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CABLE DAMEMORE TWX 910 925 5692

November 24, 1978

J. J. Johnson & Associates
P. O. Box 1661
Park City, Utah 84064

Attention: Mr. Fred Duberow

Gentlemen:

Report of Preliminary Discussions
and Recommendations
Geotechnical Considerations
Proposed Silver Springs Development
Near Snyderville, Utah
For Partners Investment Corporation

INTRODUCTION

This letter presents our preliminary recommendations and discussions pertaining to geotechnical considerations for development of the portion of the proposed Silver Springs Development located within the low relief "flatland" areas near Snyderville, Utah. The locations of the test pits excavated in conjunction with this preliminary study in relation to the specific site boundaries and adjacent facilities are shown on Plate 1, Plot Plan.

Our services were requested verbally by Mr. John Demkowicz of J. J. Johnson & Associates. The discussions and recommendations presented herein pertain only to the "flatland" portion of the overall proposed development. In the future, development of the foothill areas west of State Highway U-224 will be initiated.

PROPOSED CONSTRUCTION

The proposed construction within the "flatland" area will consist primarily of individual family-housing units with a small commercial and multi-unit housing development located in the southern portion of the site. The proposed structures are anticipated to be of masonry and standard wood-frame construction with possibly some brick veneer. Structural loads will be transmitted to conventional spread and continuous wall foundations. Maximum wall and column loads are not anticipated to exceed 2.5 kips per lineal foot and 30 kips, respectively. A minimum of earthwork associated with general site development is desired.

In addition to the structures, the proposed development includes the construction of two reservoirs capable of providing flood and culinary water storage. These reservoirs are anticipated to be on the order of 10 to 15 feet in depth. A conceptual layout of the proposed facilities is referenced on Plate 1.

retention ponds "lakes"

PURPOSE AND SCOPE

The purpose and scope of this preliminary study were planned in discussions with Messrs. John Demkowicz and Fred Duberow of J. J. Johnson & Associates and Mr. William Gordon of Dames & Moore. The purpose of this study was to define the subsurface soil and ground water conditions at the site and to provide appropriate initial geotechnical recommendations to be utilized in developing a more finalized concept for the referenced portion of the overall development. In accomplishing this purpose, our scope included the following:

1. A field program consisting of a general field reconnaissance and the excavations, sampling and logging of 17 test pits.

2. An office program consisting of the correlation of available data, engineering analyses and the preparation of this summary report.

SITE CONDITIONS

SURFACE

The site is located near Snyderville, Utah in the relatively flat geologic setting known as Parley's Park. The area considered in this investigation involves the easternmost section of the proposed Silver Springs Development. The site is bordered by State Highway No. U-224 on the west and a small creek on the east.

The topography of the site generally slopes gradually downward to the north with an overall slope of approximately two and one-half percent. The area is currently used as pasture-land with vegetation primarily consisting of short grasses and weeds. A number of irrigation channels and minor drainage paths are located throughout the site. At the time of our field investigation, the ground surface in portions of the northern and central sections of the site was extremely soft with standing water noted in several areas.

SUBSURFACE

FIELD EXPLORATION

The subsurface soil and ground water conditions across the site were explored by excavating 17 test pits with a hydraulic backhoe. The locations of the test pits are presented on Plate 1.

The field exploration program was conducted under the supervision of an experienced soils engineer from our staff. The soils penetrated were sampled and classified according to visual and textural examination in the field, and a complete log of each test pit was maintained. The field classifications were later

supplemented by further visual inspection and laboratory testing of the samples. The final logs of the test pits are retained in our files and can be provided if desired.

SUBSURFACE CONDITIONS

Results of our field investigation indicate that the soil conditions underlying the site are relatively uniform. In general, the surface of the site appears to be blanketed by a one to two and one-half foot layer of soft, dark grey, clayey silt with a trace fine sand. The upper six inches contain major root systems and have been classified as topsoil. Generally, this surficial layer is directly underlain by a dense to medium dense, reddish-brown, clayey or sandy gravel which extends to the depths penetrated by the test pits. In some localized areas, such as the northwest corner of the site, random thicknesses of red to grey, medium dense, silty fine sands and reddish-brown, medium stiff to stiff, silty clays were found to overlie the gravels.

Based on our experience with the soils in the Park City area, the natural granular soils and the stiff to medium stiff, reddish-brown, silty clays are relatively incompressible and would provide more than adequate support for the proposed structures. However, the surficial layer of dark grey, silty clay is generally highly compressible under the anticipated load ranges and would not be suitable for foundation support.

GROUND WATER

In general, the ground water table is near the ground surface throughout portions of the northern and central sections of the site and tapering to depths in excess of 12 feet along the site's southern boundary. At the time of our field investigation, major portions of the northern and central sections were not accessible due to the resulting soft ground conditions.

The ground water gradient across the site generally follows the slope of the ground surface in a north-northeasterly direction. The ground water table is directly related to the seasonal runoff and area irrigation. Therefore, relatively large fluctuations can be anticipated. Generally, the highest seasonal levels occur in the late spring or early summer months. Ground water levels measured during our field investigation have been tabulated and are presented below.

Test Pit Number	Depth To Ground Water In Feet
TP1	Ground Water Not Encountered (To 11.0 Feet)
TP2	Ground Water Not Encountered (To 10.0 Feet)
TP3	Ground Water Not Encountered (To 12.0 Feet)
TP4	9.5
TP5	9.0
TP6	7.0
TP7	3.5
TP8	8.0
TP9	4.0
TP10	7.0
TP11	3.0
TP12	4.0
TP13	3.0
TP14	Ground Water Not Encountered (To 12.0 Feet)
TP15	7.0
TP16	3.0
TP17	3.0

Slotted PVC pipe was installed in a number of the test pits to measure future fluctuations in the site ground water conditions and the effectiveness of subsurface drainages as discussed in subsequent sections.

DISCUSSIONS AND RECOMMENDATIONS

GENERAL

Discussions and recommendations presented herein are based upon visual observations during the field investigation and the information obtained from the excavation of a series of test pits. Detailed laboratory testing was not performed in conjunction with this preliminary study.

It is our conclusion that the site is suitable for the proposed development. The proposed structures may be supported upon properly prepared in-situ soil or upon structural fill. However, of primary concern in the development of the site is the proper control of the ground water conditions. Based on the high ground water levels encountered during our field investigation and the anticipated seasonal fluctuations, it is recommended that a site drainage system be installed as far in advance of other construction as possible. This will involve the initial installation of a surface drainage ditch system to reduce the soft and muddy conditions existing within central and northern portions of the site. This would facilitate movement of construction equipment during initial site development. Subsequently, this system should be replaced by a permanent subsurface drainage system designed to minimize the effect of seasonal ground water fluctuations and to maintain the ground water table at a suitable level.

The overall ground water gradient across the site is such that the structures in the southern portion of the site could be constructed with some full or partial basements. However, even with the installation of a permanent subsurface drainage system, the structures in the central and northern portions of the site will be primarily limited to slab-on-grade construction.

Preliminary recommendations and discussions regarding earthwork, foundation installation, control of the ground water and construction of the proposed reservoirs are presented in the following sections. The intent of this report is to provide sufficient data so that more detailed designs and studies can be performed. It must be noted that more specific studies related especially to drainage and the reservoirs will be required.

EARTHWORK

SITE PREPARATION

Prior to commencing major construction activities, foundation, floor slab and pavement areas should be stripped of all vegetation, root bulbs and topsoil. Topsoil is defined as the major root mat and is anticipated to be the upper six inches of soil at the site. Stripped topsoil can be stored for use in revegetation and as non-structural site grading fill.

Due to the somewhat compressible nature of the surficial, dark grey, silty clay soils, it is recommended that after the stripping operation, the exposed subgrade soils be proof rolled at least twice continuously with suitable rubber, tire-mounted equipment. If extremely soft, unsuitable soils are encountered, they should be removed and replaced with structural fill.

EXCAVATIONS

Shallow temporary excavations up to four feet in depth and not penetrating the ground water table may be constructed with near-vertical sideslopes. Deeper excavations, still not penetrating the ground water table nor exceeding eight feet, may be constructed with sideslopes no steeper than one-half horizontal to one vertical. Excavations penetrating the ground water table may tend to cave in below the ground water table and, if so, will require much flatter slopes, shoring or bracing.

All excavations should be continuously inspected by qualified personnel. If signs of instability or excessive sloughing are noted, immediate remedial action should be initiated.

FILL MATERIAL, PLACEMENT AND COMPACTION CRITERIA

Structural fill will be required as site grading fill and possibly as replacement fill below the footings or floor slabs. Fills associated with the proposed reservoirs are discussed in the PROPOSED RESERVOIR section. Structural fill is defined as any fill which will ultimately be subjected to structural loads such as floor slabs, footings, pavements and flatwork. It should be free of sod, rubbish, and other deleterious materials. Maximum particle size should generally be restricted to four inches. The on-site granular soils can be utilized as structural fill.

Structural fill should be placed in loose lifts of not more than eight inches, and compacted with suitable equipment to a minimum dry density of 90 percent of the maximum dry density as determined by the AASHTO* T-180 compaction criteria.

Non-structural site grading fill is defined as all other fill material not designated as structural fill and may consist of any cohesive, granular or topsoil material available. The fill should be placed in lifts not exceeding 12 inches and compacted by passing construction, hauling or spreading equipment over each lift at least twice.

FOUNDATIONS

DESIGN DATA

It is recommended that the proposed structures be supported upon conventional spread and continuous wall foundations established

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* American Association of State Highway and Transportation Officials.

upon 1) the existing, on-site, medium dense to dense, granular soils, 2) the natural, undisturbed, medium stiff to stiff, silty clay soils, or 3) compacted structural fill extending to suitable soils. Under no circumstances should footings be established upon topsoil, the dark grey, silty clay soils or upon disturbed soft soils.

All footings which will be exposed to the full effects of frost should be established a minimum of three feet below lowest adjacent final grade. Foundations protected from the full effects of frost such as interior footings may be established at higher elevations, although a minimum depth of embedment of one and one-half feet is recommended for confinement purposes. Concrete floor slabs may be considered equivalent to soil in determining the depth of embedment. The minimum recommended width of all footings is one and one-half feet.

Based upon our experience with similar soil conditions in the Park City area, all spread and continuous wall footings established in the manner outlined above may be conservatively proportioned using a net bearing pressure for dead plus frequently applied live loads of 2,500 pounds per square foot. The term "net bearing pressure" refers to that pressure imposed by the portion of the foundation above lowest adjacent final grade. Therefore, the weight of the footing need not be considered. This pressure may be increased by one-third for infrequently applied live loads.

FLOOR SLABS

The properly prepared, near-surface, natural soils and/or structural site grading fill will provide adequate support for floor slabs. Preparation should consist of recompacting the soft surface soils as previously described. To facilitate construction and to provide a moisture barrier, it is recommended

that the floor slab be directly underlain by a minimum of four inches of granular, free-draining, "pea" gravel or one to one-half inch minus gravel. Settlements of the floor slabs established in this manner should be minimal.

Floor slabs should be established such that the upper surface of the slab is at least two feet above the maximum design ground water level in that area. Ground water control and levels are discussed in the following section.

GROUND WATER CONTROL

PRELIMINARY SITE DRAINAGE

To facilitate movement of construction equipment during the initial development of the site, it is recommended that a system of open drainage channels be installed across the site as far in advance of other construction as possible. The locations of the channels should coincide with the locations of the subsequent permanent system as much as possible, but can be modified to facilitate surface drainage within specific areas within the central and northern portions of the site.

The channels should penetrate the surficial clayey soils and extend approximately one to two feet into the sandy and clayey gravels. The channels should maintain grades such that drainage is into the existing creeks which cross or border the site. Consideration should be given to the deepening of a number of these creeks as required.

As an aid to the design of a permanent subsurface drainage system, it is recommended that the flow rates within channels be periodically measured. The measured flow rates will present a practical indication of the pipe size required in any subsurface drainage system.

PERMANENT SUBSURFACE DRAIN SYSTEM

GENERAL

For future development of the area, it is recommended that the site ground water conditions be controlled through the installation of a permanent subsurface drainage system. A preliminary layout of the drains using the creek bordering the eastern side of the property as a primary discharge point is shown on Plate 1. Detailed consideration as to the function and design of the proposed reservoirs will have to be made as part of the final design of the permanent drain system. The layout of this system conforms to the minimum recommended drainpipe gradient of 0.5 percent and has taken into account the natural ground water gradient. If drainage from this system proves to be inadequate in the northern portion of the site, it may be necessary to extend the drainage lines into the adjacent property immediately north of the site. This option would naturally be dependent upon receiving proper authorization from the property owner or owners. It should be noted that this layout is only preliminary and could be altered to conform to drainage requirements and future site development plans.

DESIGN

The subsurface drains should penetrate the surficial, clayey soils and as deeply into the sandy and clayey gravels as excavation difficulties and grade requirements permit. Proper design should be carried out to minimize the possibility of long-term plugging of these drains. Such a design would include a plastic drainage pipe laid to an appropriate grade and having a maximum drainage hole diameter of three-eighths of an inch. Surrounding the pipe, a proper aggregate should be placed which has a gradation such that particles do not migrate into the openings of the pipe.

The material should be relatively clean, having less than five percent passing the No. 200 sieve, and should extend at least 6 inches horizontally, 4 inches below, and 12 inches above the drainpipe. A one-inch minus gravel is considered suitable for this installation. This aggregate should be wrapped in a filter cloth such as Mirafi, Bidim or equivalent.

In order to adequately intercept the ground water, it is recommended that the permeable filter aggregate extend to within one foot of the existing ground surface. However, to prevent surface water runoff from entering the filter, a minimum of one foot of natural soil cover should be maintained over the filter at all locations. For cleaning purposes, points of access to these drains will be necessary.

The volume of water to be handled by the system will be large. At this time, we anticipate that the primary lines will have to be at least 10 to 12 inches in diameter.

CONSTRUCTION OF PROPOSED RESERVOIRS

GENERAL

It is proposed that two reservoirs be constructed on the site to provide flood and culinary water storage. The reservoirs are to be constructed 10 to 15 feet in depth and as deeply as possible below the existing grade. It is anticipated that a full water treatment plant be constructed in conjunction with the reservoirs.

Due to the high ground water conditions existing across the proposed sites and the high permeability of the subsurface granular soils, it is our opinion that geotechnical difficulties and the expense required in the initial site dewatering and the required maintenance of a suitable ground water table would make

consideration of lined, below-grade reservoirs, at the presently proposed locations, impractical. Therefore, there appear to be three remaining options for the construction of the reservoirs. The first would consist of an unlined, below-grade reservoir open to the influences of the ground water. The second option would involve the construction of a lined reservoir located, even with drainage as previously discussed, no more than two to three feet below-grade. The third would consist of locating the reservoirs in the southern portion of the site where the ground water could be controlled by subdrains much deeper below existing elevations. In this case, a lined reservoir would be utilized. Discussions of the three construction options are presented in the following sections.

BELOW-GRADE, UNLINED RESERVOIR

Due to the construction of a complete water treatment facility, it is proposed that an unlined reservoir open to the ground water could be utilized for the storage of culinary water. The construction of the reservoir area would involve a dredging operation with the excavated materials used as general site grading fill to facilitate further development of the site. Excavated slopes should be on the order of four to five horizontal to one vertical and should be properly protected from the effects of wave erosion.

Although relatively inexpensive in comparison to the construction of a lined, above-grade reservoir, there are a number of potential problems foreseen. The first and primary concern is the reservoir's influence on the overall site drainage plan. A detailed investigation would have to be undertaken on the effectiveness any subsurface drainage system would have on the immediate area of the reservoir. In addition, consideration should be given to the effect fluctuations in the ground water table and siltation would have on the storage capacity of the reservoir.

ABOVE-GRADE, LINED RESERVOIR

The construction of the above-grade, lined reservoir would involve the construction of a perimeter embankment. For aesthetic purposes, it is proposed that the exterior slopes of the embankment be on the order of four horizontal to one vertical or flatter. To facilitate the lining of the reservoir, the interior embankment slopes should be no steeper than two and one-half horizontal to one vertical. The stability of the embankment constructed in this manner should be of minimal concern.

To minimize the potential for excessive seepage, a zoned embankment is recommended consisting of a downstream shell of granular material and a relatively impermeable upstream core approximately eight feet in thickness as shown in cross section on Plate 2. The embankment could be constructed from the on-site, subsurface soils. As discussed previously, the gravels underlying the surficial, dark grey, silty clays range from sandy to clayey. It is our opinion that the clay content in some of these gravels is sufficient to construct a relatively impermeable barrier. Therefore, by selectively borrowing these materials, the zone embankment will be constructed by placing the sandy gravels in the downstream shell and the clayey gravels along with the inorganic, surficial, dark grey, silty clays in the upstream core. These materials should be placed and compacted to the specifications of structural fill as discussed previously.

Lining of the pond could be accomplished using either a bentonitic clay or a synthetic impermeable liner. Due to the unavailability of suitable clay borrow source, the synthetic liner is considered as the only practical alternative. There are a number of synthetic liners available such as Polyvinyl chloride (PVC), Chlorosulfonated polyethylene (Hypalon) and Chlorinated polyethylene (CPE). Of these, the most inexpensive

is the PVC liner which can be purchased for approximately 20¢ per square foot. However, problems have been encountered in the past with these liners due to their degradation when exposed to sunlight. Therefore, it is recommended that a liner material similar to CPE be used which costs approximately 32¢ per square foot. The total cost of this liner based on a reservoir area of 16.5 acres would be on the order of $230,000. It is also recommended that the liner be underlain by a four-inch layer of fine silty sand. If possible, source of this material would be the sand tailings from the Park City Ventures mining operation. Based on costs received from a contractor utilized by Park City Ventures, the expense of loading, hauling and spreading the bedding material required for a 16.5-acre reservoir would be approximately $50,000.

BELOW-GRADE, LINED RESERVOIR

As a third option, consideration should be given to the relocation of the reservoirs into the southern portion of the site. The lower ground water conditions there would permit the construction of a below-grade, lined reservoir. A cut-and-fill operation could be utilized with the bottom of the reservoir located a minimum of two feet above the highest expected ground water level. The lining of the reservoir and the construction of the embankments would be similar to those discussed previously for the above-grade, lined reservoir.

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We appreciate the opportunity of performing this service for you. If you have any questions regarding this report or require additional information, please contact us.

Respectfully submitted,

DAMES & MOORE

William J. Gordon
Associate
Professional Engineer No. 3457
State of Utah

James F. Zitnik
Staff Engineer

WJG/JFZ/nb

Attachments:

Plate 1 - Plot Plan
Plate 2 - Preliminary Embankment Cross Section