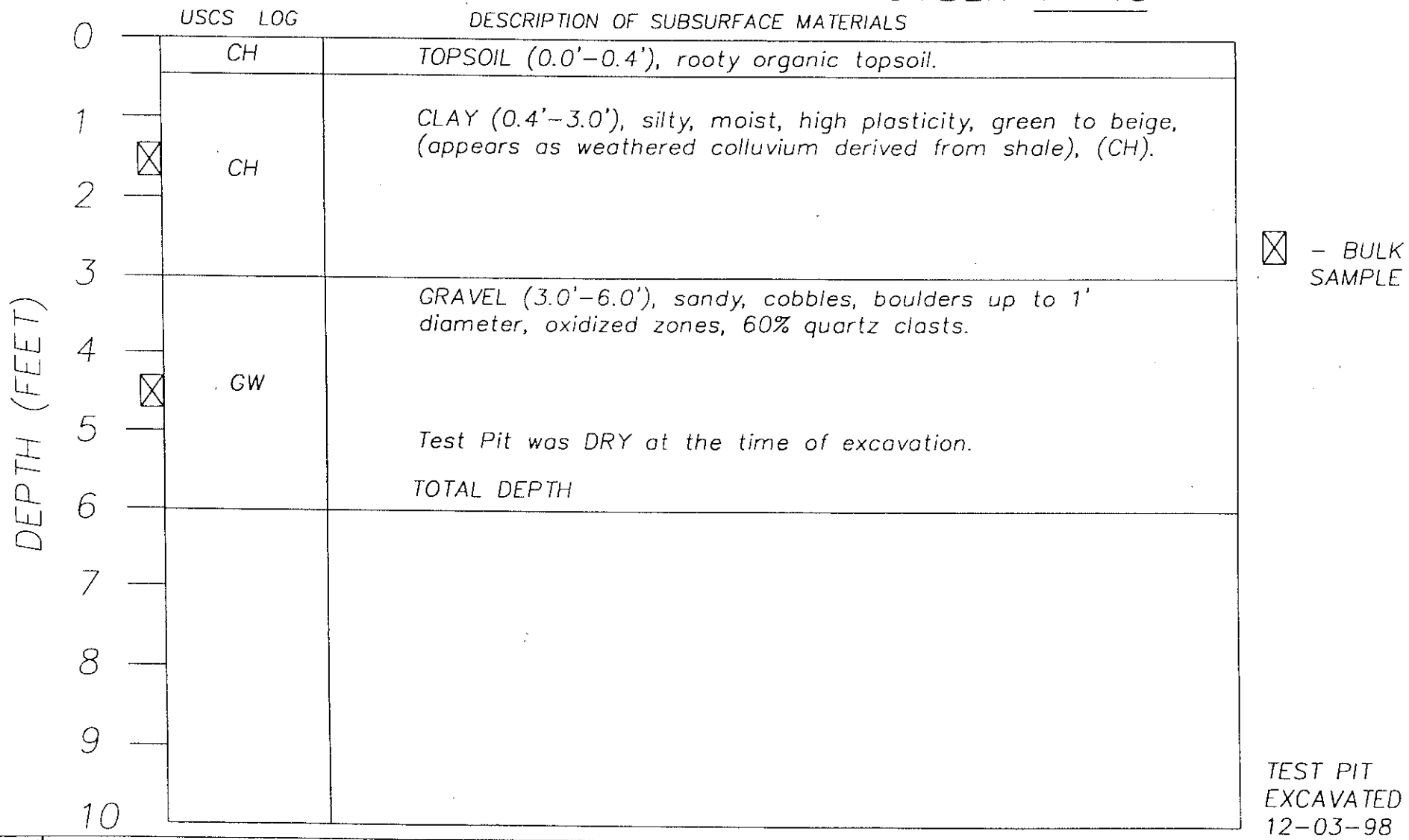
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH (SMITH)
RESIDENTIAL AREA
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: ?2

GEOLOGIC LOG OF TEST PIT NUMBER TP-18



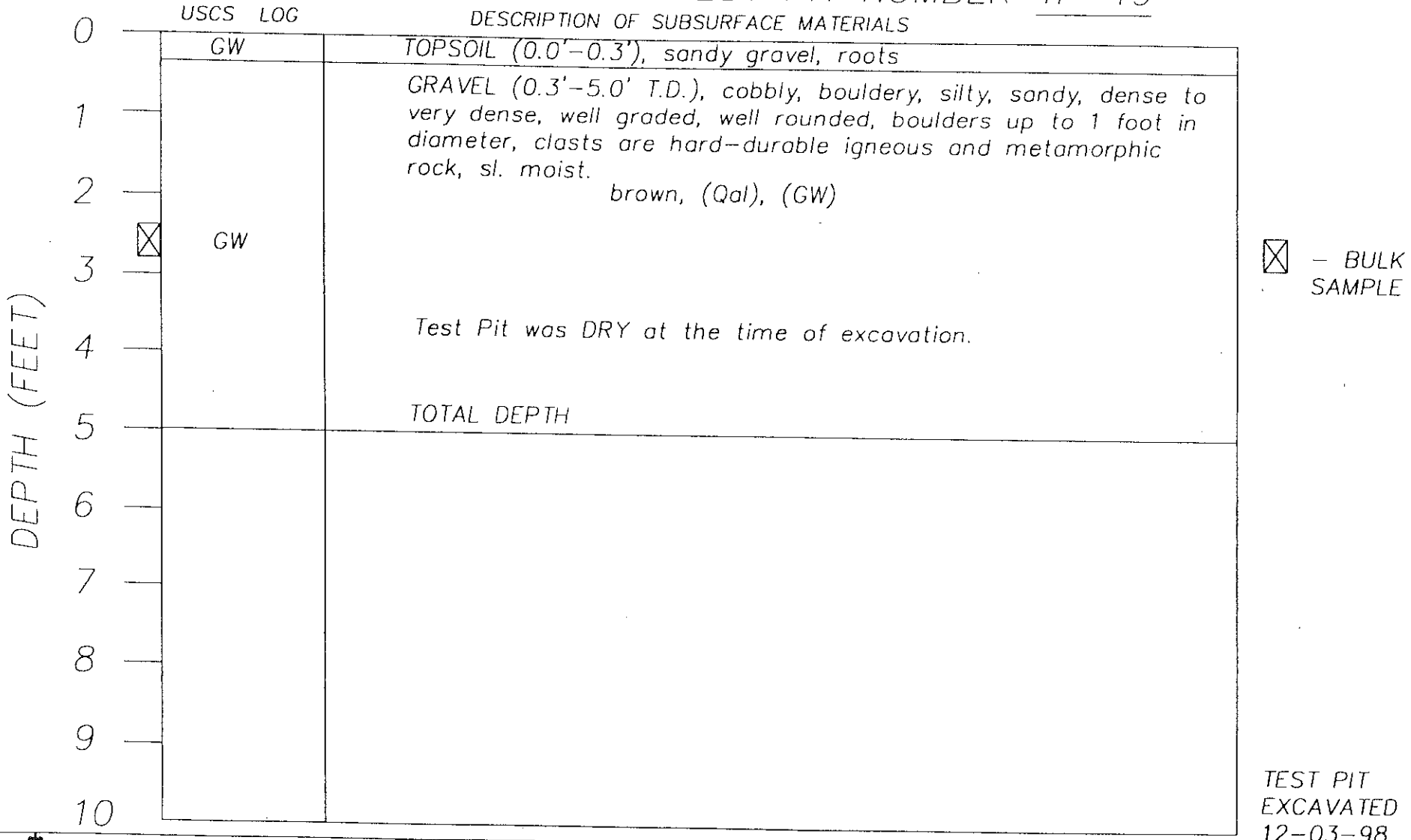
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH (SMITH)
RESIDENTIAL AREA
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 23

GEOLOGIC LOG OF TEST PIT NUMBER TP-19



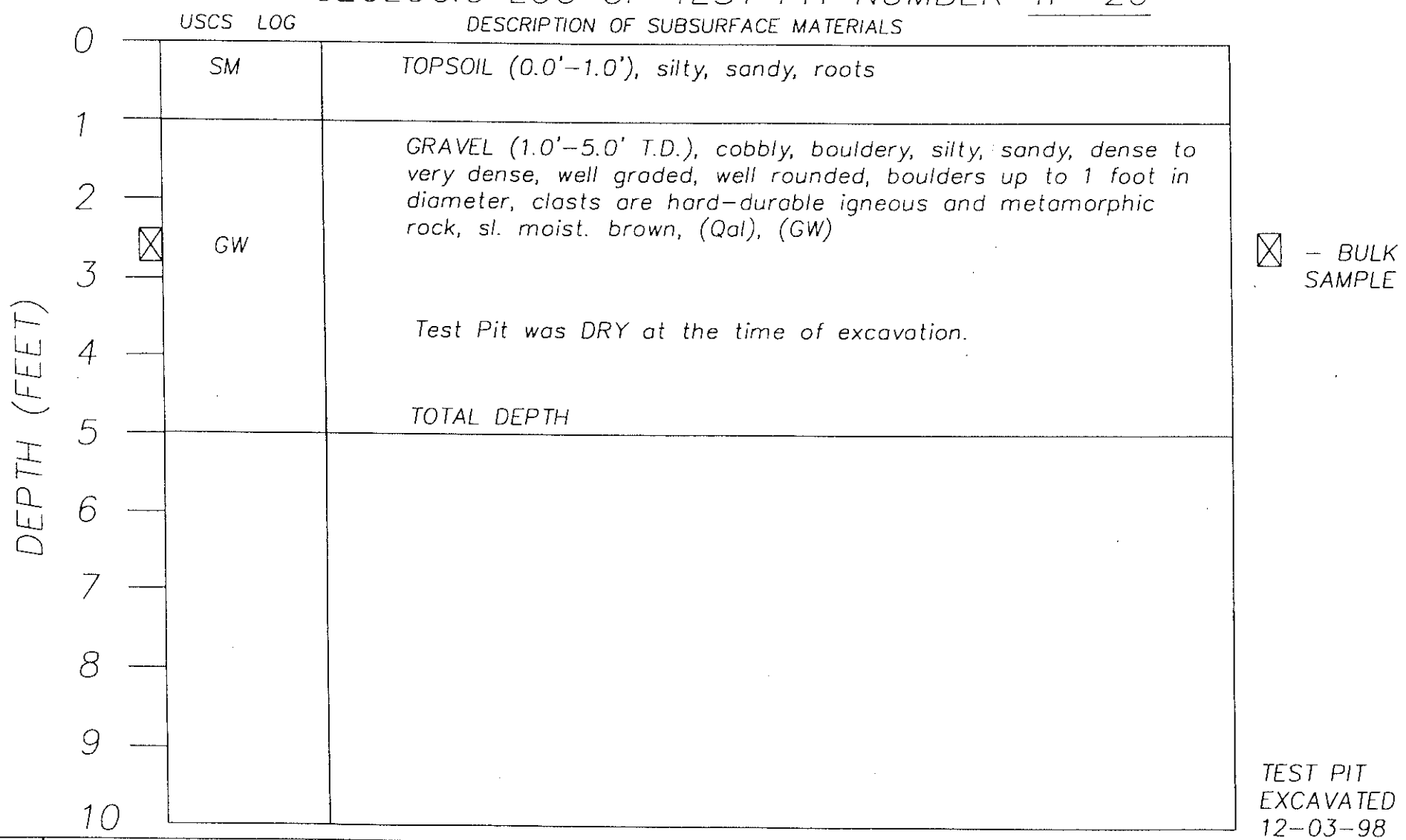
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH (SMITH)
RESIDENTIAL AREA
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 24

GEOLOGIC LOG OF TEST PIT NUMBER TP-20



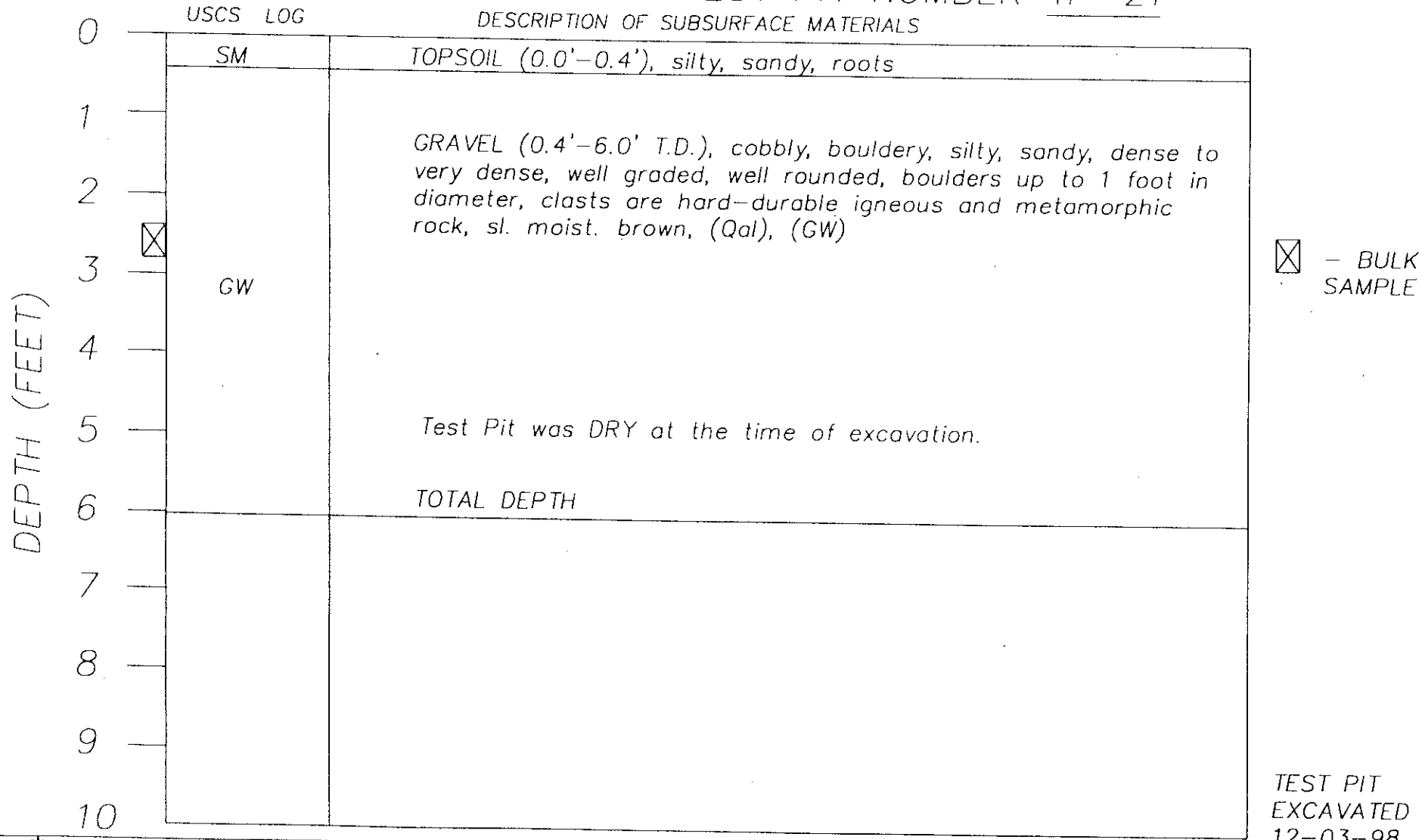
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH (SMITH)
RESIDENTIAL AREA
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 25

GEOLOGIC LOG OF TEST PIT NUMBER TP-21



TEST PIT EXCAVATED 12-03-98

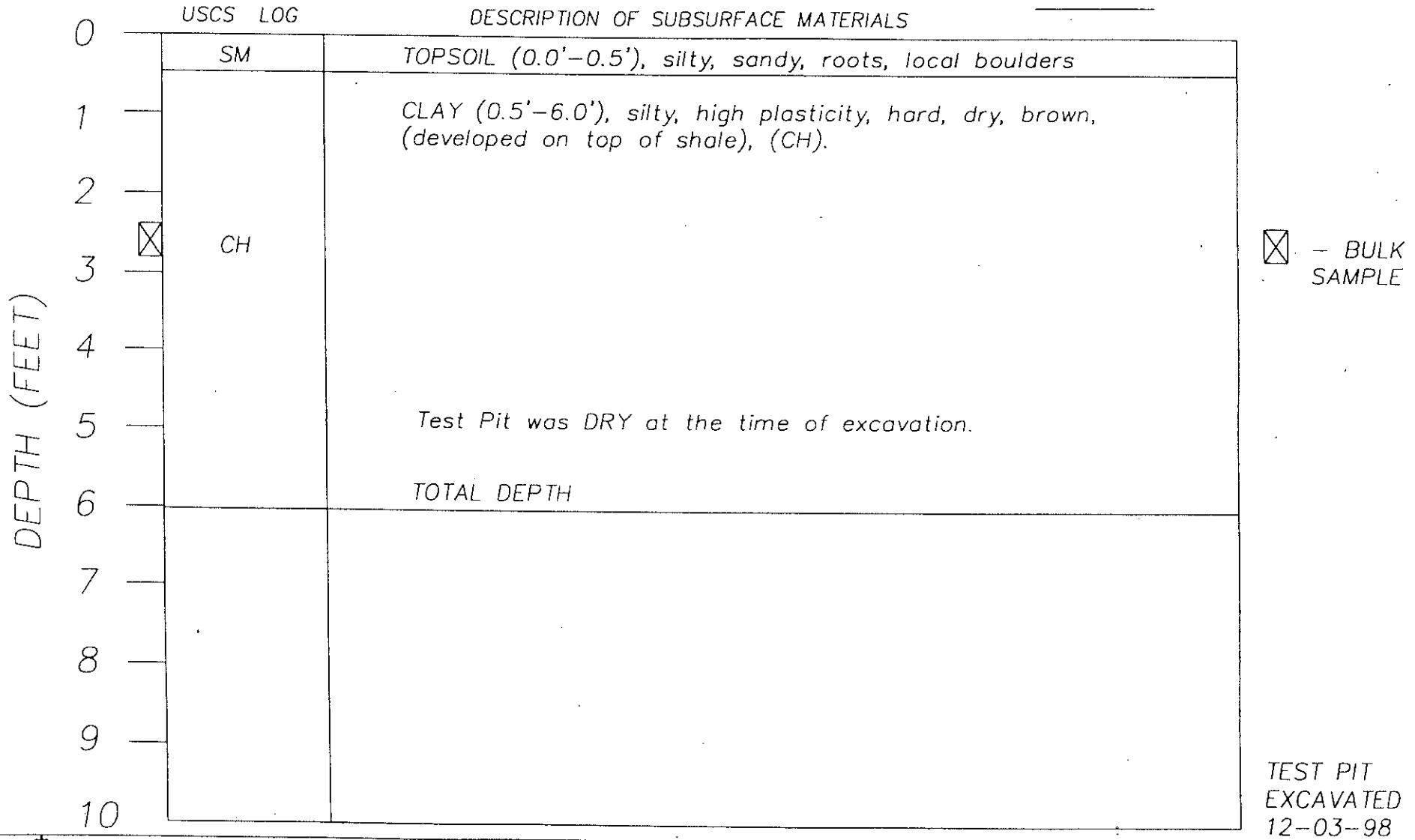
MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH (SMITH)
RESIDENTIAL AREA
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE:

GEOLOGIC LOG OF TEST PIT NUMBER TP-22



MICHAEL W. WEST & ASSOCIATES, INC.

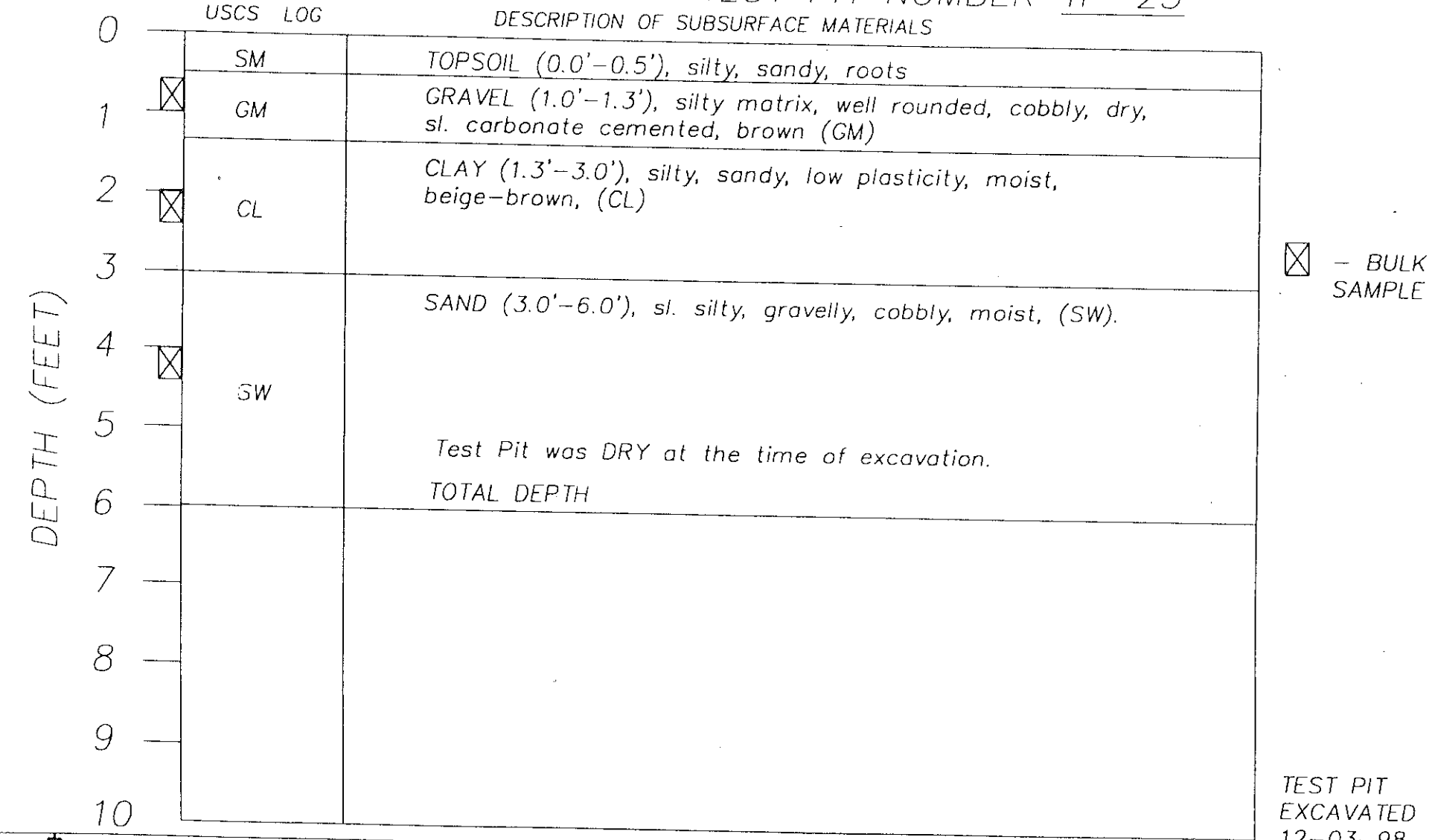
BUFFALO MOUNTAIN RANCH (SMITH) RESIDENTIAL AREA

LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 27

GEOLOGIC LOG OF TEST PIT NUMBER TP-23

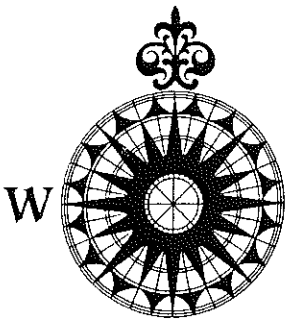


MICHAEL W. WEST & ASSOCIATES, INC.

BUFFALO MOUNTAIN RANCH (SMITH)
RESIDENTIAL AREA
LOG OF TEST PIT

BY: JCM DECEMBER 1998

PROJ: 98299 FIGURE: 8



APPENDIX
LABORATORY TESTING

GRAIN SIZE ANALYSIS, MECHANICAL
ASTM D 422

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D-422

CLIENT Mike West

JOB NO. 2058-19

BORING NO.	Buf 2	SAMPLED	
DEPTH	8.0-26.0"	DATE TESTED	12-5-98 CL
SAMPLE NO.		WASH SIEVE	Yes
SOIL DESCR.	Buffalo Mt. Proj.	DRY SIEVE	No

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	573.9
Wt. Dry Soil & Pan Before Washing (g)	565.4
Weight of Pan (g)	109.2
Wt. of Dry Soil Before Washing	456.2
Wt. Dry Soil & Pan After Washing (g)	402.2
Wt. of Dry Soil After Washing (g)	293.0
-#200 Wash. Out %	35.8

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	3.85	40.46	36.61	36.61	8.0	92.0
#4	3.67	49.04	45.37	81.98	18.0	82.0
#10	3.75	59.80	56.05	138.03	30.3	69.7
#20	3.65	52.97	49.32	187.35	41.1	58.9
#40	3.89	41.75	37.86	225.21	49.4	50.6
#60	3.66	27.20	23.54	248.75	54.5	45.5
#100	3.78	23.24	19.46	268.21	58.8	41.2
#200	3.80	28.59	24.79	293.00	64.2	35.8

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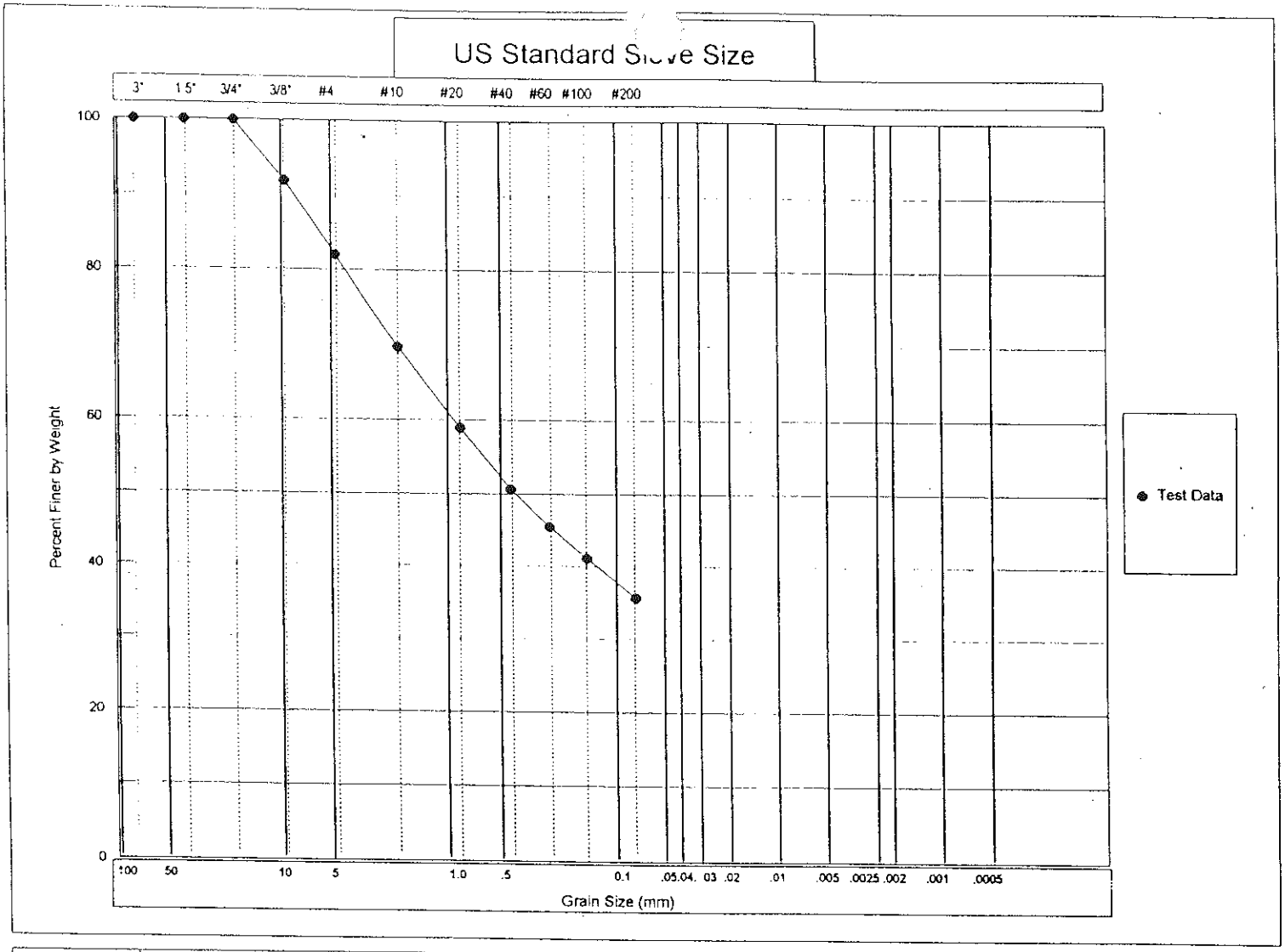
ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES	PEBBLE GRAVEL				SAND			SILT	CLAY
TO BOULDERS	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client: Mike West
Job Number: 2058-19
Classification_____

Boring No.: Buf 2
Depth: 8.0-26.0"
Sample No..

Advanced Terra Testing, Inc.

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D-422

CLIENT Mike West

JOB NO. 2058-19

BORING NO.	Buf 10
DEPTH	4.0-18.0"
SAMPLE NO.	
SOIL DESCR.	Buffalo Mt. Proj.

SAMPLED	
DATE TESTED	12-6-98 DPM
WASH SIEVE	Yes
DRY SIEVE	No

WASH SIEVE ANALYSIS

Wt. Wet Soil & Pan Before Washing (g)	573.7
Wt. Dry Soil & Pan Before Washing (g)	570.0
Weight of Pan (g)	13.3
Wt. of Dry Soil Before Washing	556.7
Wt. Dry Soil & Pan After Washing (g)	464.5
Wt. of Dry Soil After Washing (g)	451.2
-#200 Wash. Out %	19.0

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	3.72	60.64	56.92	56.92	10.2	89.8
#4	3.69	76.46	72.77	129.69	23.3	76.7
#10	3.72	123.34	119.62	249.31	44.8	55.2
#20	3.79	101.39	97.60	346.91	62.3	37.7
#40	3.75	50.34	46.59	393.50	70.7	29.3
#60	3.65	27.16	23.51	417.01	74.9	25.1
#100	3.66	18.52	14.86	431.87	77.6	22.4
#200	3.66	22.95	19.29	451.16	81.0	19.0

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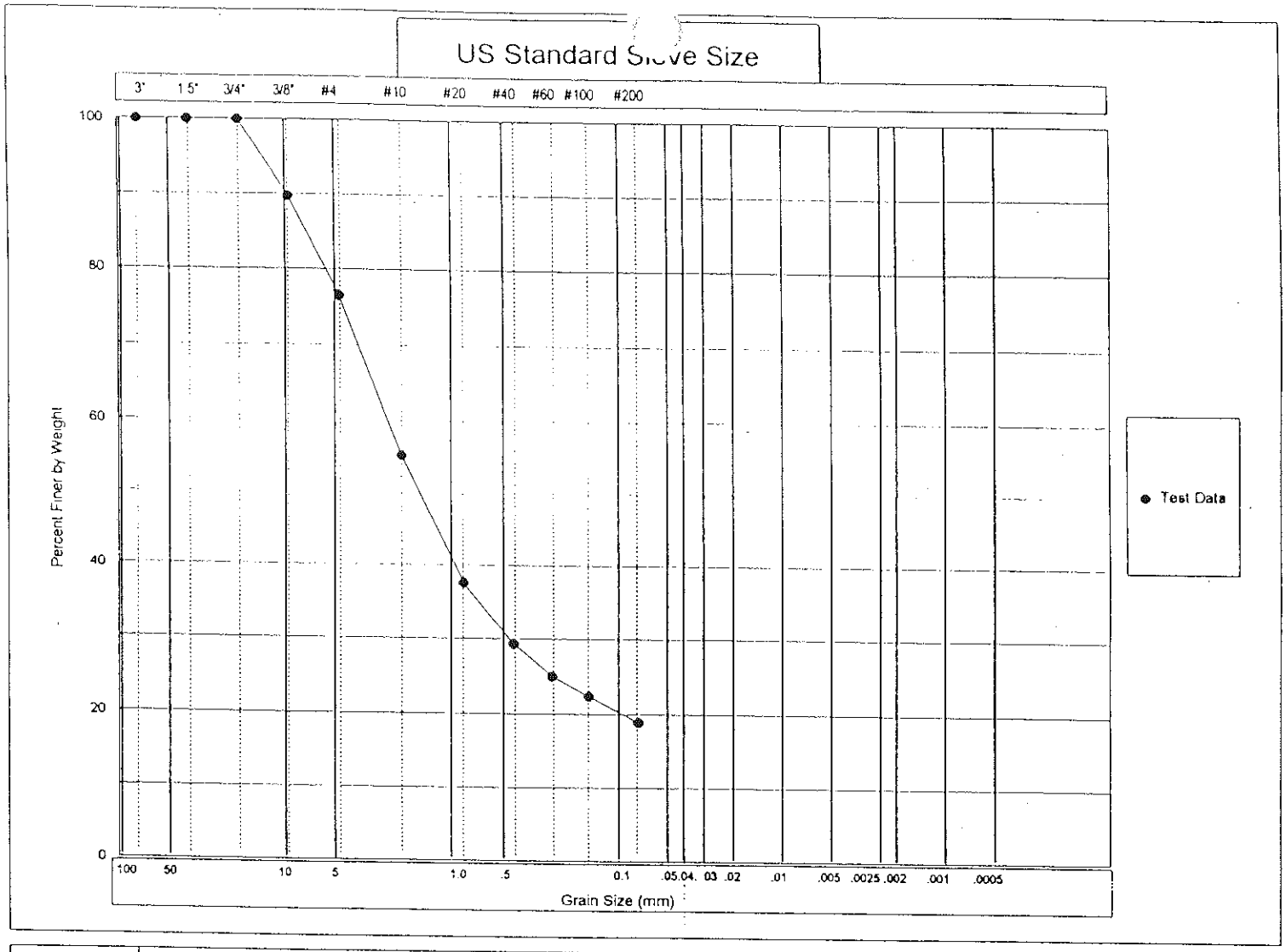
ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES	PEBBLE GRAVEL				SAND			SILT	CLAY
TO BOULDERS	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client: Mike West
Job Number: 2058-19
Classification_____

Boring No.: Buf 10
Depth: 4.0-18.0"
Sample No.:

Advanced Terra Testing, Inc.

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT Mike West

JOB NO. 2058-19

BORING NO.	Buf 6	SAMPLED	
DEPTH	4.0-40.0"	DATE TESTED	12-4-98 CL
SAMPLE NO.		WASH SIEVE	Yes
SOIL DESCR.	Buffalo Mt. Proj.	DRY SIEVE	No

MOISTURE DATA

HYGROSCOPIC	Yes	
NATURAL	No	
Wt. Wet Soil & Pan (g)		100.02
Wt. Dry Soil & Pan (g)		99.57
Wt. Lost Moisture (g)		0.45
Wt. of Pan Only (g)		3.66
Wt. of Dry Soil (g)		95.91
Moisture Content %		0.5
Wt. Hydrom. Sample Wet (g)		227.47
Wt. Hydrom. Sample Dry (g)		226.41

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	1203.13
Weight of + #10 Before Washing (g)	464.71
Weight of + #10 After Washing (g)	420.35
Weight of - #10 Wet (g)	738.42
Weight of - #10 Dry (g)	779.12
Wt. Total Sample Dry (g)	1199.47
Calc. Wt. "W" (g)	348.56
Calc. Mass + #10	122.15

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	54.65	54.65	54.65	4.6	95.4
3/8"	0.00	123.40	123.40	178.05	14.8	85.2
#4	0.00	108.36	108.36	286.41	23.9	76.1
#10	0.00	133.94	133.94	420.35	35.0	65.0
#20	3.80	43.26	39.46	39.46	46.4	53.6
#40	3.64	51.77	48.13	87.59	60.2	39.8
#60	3.75	41.52	37.77	125.36	71.0	29.0
#100	3.87	32.73	28.86	154.22	79.3	20.7
#200	3.74	30.23	26.49	180.71	86.9	13.1

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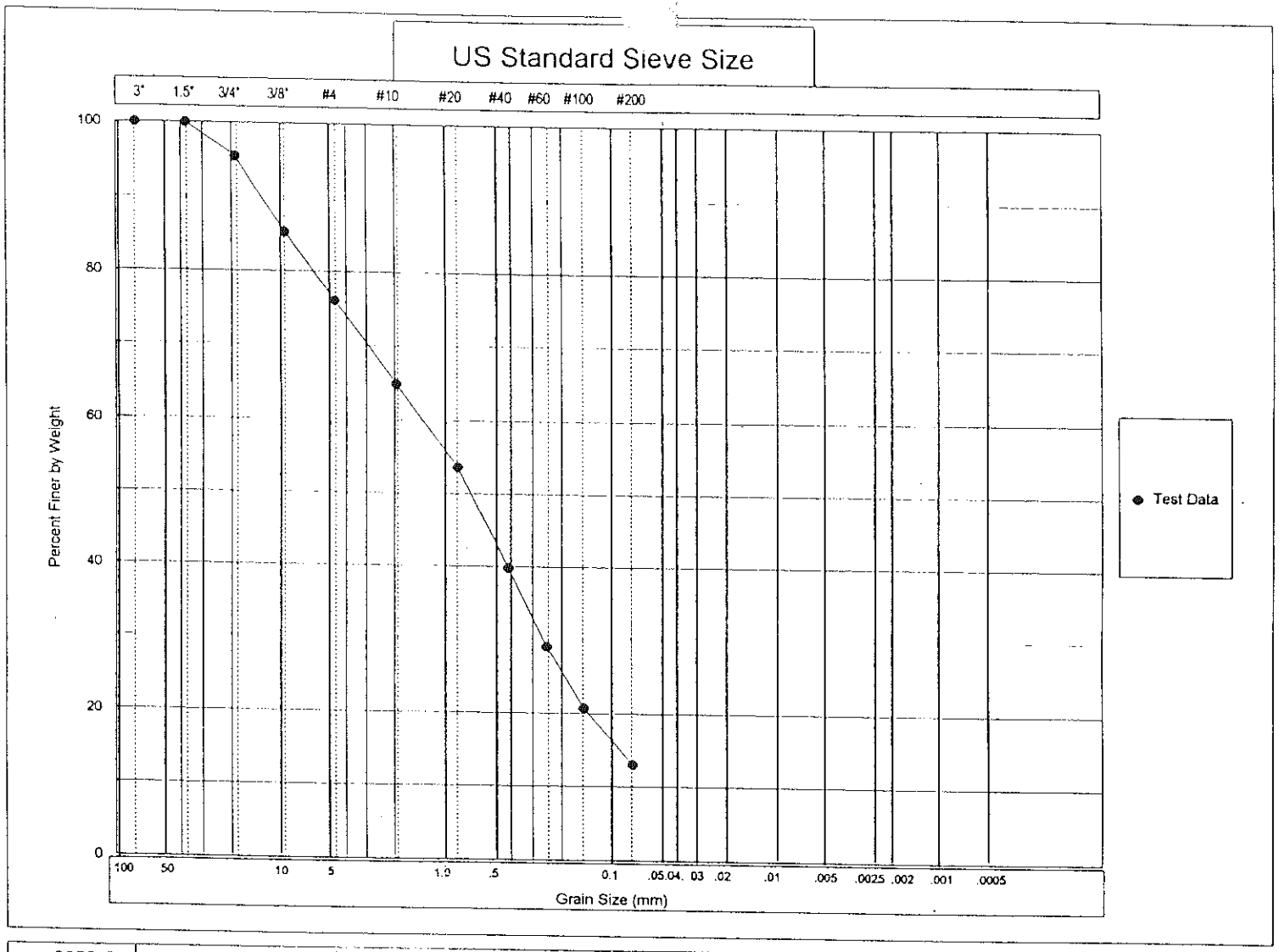
ADVANCED TERRA TESTING, INC.



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	CRS	MEDIUM	FINE	

USCS

COBBLES TO BOULDERS	PEBBLE GRAVEL				SAND			SILT	CLAY
	COARSE	MED	FINE	GRAN	COARSE	MED	FINE		

WENTWORTH

Client: Mike West
Depth: 4.0-40.0"
Classification:

Boring No Buf 6
Job Number: 2058-19
Sample No.:

Advanced Terra Testing, Inc.

MECHANICAL ANALYSIS - SIEVE TEST DATA
ASTM D 422

CLIENT Mike West

JOB NO. 2058-19

BORING NO.	Buf 12	SAMPLED	
DEPTH	8.0-25.0"	DATE TESTED	12-4-98 CL
SAMPLE NO.		WASH SIEVE	Yes
SOIL DESCR.	Buffalo Mt. Proj.	DRY SIEVE	No

MOISTURE DATA

HYGROSCOPIC	Yes
NATURAL	No

Wt. Wet Soil & Pan	(g)	106.49
Wt. Dry Soil & Pan	(g)	105.42
Wt. Lost Moisture	(g)	1.07
Wt. of Pan Only	(g)	3.67
Wt. of Dry Soil	(g)	101.75
Moisture Content	%	1.1
Wt. Hydrom. Sample Wet	(g)	213.26
Wt. Hydrom. Sample Dry	(g)	211.04

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	1253.35
Weight of + #10 Before Washing (g)	394.45
Weight of + #10 After Washing (g)	334.70
Weight of - #10 Wet (g)	858.90
Weight of - #10 Dry (g)	909.09
Wt. Total Sample Dry (g)	1243.79
Calc. Wt. "W" (g)	288.74
Calc. Mass + #10	77.70

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
3"	0.00	0.00	0.00	0.00	0.0	100.0
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	9.94	9.94	9.94	0.8	99.2
3/8"	0.00	68.20	68.20	78.14	6.3	93.7
#4	0.00	112.58	112.58	190.72	15.3	84.7
#10	0.00	143.98	143.98	334.70	26.9	73.1
#20	3.89	24.04	20.15	20.15	33.9	66.1
#40	3.67	24.35	20.68	40.83	41.1	58.9
#60	3.77	25.51	21.74	62.57	48.6	51.4
#100	3.63	26.02	22.39	84.96	56.3	43.7
#200	3.66	31.97	28.31	113.27	66.1	33.9

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ADVANCED TERRA TESTING, INC.