NOTICE OF MEETING
HILLSIDE REVIEW BOARD
CITY OF ST. GEORGE
WASHINGTON COUNTY, UTAH

Public Notice

Notice is hereby given that the Hillside Review Board of the City of St. George, Washington County, Utah, will hold meetings at the referenced site on **Wednesday, July 15, 2020** commencing on-site at 8:30 a.m.

The estimated site times are in bold.
The agenda for the meetings are as follows:

1. Consider a request for a Hillside Development Permit to allow development of a community park to be called "**Desert Canyons East Park**." The property is located on the south-east corner of Broken Rock Way and Desert Canyons Parkway. This area is a part of the Desert Canyons Master Plan. The property is zoned PD-R (Planned Development Residential). The applicant is Desert Canyon Lands, LLC and the representative is Curt Gordon. Case No. 2020-HS-008). The time to meet is **8:30 am** (See 'Meeting Place' exhibit below).

2. Consider a request for a Hillside Development Permit to allow development of two (2) professional office buildings to be called "**Hillside Professional Offices**" The property is generally located north of the intersection of Riverside and Riverbend Drives. The property is zoned PD-AP (Planned Development – Administrative Professional). The applicant is Cole Fowler & Sorensen and the representative is Vaun Beal. Case No. 2020-HS-010. The **estimated** time to meet is **9:00 am** (*See meeting Place' exhibit below*).

3. Consider a request for a Hillside Development Permit to allow development of a multi-family housing subdivision to be called "**The Cove**." The property is generally located west of Bluff Street at approximately 300 West and 900 South. The property is currently zoned C-2 (Highway Commercial). The owner is Cove Towers LLC, the applicant is Brent Holdaway, and the representative is Bush & Gudgell, Inc. Case No. 2020-HS-007. The estimated time to meet is **9:30 am** (*See 'Meeting Place' exhibit below*).

Dan Boles, AICP
Senior Planner
Development Services

Reasonable Accommodation: The City of St. George will make efforts to provide reasonable accommodations to disabled members of the public in accessing City programs. Please contact the City Human Resources Office at (435) 627-4674 at least 24 hours in advance if you have special needs.

Meeting Place for #1
“Desert Canyon East Park”



Meeting Place #2 “Hillside Professional Offices”



Meeting Place for #1 “The Cove”



Item #1

St.George
Community Development

Hillside Permit

HILLSIDE REVIEW BOARD AGENDA REPORT: **07/15/2020**

HILLSIDE DEVELOPMENT PERMIT
Desert Canyon East Park
Case No. 2020-HS-008

Request:	This is a request for a Hillside Development Permit for "Desert Canyon East Park"
Location:	The property is generally located on the south-east corner of Broken Rock Way and Desert Canyons Parkway.
APN:	SG-5-3-35-4421
Proposed:	The property is proposed to be developed into a community park.
Background:	A portion of the park is located in the hillside zone, a rockfall study has been completed in this area. It's proposed to install a rockfall berm on the south side of the park that will comply with the rockfall mitigation letter provided by AGEC.
Narrative:	See 'narrative' inserted in this report
Owner:	Desert Canyons Lands LLC
Applicant:	Desert Canyons Lands LLC
Representative:	Curt Gordon / Ken Miller
Drainage:	A drainage study was prepared by Development Solutions and dated May 2020.
Rockfall Report:	See 'rockfall assessment' letter inserted into this report.
Rockfall Berm:	See 'rockfall berm' letter inserted into this report.
Zoning:	PD-R and R-1-10
General Plan:	OS (Open Space).
Area:	The area is approximately 4.5 acres.

Surrounding: The surrounding properties to the north, east and west are in various stages of approval or construction and will all be residential.

Plans: The applicant produced a conceptual that is included in this packet. Also included in this packet are two conceptual plans that were produced by the City parks and trails department.

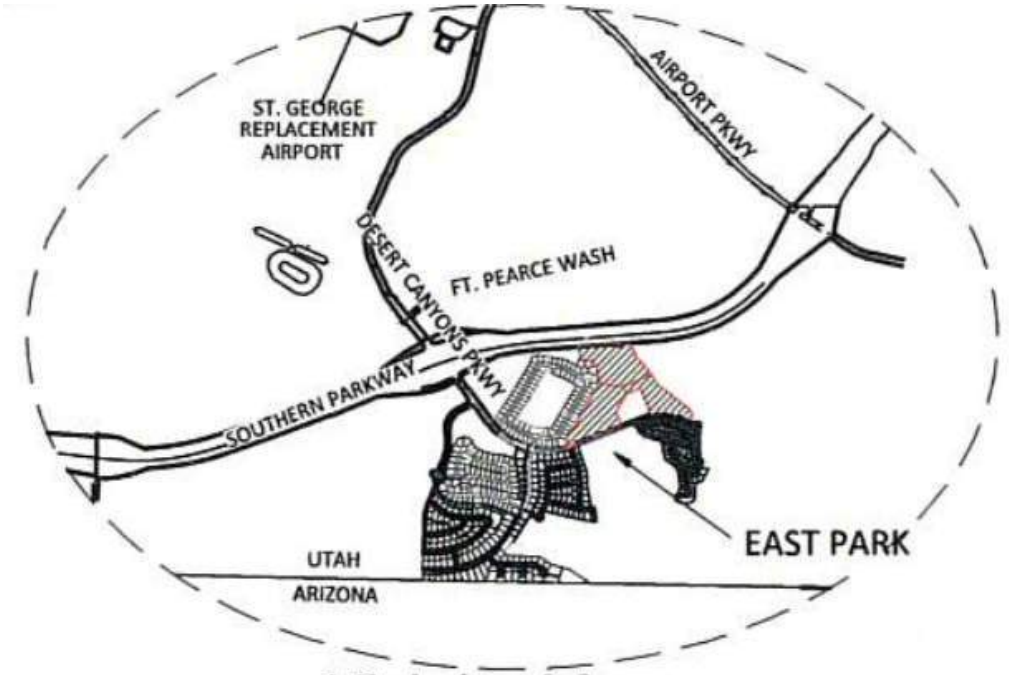
Staff Comments: If the HSRB recommends approval of the hillside permit, then the permit request advances forward to the Planning Commission (PC) for review and recommendation and then on to the City Council (CC) for approval or denial.

1. Hillside Permit - A hillside permit is required per ordinance and the HSRB will make recommendations to the PC & CC.
2. Zoning – Currently the zoning is PD-R and R-1-10, but the applicant will have to approach the city council with a zone change amendment request in order to proceed with the development.
3. Development – It's proposed to grade the area as presented.
4. Geotechnical Investigation – Given the nature of the application, a geotechnical report was not required.
5. Grading Permit - If approved, the applicant will work with staff for submittal of a Grading Permit with the required accompanying civil engineering plan set (for plan review).

Draft Motion: The HSRB recommends approval of "The Desert Canyon East Park" and the following are recommended conditions and comments:

1. Grading Permit – The applicant shall work with staff for submittal of a Grading Permit for "The Desert Canyon East Park" with the required accompanying civil engineering plan set (for plan review).
2. Non-contiguous Areas – The non-contiguous, insignificant areas, and man-made spoils over 40% may be removed.

Vicinity Map



Vicinity Map

DESERT CANYONS EAST PARK
NARRATIVE

The purpose of this Hillside application is to request approval for a community park to be constructed within the Desert Canyons project.

The proposed community park will have a restroom facility, a grass area, playground area and a pickleball court. There will also be boulders that have rock art located on the faces that will be protected in place.

A portion of the park is located in the Hillside Zone, a Rockfall Hazard Study has been completed in this area. There will be a rockfall mitigation berm on the south side of the park that will be in compliance with the rockfall mitigation letter provided by AGEC.

The proposed community park will be accessed from Desert Canyons Parkway. All utilities will be located within the public roadways, and will connect to the existing utilities in Desert Canyons Parkway. Access points for the Desert Canyons Masterplan are located at Interchange #6 & #7 of the Southern Parkway. Access to the proposed project is currently served by Interchange #6.

The community park will meet all standards as follows:

A. Noise: No noise other than typical motor vehicle traffic and recreational noise is planned.
B. Dust: All roads will be paved and disturbed areas will be landscaped to eliminate dust issues.
C. Odors: The Park will have trash receptacles for trash collection.
D. Aesthetics: The community park will be consistent with other parks built to the City of St. George parks standards, and all City of St. George Landscape standards will be followed.
E. Safety: No unusual traffic is planned which would create unsafe conditions. The Park is located outside of the 100 year floodplain boundary.
F. Traffic: The Desert Canyons Master Plan traffic study contemplates and accommodates the level of development shown on the attached plan.
G. Density: N/A
H. Height: Not to exceed 35 feet.
I. Hours of Operation: Hours of operation will be similar to any surrounding residential uses.
J. Character and purpose of Zone: N/A
K. Public Health: All sanitation and solid waste disposal measures will follow applicable codes.
L. Phasing: The current phasing plan consists of X phases as shown on the concept phasing plan.

The proposed community park will conform to all City of St. George standards and zoning provisions.

AGEC
Applied GeoTech

January 22, 2018

Desert Canyons Development
113 East 200 North
St George, Utah 84770

Attention: Curt Gordon

Subject: Rockfall Hazard Assessment
Desert Canyon Broken Rock Ridge East Subdivision
South of Desert Canyons Boulevard
St George, Utah
Project No. 2170882

Reference: Rock Fall Study, by AGEC dated August 10, 2017, project No. 2170882.

Applied Geotechnical Engineering Consultants, Inc. (AGEC) has requested to re-evaluate a section near Desert Canyons Blvd. of the rockfall study (Ref. No. 1) for the proposed Desert Canyon Broken Rock Ridge East subdivision located south of Desert Canyons Boulevard in St George, Utah.

The area of concern has a ridge with a low area behind the ridge. We understand that the ridge will be cut slightly, but the low area will remain behind the ridge. The runout line from Reference No. 1 did not take into account the planned grading for this area. The revised run-out line is provided based on our re-evaluation. The ridge will act as a rockfall barrier and should be graded to have at least a 5 foot high ridge or barrier. The back side should be as close to vertical as can be graded.

If you have questions or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.



G. Wayne Rogers, P.E.
Enclosure

AGEC
Applied GeoTech

September 30, 2019

Desert Canyons Development
113 East 200 North
St George, Utah 84770

Attention: Curt Gordon

Subject: Rockfall Protection Berm
Proposed Park
Desert Canyons Parkway and Broken Rock Drive
St George, Utah
Project No. 2170882

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. (AGEC) was requested to provide recommendations for a rockfall protection berm to be constructed at the proposed park at the southeast corner of Desert Canyons Parkway and Broken Rock Drive in St George, Utah.

BERMS

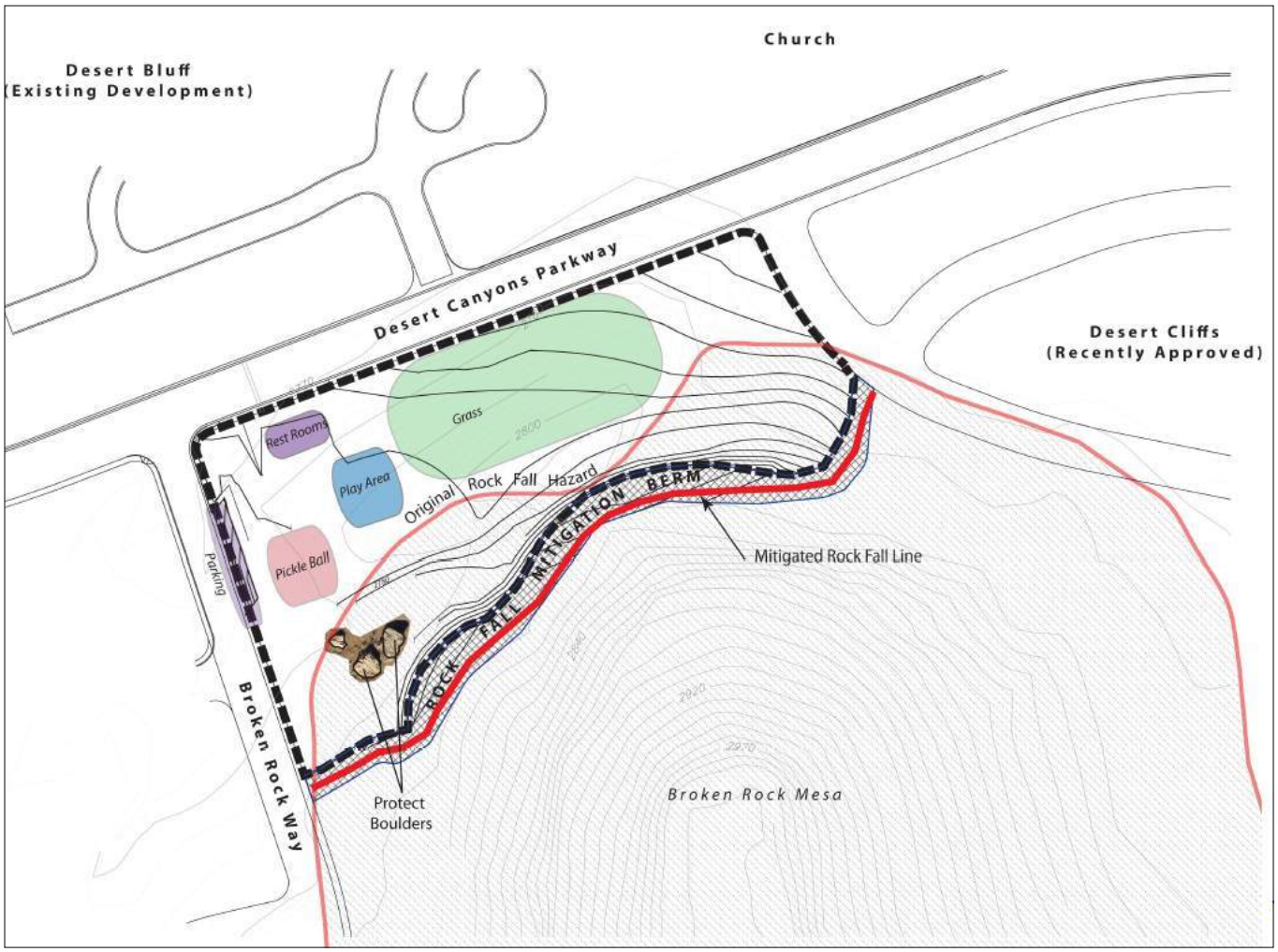
The approximate rockfall hazard zone was presented in a report dated August 10, 2017. The extent of the rockfall hazard was determined based on guidelines presented by Bowman and Lund (2016). The rockfall-hazard zone shown is intended to capture most of the potential rockfall-runout area but there may be a potential for rockfall hazard to extend beyond this zone.

Rockfall modeling using the Colorado Rockfall Simulation Program was performed for the slope based on the topography provided. Results of the modeling indicate that a berm could be constructed along the east side of park to mitigate the rockfall hazard (See Figure 1). The berm should be at least 8 feet high for the south half and 6 feet high for the north half.

The rockfall-protection berm should have a top width of at least 4 feet and an upslope face of ½ horizontal to 1 vertical or steeper. It is important to have a steep upslope face for the berm so rocks are not directed over the berm. The berm should be reinforced using geogrid to maintain a steep upslope face. The reinforcement spacing and slope construction will depend on the type of fill used and reinforcement selected. Design of the reinforced berm could be provided upon request. Other berm locations and configurations can be evaluated. Both the design and evaluation of other configurations are beyond the scope of this study.

600 West Sandy Parkway • Sandy, Utah 84070 • (801) 566-6399 • FAX (801) 566-6493

Rough Park 'Concept'



City Produced Concept Plans

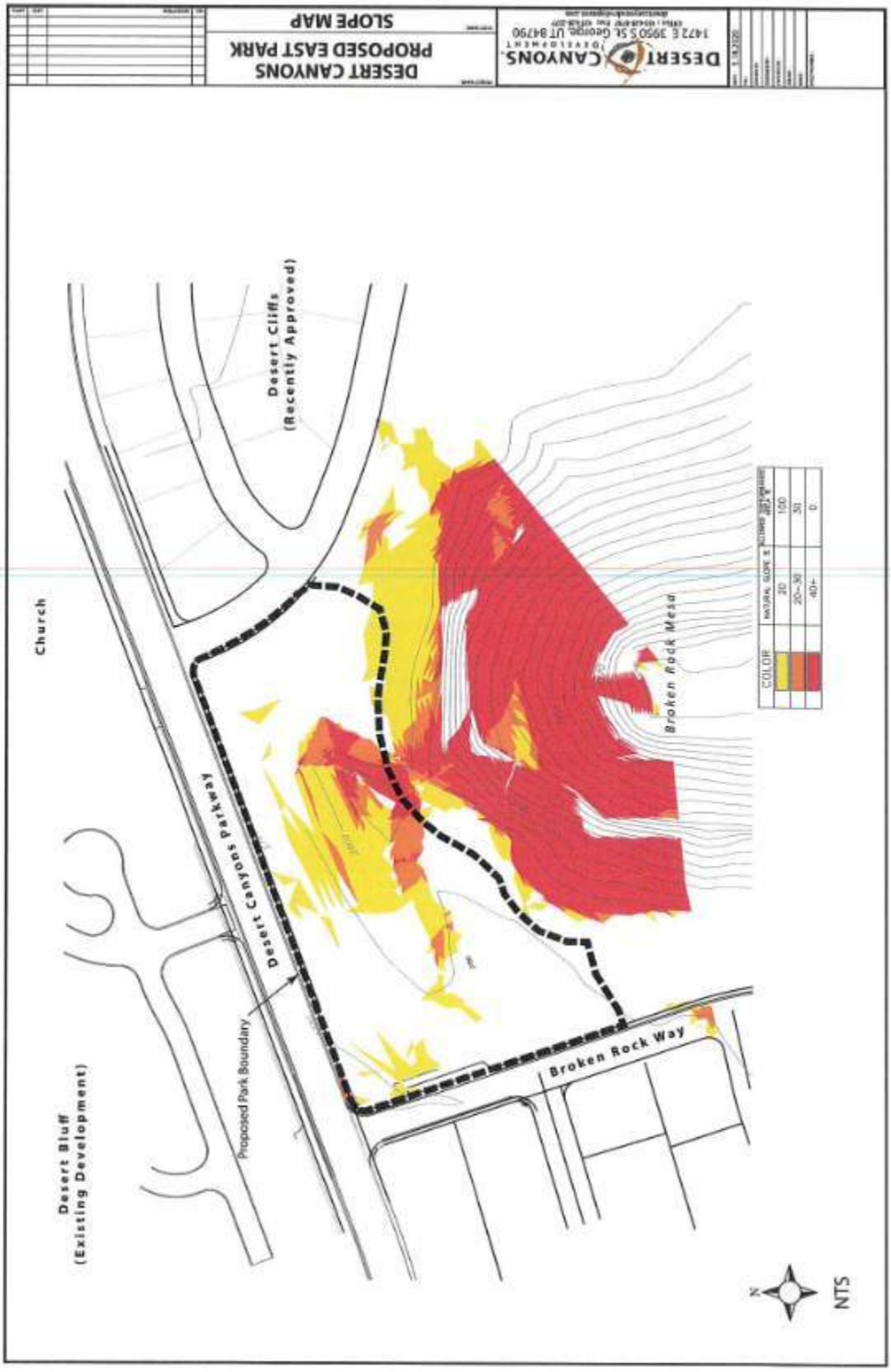




Grading Plan



Slope Map


SLOPE MAP
DESERT CANYONS
PROPOSED EAST PARK
DESERT CANYONS
Desert Cliffs
(Recently Approved)
Church
Desert Canyons Parkway
Broken Rock Mesa
Broken Rock Way
Proposed Park Boundary
Desert Bluff
(Existing Development)
COLOR
NATURAL SLOPE %
ACRES
20
100
20–30
30
40+
0
N
NTS

Drainage Study

DESERT CANYONS EAST PARK

Drainage Study

St. George, Utah



Prepared By:

DEVELOPMENT SOLUTIONS

113 East 200 North Suite #2
St. George, Utah 84770
(435) 628-2121

May, 2020

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1.0 INTRODUCTION

This Preliminary Drainage Study addresses the hydrologic impacts of the proposed Desert Canyons East Park site located in St. George, Utah. The objective of this study is to analyze the off-site and on-site hydrology under current conditions, and to analyze the impact of the proposed development on the existing on-site and downstream runoff. Flow patterns, points of discharge, and peak runoff are evaluated and compared to determine compliance with City of St. George drainage requirements. A plan was developed for the conveyance of storm flows through and around the site, establishment of flow rates for use as the basis of design for permanent and temporary flood protection facilities and for the determination of potential impacts to adjacent properties and facilities.

2.0 PROJECT DESCRIPTION

2.1 Location

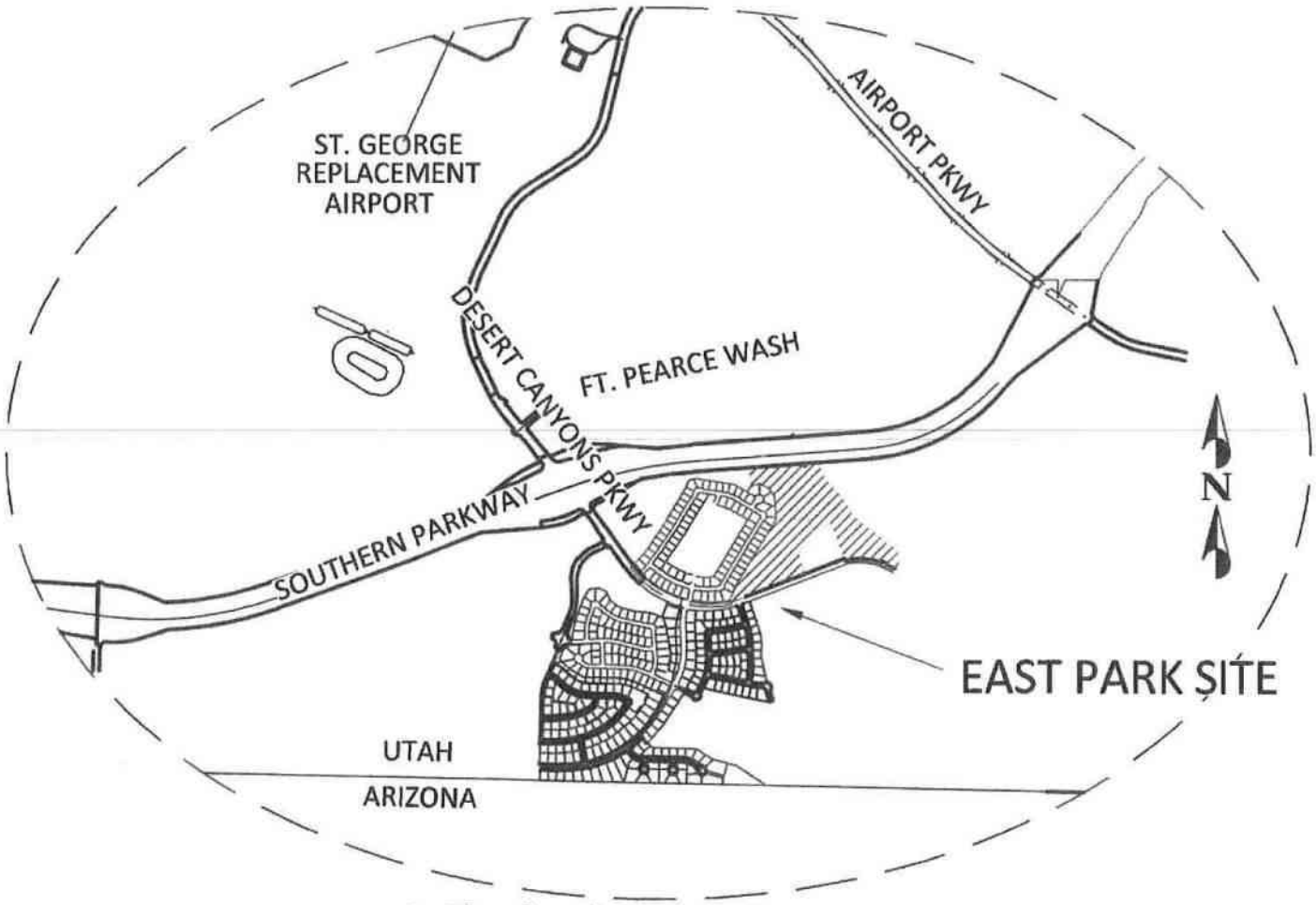
The project site is located in the southern portion of St. George City, within Section 35, Township 43 South, Range 15 West, Salt Lake Base and Meridian. The East Park site is located on the south side of Desert Canyons Park east of Broken Rock Way. A map illustrating the location of the project in relation to St. George and the surrounding area is presented in Figure 1 of Appendix.

2.2 Project Description

The project consists of rough grading of a future public park site located on approximately 3.2 acres. The project site is located in an upland terrace area. Properties located to the east and south of the project site are undeveloped, and consist primarily of sparsely vegetated upland desert habitat. The project is located adjacent to, and easterly of the existing Desert Valley subdivision.

2.3 Soils

Soils information was referenced from the USDA Web Soil Survey. A copy of the soil map is included in the Appendix. Soils found within onsite sub-basins consist of the Nikey sandy loam soils (hydrologic group "B"). Surrounding steep hillsides comprising the offsite hydrologic basins consist of Badlands type soils (hydrologic group "C" and "D"). Composite SCS Curve number calculations based upon soil types and land uses are included in the Appendix.

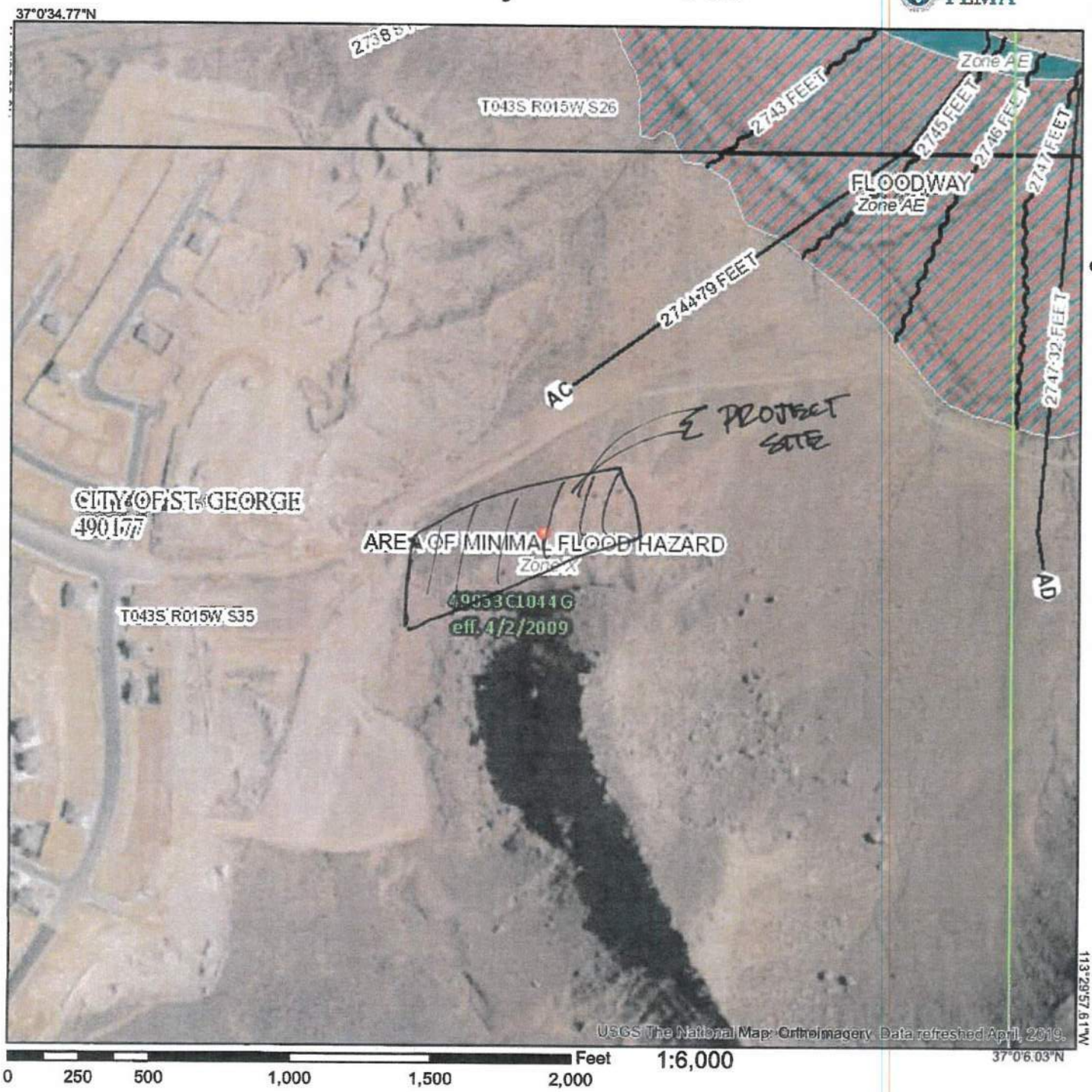


Vicinity Map

NOT TO SCALE

FIGURE 1

National Flood Hazard Layer FIRMette



FEMA

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) Zone A, V, A99
- With BFE or Depth Zone AE, AO, AH, VE, AR
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Area of 1% annual chance flood with average depth less than one foot or with drainag areas of less than one square mile Zone
- Future Conditions 1% Annual Chance Flood Hazard Zone X
- Area with Reduced Flood Risk due to Levee. See Notes. Zone X
- Area with Flood Risk due to Levee Zone D

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard Zone X
- Effective LOMRs
- Area of Undetermined Flood Hazard Zone

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represe an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 5/28/2020 at 2:35:00 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

FIGURE 2

3.0 DRAINAGE BASINS

3.1 FEMA Floodplain

Based upon the Flood Insurance Rate Map (FIRM) the entire site lies within an area designated as Zone "X", defined by FEMA as an area outside the 100-year floodplain and is shown on FEMA map ID 49053C1044G (See Figure 2).

3.2 Master Plan Drainage Facilities

No master planned drainage facilities are addressed in the St. George City Master Drainage Study within the project boundaries.

3.3 Existing Drainage Conditions

The existing hydrologic conditions consist of relatively steep upland areas on the south side of the project transitioning to gradually sloping topography to the north. The site drains to the existing Desert Canyons Parkway street improvements. See Figure 3 for existing conditions.

3.4 Developed Drainage Conditions

The proposed site development will consist of rough grading, construction of a rockfall mitigation berm along the south boundary with accompanying drainage swales, and sedimentation control facilities. See Figure 4 for developed conditions. Runoff generated onsite will be conveyed by graded swale to existing downstream collection and conveyance facilities. A proposed sediment basin will be designed to detain and settle the 80% storm runoff event (est. 1.25-yr storm event).

4.0 HYDROLOGICAL DESIGN METHODS

4.1 Rainfall Methodology

The rainfall and runoff data developed for this hydrologic analysis was prepared for use with the Army Corp of Engineering's program HEC-HMS in accordance with the City of St. George Drainage Design Manual. HEC-HMS input data was generated using the St. George Drainage Manual. Runoff modeling was performed for the 10-year and 100-year storm frequencies.

A 100-year, 3-hour point rainfall depth of 2.26 inches was utilized in the HEC-HMS portion of this hydrology analysis to size proposed drainage facilities. No area reduction was utilized in the point rainfall determinations.

4.2 Runoff Methodology

The SCS Curve number method was used for the loss calculations in all scenarios. The curve numbers for the water sheds were determined using a weighted average based on soil type, vegetation and land use. The lag time for each basin

was calculated using both the travel time component method and the SCS empirical method. The shortest lag time was then used in the transform analysis. The time of concentration was calculated as follows:

$T_c = T_i + T_t$
where:
T_c = Time of concentration
T_i = Initial, inlet or sheet flow travel time
T_t = Travel time for shallow concentrated flow

Initial flow time was calculated as follows:

$T_i = 0.007(nL)^{0.8}/(P_2)^{0.5}s^{0.4}$
where:
T_i = Initial overland travel time (minutes)
n = manning's number
L = sheet flow length (typically less than 300 feet)
P_2 = 2-yr 24-hr precipitation (inches)
s = slope (ft/ft)

Shallow concentrated flow travel time was calculated as follows:

$T_t = L/3600V$
Where:
T_t = travel time for shallow concentrated flow
L = flow length (feet)
V = average velocity (ft/s)

The velocity used in the travel time computations for all offsite and onsite basins was estimated using TR-55's Figure 3-1 and assuming unpaved surfaces.
The lag time was calculated as follows:

$T_{lag} = 0.6T_c$ (hours)

5.0 RESULTS OF ANALYSIS

5.1 Peak Runoff

Historical, existing on-site, and developed on-site calculated peak runoff at critical points of discharge are indicated on Figures 3 and 4. Final downstream points of discharge are the same for the developed and existing condition.

5.2 Hydraulic Results

Hydraulic analysis included depth of flow and velocity within the proposed drainage swales. All hydraulic calculations and analysis are included the Appendix.

Based upon volume calculation for the 80th percentile storm event for the graded (developed) site, a total storage volume of 3,000 cubic feet should be incorporated into sediment/detention basin design. The sediment basin should have an 8-feet long, 6" perforated pipe low flow pipe outlet. The low flow outlet pipe should be encased in a filter sock, overlain with at least 8 inches of ¾" drain rock. Storm drain and detention basin orifice calculations are included in the Appendix.

APPENDIX

Hydrologic Criteria

HYDROLOGIC CRITERIA AND DRAINAGE DESIGN MANUAL

TIME OF CONCENTRATION

PROJECT: DESERT VALLEY EAST PARK SITE **Run:** Final

FILE : SF4 **CALCULATED BY:** kmm **DATE :** 5/27/2020

Sub-Basin Data					Initial/Overland Time (Ti)			Travel Time (Tt)				Tc	Tc Check (Urbanized Basins)		Final Tc	Tlag
DESIG (1)	CN	K (2)	AREA (acres) (3)	AREA (mi^2)	LENGTH (ft) (4)	SLOPE (%) (5)	Ti (min) (6)	LENGTH (ft) (7)	SLOPE (%) (8)	VELOCITY (fps) (9)	Tt (min) (10)	Tc=Ti+Tt (min) (11)	TOTAL (ft) (12)	Tc (min) (13)	(min) (14)	Tlag (hrs)
OFFSITE BASINS - EXISTING CONDITIONS																
OFF1	88	0.772	2.19	0.0034	250	88.00	2.1	250	12.00	4.0	1.0	3.1	500.0	NA	3.1	0.031
OFF2	88	0.772	0.60	0.0009	45	81.00	0.9	163	22.00	5.0	0.5	1.5	208.0	NA	1.5	0.015
ON-SITE BASINS - EXISTING CONDITIONS																
ONEX	85	0.732	3.20	0.0050	76	21.00	2.1	280	7.50	3.0	1.6	3.6	356.0	NA	3.6	0.036
ON-SITE BASINS - EXISTING CONDITIONS																
ONDV	91	0.811	3.20	0.0050	60	45.00	1.1	300	2.00	2.0	2.5	3.6	360.0	NA	3.6	0.036

Ti=(1.8(1.1-K)L^(1/2))/(S^1/3)

Tc= Ti+TT

K=0.0132(CN)-.39 Tlag=.6Tc

* Soil is Type 'C'.

REFERENCE: **STANDARD FORM 4**

Hydrologic Soil Group—Washington County Area, Utah
(DC EAST PARK)



Map Scale: 1:1,480 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

USDA **Natural Resources Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Washington County Area, Utah
Survey Area Data: Version 13, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Feb 16, 2015—Oct 22, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BB	Badland, very steep		3.3	68.2%
NLE	Nikey sandy loam, 3 to 15 percent slopes	B	1.5	31.8%
Totals for Area of Interest			4.8	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

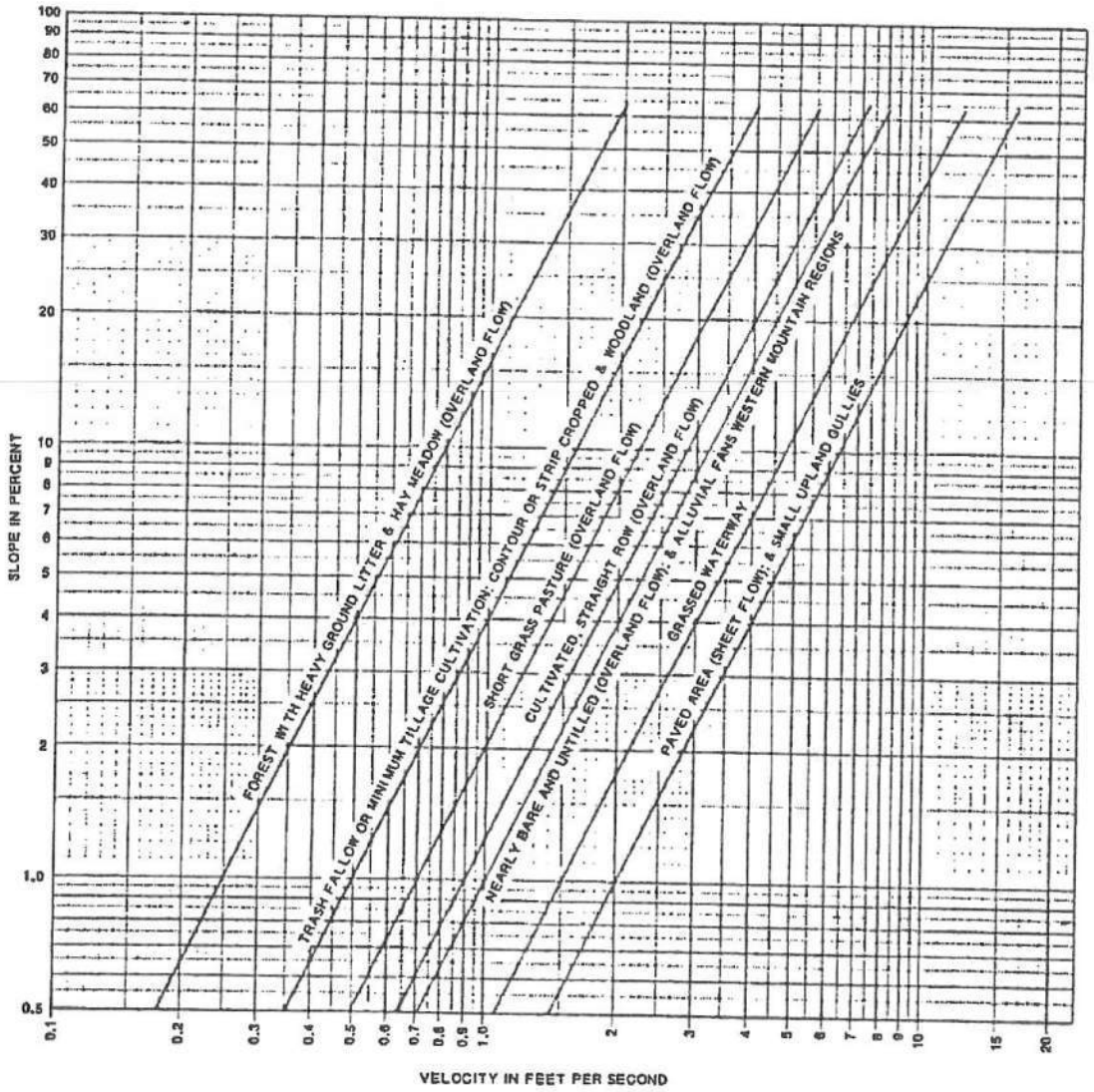
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

TRAVEL TIME VELOCITY



Revision	Date

WRC ENGINEERING	REFERENCE: SCS National Engineering Handbook Section 4, Hydrology, March, 1985	FIGURE 602

RUNOFF CURVE NUMBERS
(URBAN AREAS[1])

Cover description		Curve numbers for hydrologic soil group—			
Cover type and hydrologic condition	Average percent impervious area[2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved: curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved: open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
See Table 602A					
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation)[5]		77	86	91	94

1 Average runoff condition, and $I_a = 0.2S$.

2 The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system. Impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using Figure 603.

3 CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

4 Composite CN's for natural desert landscaping should be computed using Figure 603 based on the impervious area percentage (CN #98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

5 Composite CN's to use for the design of temporary measures during grading and construction should be computed using Figure 603 based on the degree of development impervious area percentage) and the CN's for the newly graded pervious areas.

Revision	Date

RUNOFF CURVE NUMBERS
(SEMIARID RANGELANDS[1])

Cover description		Curve numbers for hydrologic soil group—			
Cover type	Hydrologic condition[2]	A[3]	B	C	D
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush.	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper—pinyon, juniper, or both; grass understory.	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory.	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, burasge, palo verde, mesquite, and cactus.	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

[1]Average runoff condition, and $I_a = 0.2S$.

[2]*Poor:* <30% ground cover (litter, grass, and brush overstory).
Fair: 30 to 70% ground cover.
Good: >70% ground cover.

[3]Curve numbers for group A have been developed only for desert shrub.

Revision	Date

HEC-1 Calculations
80th Percentile Storm
Existing and Developed Conditions

```
1****************************************
****************************************
 *                                      *                                        *
    *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                        *   U.S. ARMY CORPS OF
ENGINEERS     *
 *           SEPTEMBER 1990             *                                        *   HYDROLOGIC ENGINEERING
CENTER    *
 *            VERSION 4.0               *                                        *         609 SECOND STREET
    *
 *                                      *                                        *       DAVIS, CALIFORNIA 95616
    *
 *  RUN DATE  09/12/2007  TIME  04:07:05 *                                        *          (916) 756-1104
    *
 *                                      *                                        *
    *
 ****************************************
****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.

THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

```
          LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

            1           ID    HEC-1 Analysis using GeoShed
            2           ID    DESERT VALLEY EAST PARK SITE
            3           ID    8TH PERCENTILE STORM, 3-HR
                        *DIAGRAM
            4           IT       5  1JAN20       0     100
            5           IO       0

            6           KK    ONDV
            7           KO       0       0       0       0      22
            8           BA   0.005
            9           PB    0.98
           10           IN       5  1JAN20       0
                        * FARM3HR
           11           PC       0       0       1       1       2       2       3      28      48      62
           12           PC      71      77      81      84      86      88      90      91      92      93
           13           PC      93      94      94      94      95      95      96      96      97      97
           14           PC      97      98      98      99      99     100     100
           15           LS       0      91       0
           16           UD    0.05

           17           KK      V1
                        * RESERVOIR STORAGE
           18           KO       0       0       0       0      22
           19           RS       1    STOR       0       0
                        * PARKRESSTOR
           20           SV       0     0.1     0.1
```

```
                * PARKRESELEV
          21    SE       0       3     3.1
                * PARKRESOUT
          22    SQ       0       1
                * PARKRESELOUT
          23    SE       3     3.1

          24    KK      4R   CNAME      4C
          25    KO       0       0       0       0      22
          26    RN      4R

          27    KK    ONEX
          28    KO       0       0       0       0      22
          29    BA   0.005
          30    LS       0      85       0
          31    UD    0.05

          32    KK      3R   CNAME      3C
          33    KO       0       0       0       0      22
          34    RN      3R

          35    KK    OFF1
          36    KO       0       0       0       0      22
          37    BA  0.0034
          38    LS       0      88       0
          39    UD    0.05
1                                      HEC-1 INPUT                                    PAGE  2

        LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9.....10

          40    KK      2R   CNAME      2C
          41    KO       0       0       0       0      22
          42    RN      2R

          43    KK    OFF2
          44    KO       0       0       0       0      22
          45    BA  0.0009
          46    LS       0      88       0
          47    UD    0.05

          48    KK      1R   CNAME      1C
          49    KO       0       0       0       0      22
          50    RN      1R
          51    ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

     6        ONDV
               V
               V
    17         V1
               V
               V
    24         4R
               .
               .
    27         .        ONEX
               .          V
               .          V
    32         .          3R
               .           .
               .           .
    35         .           .       OFF1
               .           .         V
               .           .         V
    40         .           .         2R
               .           .         .
               .           .         .
    43         .           .         .       OFF2
```

```
             .         .         .         V
             .         .         .         V
   48        .         .         .         1R

 (***) RUNOFF ALSO COMPUTED AT THIS LOCATION
1*****************************************
****************************************
*                                         *                                          *
    *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)    *                                          *   U.S. ARMY CORPS OF
ENGINEERS     *
*          SEPTEMBER 1990                *                                          *   HYDROLOGIC ENGINEERING
CENTER    *
*            VERSION 4.0                 *                                          *        609 SECOND STREET
    *
*                                         *                                          *     DAVIS, CALIFORNIA 95616
    *
*  RUN DATE  09/12/2007  TIME  04:07:05  *                                          *        (916) 756-1104
    *
*                                         *                                          *
    *
*****************************************
****************************************
```

```
                         HEC-1 Analysis using GeoShed
                         DESERT VALLEY EAST PARK SITE
                         8TH PERCENTILE STORM, 3-HR

   5 IO          OUTPUT CONTROL VARIABLES
                      IPRNT           0  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT           HYDROGRAPH TIME DATA
                       NMIN           5  MINUTES IN COMPUTATION INTERVAL
                      IDATE      1JAN20  STARTING DATE
                      ITIME        0000  STARTING TIME
                         NQ         100  NUMBER OF HYDROGRAPH ORDINATES
                     NDDATE      1JAN20  ENDING DATE
                     NDTIME        0815  ENDING TIME
                      ICENT          19  CENTURY MARK

                COMPUTATION INTERVAL    .08 HOURS
                     TOTAL TIME BASE   8.25 HOURS

         ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT


*** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
*** ***


            **************
            *            *
   6 KK     *     ONDV   *
            *            *
            **************

   7 KO          OUTPUT CONTROL VARIABLES
                      IPRNT           0  PRINT CONTROL
                      IPLOT           0  PLOT CONTROL
                      QSCAL          0.  HYDROGRAPH PLOT SCALE
```

```
          IPNCH          0  PUNCH COMPUTED HYDROGRAPH
           IOUT         22  SAVE HYDROGRAPH ON THIS UNIT
          ISAV1          1  FIRST ORDINATE PUNCHED OR SAVED
          ISAV2        100  LAST ORDINATE PUNCHED OR SAVED
         TIMINT       .083  TIME INTERVAL IN HOURS


 10 IN    TIME DATA FOR INPUT TIME SERIES
           JXMIN          5  TIME INTERVAL IN MINUTES
          JXDATE      1JAN20  STARTING DATE
          JXTIME           0  STARTING TIME

      SUBBASIN RUNOFF DATA

  8 BA    SUBBASIN CHARACTERISTICS
           TAREA         .00  SUBBASIN AREA

      PRECIPITATION DATA

  9 PB         STORM        .98  BASIN TOTAL PRECIPITATION

 11 PI      INCREMENTAL PRECIPITATION PATTERN
             .00    1.00     .00    1.00     .00    1.00   25.00   20.00   14.00    9.00
            6.00    4.00    3.00    2.00    2.00    2.00    1.00    1.00    1.00     .00
            1.00     .00     .00    1.00     .00    1.00     .00    1.00     .00     .00
            1.00     .00    1.00     .00    1.00

 15 LS    SCS LOSS RATE
           STRTL         .20  INITIAL ABSTRACTION
          CRVNBR       91.00  CURVE NUMBER
           RTIMP         .00  PERCENT IMPERVIOUS AREA

 16 UD    SCS DIMENSIONLESS UNITGRAPH
           TLAG         .05  LAG

                                                  ***

WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG

                                              UNIT HYDROGRAPH
                                          5 END-OF-PERIOD ORDINATES
              26.       10.        2.        1.        0.
```

****

HYDROGRAPH AT STATION ONDV

****

DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q	DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q
1	JAN	0000	1	.00	.00	.00	0.	1	JAN	0410	51	.00	.00	.00	0.
1	JAN	0005	2	.00	.00	.00	0.	1	JAN	0415	52	.00	.00	.00	0.
1	JAN	0010	3	.01	.01	.00	0.	1	JAN	0420	53	.00	.00	.00	0.
1	JAN	0015	4	.00	.00	.00	0.	1	JAN	0425	54	.00	.00	.00	0.
1	JAN	0020	5	.01	.01	.00	0.	1	JAN	0430	55	.00	.00	.00	0.
1	JAN	0025	6	.00	.00	.00	0.	1	JAN	0435	56	.00	.00	.00	0.
1	JAN	0030	7	.01	.01	.00	0.	1	JAN	0440	57	.00	.00	.00	0.
1	JAN	0035	8	.25	.24	.01	0.	1	JAN	0445	58	.00	.00	.00	0.
1	JAN	0040	9	.20	.14	.05	1.	1	JAN	0450	59	.00	.00	.00	0.
1	JAN	0045	10	.14	.08	.06	2.	1	JAN	0455	60	.00	.00	.00	0.
1	JAN	0050	11	.09	.04	.05	2.	1	JAN	0500	61	.00	.00	.00	0.
1	JAN	0055	12	.06	.03	.03	2.	1	JAN	0505	62	.00	.00	.00	0.
1	JAN	0100	13	.04	.02	.02	1.	1	JAN	0510	63	.00	.00	.00	0.
1	JAN	0105	14	.03	.01	.02	1.	1	JAN	0515	64	.00	.00	.00	0.
1	JAN	0110	15	.02	.01	.01	1.	1	JAN	0520	65	.00	.00	.00	0.
1	JAN	0115	16	.02	.01	.01	1.	1	JAN	0525	66	.00	.00	.00	0.
1	JAN	0120	17	.02	.01	.01	0.	1	JAN	0530	67	.00	.00	.00	0.
1	JAN	0125	18	.01	.00	.01	0.	1	JAN	0535	68	.00	.00	.00	0.
1	JAN	0130	19	.01	.00	.01	0.	1	JAN	0540	69	.00	.00	.00	0.

1 JAN 0135	20	.01	.00	.01	0.	*	1 JAN 0545	70	.00	.00	.00	0.
1 JAN 0140	21	.00	.00	.00	0.	*	1 JAN 0550	71	.00	.00	.00	0.
1 JAN 0145	22	.01	.00	.01	0.	*	1 JAN 0555	72	.00	.00	.00	0.
1 JAN 0150	23	.00	.00	.00	0.	*	1 JAN 0600	73	.00	.00	.00	0.
1 JAN 0155	24	.00	.00	.00	0.	*	1 JAN 0605	74	.00	.00	.00	0.
1 JAN 0200	25	.01	.00	.01	0.	*	1 JAN 0610	75	.00	.00	.00	0.
1 JAN 0205	26	.00	.00	.00	0.	*	1 JAN 0615	76	.00	.00	.00	0.
1 JAN 0210	27	.01	.00	.01	0.	*	1 JAN 0620	77	.00	.00	.00	0.
1 JAN 0215	28	.00	.00	.00	0.	*	1 JAN 0625	78	.00	.00	.00	0.
1 JAN 0220	29	.01	.00	.01	0.	*	1 JAN 0630	79	.00	.00	.00	0.
1 JAN 0225	30	.00	.00	.00	0.	*	1 JAN 0635	80	.00	.00	.00	0.
1 JAN 0230	31	.00	.00	.00	0.	*	1 JAN 0640	81	.00	.00	.00	0.
1 JAN 0235	32	.01	.00	.01	0.	*	1 JAN 0645	82	.00	.00	.00	0.
1 JAN 0240	33	.00	.00	.00	0.	*	1 JAN 0650	83	.00	.00	.00	0.
1 JAN 0245	34	.01	.00	.01	0.	*	1 JAN 0655	84	.00	.00	.00	0.
1 JAN 0250	35	.00	.00	.00	0.	*	1 JAN 0700	85	.00	.00	.00	0.
1 JAN 0255	36	.01	.00	.01	0.	*	1 JAN 0705	86	.00	.00	.00	0.
1 JAN 0300	37	.00	.00	.00	0.	*	1 JAN 0710	87	.00	.00	.00	0.
1 JAN 0305	38	.00	.00	.00	0.	*	1 JAN 0715	88	.00	.00	.00	0.
1 JAN 0310	39	.00	.00	.00	0.	*	1 JAN 0720	89	.00	.00	.00	0.
1 JAN 0315	40	.00	.00	.00	0.	*	1 JAN 0725	90	.00	.00	.00	0.
1 JAN 0320	41	.00	.00	.00	0.	*	1 JAN 0730	91	.00	.00	.00	0.
1 JAN 0325	42	.00	.00	.00	0.	*	1 JAN 0735	92	.00	.00	.00	0.
1 JAN 0330	43	.00	.00	.00	0.	*	1 JAN 0740	93	.00	.00	.00	0.
1 JAN 0335	44	.00	.00	.00	0.	*	1 JAN 0745	94	.00	.00	.00	0.
1 JAN 0340	45	.00	.00	.00	0.	*	1 JAN 0750	95	.00	.00	.00	0.
1 JAN 0345	46	.00	.00	.00	0.	*	1 JAN 0755	96	.00	.00	.00	0.
1 JAN 0350	47	.00	.00	.00	0.	*	1 JAN 0800	97	.00	.00	.00	0.
1 JAN 0355	48	.00	.00	.00	0.	*	1 JAN 0805	98	.00	.00	.00	0.
1 JAN 0400	49	.00	.00	.00	0.	*	1 JAN 0810	99	.00	.00	.00	0.
1 JAN 0405	50	.00	.00	.00	0.	*	1 JAN 0815	100	.00	.00	.00	0.
						*						

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******

TOTAL RAINFALL = .98, TOTAL LOSS = .63, TOTAL EXCESS = .35

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	8.25-HR
+ (CFS)	(HR)					
		(CFS)				
+ 2.	.75		0.	0.	0.	0.
		(INCHES)	.345	.345	.345	.345
		(AC-FT)	0.	0.	0.	0.

CUMULATIVE AREA = .00 SQ MI

*** ***
*** ***

```
              **************
              *            *
17 KK         *        V1  *
              *            *
              **************
```

18 KO OUTPUT CONTROL VARIABLES

IPRNT	0	PRINT CONTROL
IPLOT	0	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE
IPNCH	0	PUNCH COMPUTED HYDROGRAPH
IOUT	22	SAVE HYDROGRAPH ON THIS UNIT
ISAV1	1	FIRST ORDINATE PUNCHED OR SAVED
ISAV2	100	LAST ORDINATE PUNCHED OR SAVED
TIMINT	.083	TIME INTERVAL IN HOURS

HYDROGRAPH ROUTING DATA

```
 19 RS          STORAGE ROUTING
                     NSTPS          1  NUMBER OF SUBREACHES
                      ITYP       STOR  TYPE OF INITIAL CONDITION
                    RSVRIC        .00  INITIAL CONDITION
                         X        .00 WORKING R AND D COEFFICIENT

 20 SV            STORAGE          .0        .1        .1

 21 SE          ELEVATION         .00      3.00      3.10

 22 SQ          DISCHARGE          0.        1.

 23 SE          ELEVATION        3.00      3.10
```

***

COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

STORAGE	.00	.10	.10
OUTFLOW	.00	.00	1.00
ELEVATION	.00	3.00	3.10

****

HYDROGRAPH AT STATION V1

****

DA MON HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA MON HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA MON HRMN	ORD	OUTFLOW	STORAGE	STAGE
1 JAN 0000	1	0.	.0	.0	1 JAN 0250	35	0.	.1	2.7	1 JAN 0540	69	0.	.1	2.8
1 JAN 0005	2	0.	.0	.0	1 JAN 0255	36	0.	.1	2.7	1 JAN 0545	70	0.	.1	2.8
1 JAN 0010	3	0.	.0	.0	1 JAN 0300	37	0.	.1	2.8	1 JAN 0550	71	0.	.1	2.8
1 JAN 0015	4	0.	.0	.0	1 JAN 0305	38	0.	.1	2.8	1 JAN 0555	72	0.	.1	2.8
1 JAN 0020	5	0.	.0	.0	1 JAN 0310	39	0.	.1	2.8	1 JAN 0600	73	0.	.1	2.8
1 JAN 0025	6	0.	.0	.0	1 JAN 0315	40	0.	.1	2.8	1 JAN 0605	74	0.	.1	2.8
1 JAN 0030	7	0.	.0	.0	1 JAN 0320	41	0.	.1	2.8	1 JAN 0610	75	0.	.1	2.8
1 JAN 0035	8	0.	.0	.0	1 JAN 0325	42	0.	.1	2.8	1 JAN 0615	76	0.	.1	2.8
1 JAN 0040	9	0.	.0	.2	1 JAN 0330	43	0.	.1	2.8	1 JAN 0620	77	0.	.1	2.8
1 JAN 0045	10	0.	.0	.5	1 JAN 0335	44	0.	.1	2.8	1 JAN 0625	78	0.	.1	2.8
1 JAN 0050	11	0.	.0	1.0	1 JAN 0340	45	0.	.1	2.8	1 JAN 0630	79	0.	.1	2.8
1 JAN 0055	12	0.	.0	1.3	1 JAN 0345	46	0.	.1	2.8	1 JAN 0635	80	0.	.1	2.8
1 JAN 0100	13	0.	.1	1.6	1 JAN 0350	47	0.	.1	2.8	1 JAN 0640	81	0.	.1	2.8
1 JAN 0105	14	0.	.1	1.8	1 JAN 0355	48	0.	.1	2.8	1 JAN 0645	82	0.	.1	2.8
1 JAN 0110	15	0.	.1	1.9	1 JAN 0400	49	0.	.1	2.8	1 JAN 0650	83	0.	.1	2.8
1 JAN 0115	16	0.	.1	2.0	1 JAN 0405	50	0.	.1	2.8	1 JAN 0655	84	0.	.1	2.8
1 JAN 0120	17	0.	.1	2.1	1 JAN 0410	51	0.	.1	2.8	1 JAN 0700	85	0.	.1	2.8
1 JAN 0125	18	0.	.1	2.2	1 JAN 0415	52	0.	.1	2.8	1 JAN 0705	86	0.	.1	2.8
1 JAN 0130	19	0.	.1	2.3	1 JAN 0420	53	0.	.1	2.8	1 JAN 0710	87	0.	.1	2.8
1 JAN 0135	20	0.	.1	2.3	1 JAN 0425	54	0.	.1	2.8	1 JAN 0715	88	0.	.1	

```
 2.8
  1 JAN 0140  21         0.        .1       2.4 *  1 JAN 0430  55         0.        .1       2.8 *  1 JAN 0720  89         0.        .1
 2.8
  1 JAN 0145  22         0.        .1       2.4 *  1 JAN 0435  56         0.        .1       2.8 *  1 JAN 0725  90         0.        .1
 2.8
  1 JAN 0150  23         0.        .1       2.4 *  1 JAN 0440  57         0.        .1       2.8 *  1 JAN 0730  91         0.        .1
 2.8
  1 JAN 0155  24         0.        .1       2.4 *  1 JAN 0445  58         0.        .1       2.8 *  1 JAN 0735  92         0.        .1
 2.8
  1 JAN 0200  25         0.        .1       2.5 *  1 JAN 0450  59         0.        .1       2.8 *  1 JAN 0740  93         0.        .1
 2.8
  1 JAN 0205  26         0.        .1       2.5 *  1 JAN 0455  60         0.        .1       2.8 *  1 JAN 0745  94         0.        .1
 2.8
  1 JAN 0210  27         0.        .1       2.5 *  1 JAN 0500  61         0.        .1       2.8 *  1 JAN 0750  95         0.        .1
 2.8
  1 JAN 0215  28         0.        .1       2.5 *  1 JAN 0505  62         0.        .1       2.8 *  1 JAN 0755  96         0.        .1
 2.8
  1 JAN 0220  29         0.        .1       2.6 *  1 JAN 0510  63         0.        .1       2.8 *  1 JAN 0800  97         0.        .1
 2.8
  1 JAN 0225  30         0.        .1       2.6 *  1 JAN 0515  64         0.        .1       2.8 *  1 JAN 0805  98         0.        .1
 2.8
  1 JAN 0230  31         0.        .1       2.6 *  1 JAN 0520  65         0.        .1       2.8 *  1 JAN 0810  99         0.        .1
 2.8
  1 JAN 0235  32         0.        .1       2.6 *  1 JAN 0525  66         0.        .1       2.8 *  1 JAN 0815 100         0.        .1
 2.8
  1 JAN 0240  33         0.        .1       2.6 *  1 JAN 0530  67         0.        .1       2.8 *
  1 JAN 0245  34         0.        .1       2.7 *  1 JAN 0535  68         0.        .1       2.8 *
                                                *                                                *

**********************************************************************************************************************************
******

   PEAK FLOW      TIME                          MAXIMUM AVERAGE FLOW
                                        6-HR        24-HR        72-HR        8.25-HR
 +   (CFS)        (HR)
                             (CFS)
 +        0.        .08                   0.          0.           0.            0.
                           (INCHES)     .000        .000         .000          .000
                            (AC-FT)       0.          0.           0.            0.

  PEAK STORAGE    TIME                         MAXIMUM AVERAGE STORAGE
                                        6-HR        24-HR        72-HR        8.25-HR
 +  (AC-FT)       (HR)
          0.      3.00                    0.          0.           0.            0.

   PEAK STAGE     TIME                          MAXIMUM AVERAGE STAGE
                                        6-HR        24-HR        72-HR        8.25-HR
 +   (FEET)       (HR)
        2.76      3.33                  2.75         2.38         2.38          2.38

                             CUMULATIVE AREA =     .00 SQ MI


 *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** *** ***
*** ***


1
                                                          RUNOFF SUMMARY
                                                   FLOW IN CUBIC FEET PER SECOND
                                                TIME IN HOURS,  AREA IN SQUARE MILES

                                               PEAK     TIME OF        AVERAGE FLOW FOR MAXIMUM PERIOD          BASIN      MAXIMUM     TIME OF
             OPERATION          STATION        FLOW      PEAK                                                    AREA       STAGE     MAX STAGE
 +                                                                  6-HOUR        24-HOUR        72-HOUR

             HYDROGRAPH AT
 +                                 ONDV          2.       .75          0.            0.             0.           .00

             ROUTED TO
 +                                   V1          0.       .08          0.            0.             0.           .00
```

+								2.76	3.33
	ROUTED TO								
+		4R	0.	.08	0.	0.	0.	.00	
	HYDROGRAPH AT								
+		ONEX	1.	.83	0.	0.	0.	.00	
	ROUTED TO								
+		3R	1.	.83	0.	0.	0.	.00	
	HYDROGRAPH AT								
+		OFF1	1.	.83	0.	0.	0.	.00	
	ROUTED TO								
+		2R	1.	.83	0.	0.	0.	.00	
	HYDROGRAPH AT								
+		OFF2	0.	.83	0.	0.	0.	.00	
	ROUTED TO								
+		1R	0.	.83	0.	0.	0.	.00	

*** NORMAL END OF HEC-1 ***

HEC-1 Calculations
100-year Storm
Existing and Developed Conditions

```
1****************************************
****************************************
 *                                      *                                *
    *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *                                *   U.S. ARMY CORPS OF
ENGINEERS     *
 *            SEPTEMBER 1990            *                                *   HYDROLOGIC ENGINEERING
CENTER    *
 *             VERSION 4.0              *                                *        609 SECOND STREET
    *
 *                                      *                                *      DAVIS, CALIFORNIA 95616
    *
 *  RUN DATE  09/11/2007  TIME  23:04:21 *                                *          (916) 756-1104
    *
 *                                      *                                *
    *
 ****************************************
****************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.

THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

```
LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

  1           ID   HEC-1 Analysis using GeoShed
  2           ID   DESERT VALLEY EAST PARK SITE
  3           ID   100-YR, 3-HR
              *DIAGRAM
  4           IT       5  1JAN20       0     100
  5           IO       0

  6           KK    ONDV
  7           KO       0       0       0       0      22
  8           BA   0.005
  9           PB    2.26
 10           IN       5  1JAN20       0
              * FARM3HR
 11           PC       0       0       1       1       2       2       3      28      48      62
 12           PC      71      77      81      84      86      88      90      91      92      93
 13           PC      93      94      94      94      95      95      96      96      97      97
 14           PC      97      98      98      99      99     100     100
 15           LS       0      91       0
 16           UD    0.05

 17           KK      4R   CNAME      4C
 18           KO       0       0       0       0      22
 19           RN      4R

 20           KK    ONEX
 21           KO       0       0       0       0      22
```

```
          22          BA   0.005
          23          LS       0      85       0
          24          UD    0.05

          25          KK      3R   CNAME      3C
          26          KO       0       0       0       0      22
          27          RN      3R

          28          KK    OFF1
          29          KO       0       0       0       0      22
          30          BA  0.0034
          31          LS       0      88       0
          32          UD    0.05

          33          KK      2R   CNAME      2C
          34          KO       0       0       0       0      22
          35          RN      2R

          36          KK    OFF2
          37          KO       0       0       0       0      22
          38          BA  0.0009
          39          LS       0      88       0
          40          UD    0.05
1                                        HEC-1 INPUT                                                    PAGE  2

        LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10


          41          KK      1R   CNAME      1C
          42          KO       0       0       0       0      22
          43          RN      1R
          44          ZZ
1
              SCHEMATIC DIAGRAM OF STREAM NETWORK
 INPUT
  LINE      (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

   NO.      (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

     6        ONDV
              V
              V
    17        4R
              .
              .
    20        .        ONEX
              .          V
              .          V
    25        .          3R
              .          .
              .          .
    28        .          .        OFF1
              .          .          V
              .          .          V
    33        .          .          2R
              .          .          .
              .          .          .
    36        .          .          .        OFF2
              .          .          .          V
              .          .          .          V
    41        .          .          .          1R


1
                                        RUNOFF SUMMARY
                                    FLOW IN CUBIC FEET PER SECOND
                                  TIME IN HOURS,  AREA IN SQUARE MILES

                                    PEAK    TIME OF     AVERAGE FLOW FOR MAXIMUM PERIOD      BASIN      MAXIMUM      TIME OF
          OPERATION      STATION    FLOW     PEAK                                            AREA       STAGE      MAX STAGE
+                                                       6-HOUR      24-HOUR      72-HOUR

          HYDROGRAPH AT
```

```
+                       ONDV      9.    .75       1.        1.        1.       .00
        ROUTED TO
+                         4R      9.    .75       1.        1.        1.       .00
        HYDROGRAPH AT
+                       ONEX      6.    .75       1.        0.        0.       .00
        ROUTED TO
+                         3R      6.    .75       1.        0.        0.       .00
        HYDROGRAPH AT
+                       OFF1      5.    .75       0.        0.        0.       .00
        ROUTED TO
+                         2R      5.    .75       0.        0.        0.       .00
        HYDROGRAPH AT
+                       OFF2      1.    .75       0.        0.        0.       .00
        ROUTED TO
+                         1R      1.    .75       0.        0.        0.       .00

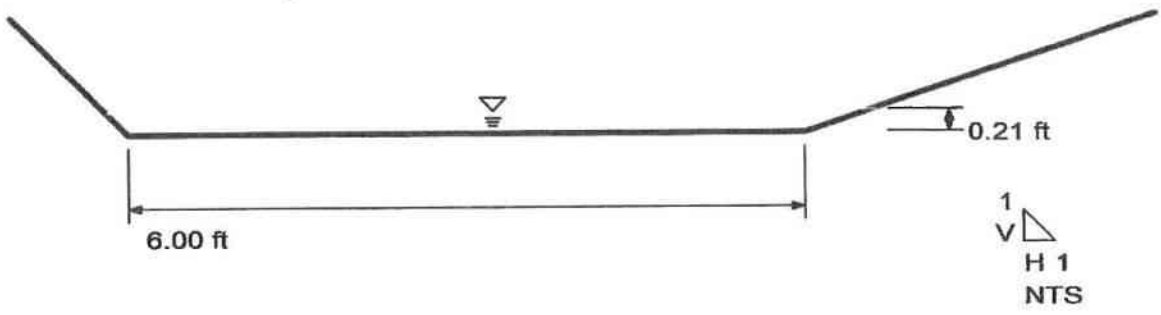

*** NORMAL END OF HEC-1 ***
```

Hydraulic Calculations

Cross Section
Cross Section for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\desert c.fm2
Worksheet	DV EAST PARK SWALE
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Section Data		
Mannings Coefficient	0.030	
Channel Slope	0.050000	ft/ft
Depth	0.21	ft
Left Side Slope	1.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	6.00	ft
Discharge	5.00	cfs

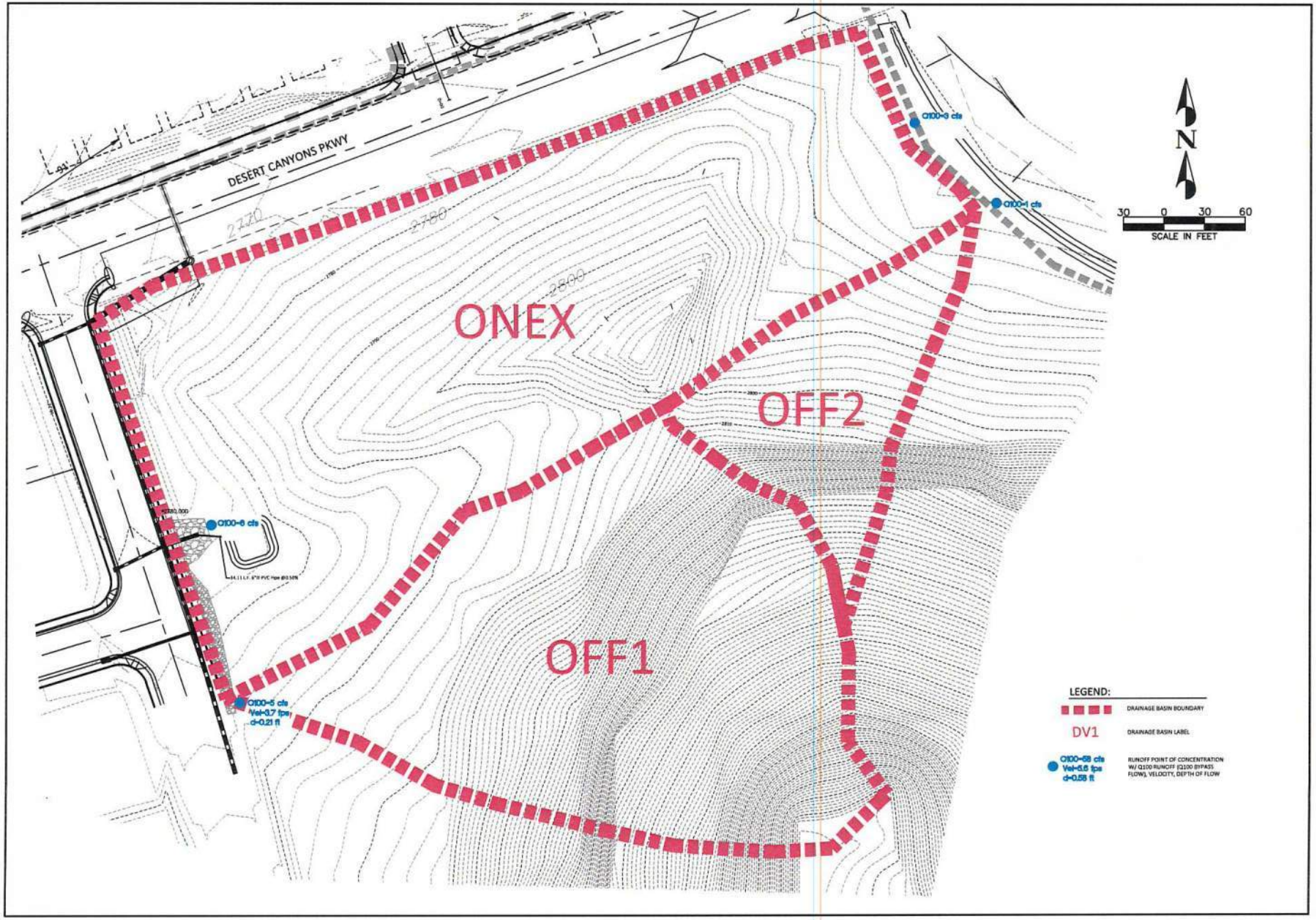


EAST PARK SWALE 100-YR
Worksheet for Trapezoidal Channel

Project Description	
Project File	c:\haestad\fmw\desert c.fm2
Worksheet	DV EAST PARK SWALE
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.030	
Channel Slope	0.050000	ft/ft
Left Side Slope	1.000000	H : V
Right Side Slope	3.000000	H : V
Bottom Width	6.00	ft
Discharge	5.00	cfs

Results		
Depth	0.21	ft
Flow Area	1.35	ft²
Wetted Perimeter	6.96	ft
Top Width	6.84	ft
Critical Depth	0.27	ft
Critical Slope	0.021449	ft/ft
Velocity	3.71	ft/s
Velocity Head	0.21	ft
Specific Energy	0.42	ft
Froude Number	1.47	
Flow is supercritical.		



NO	DESCRIPTION	DATE	APP'D

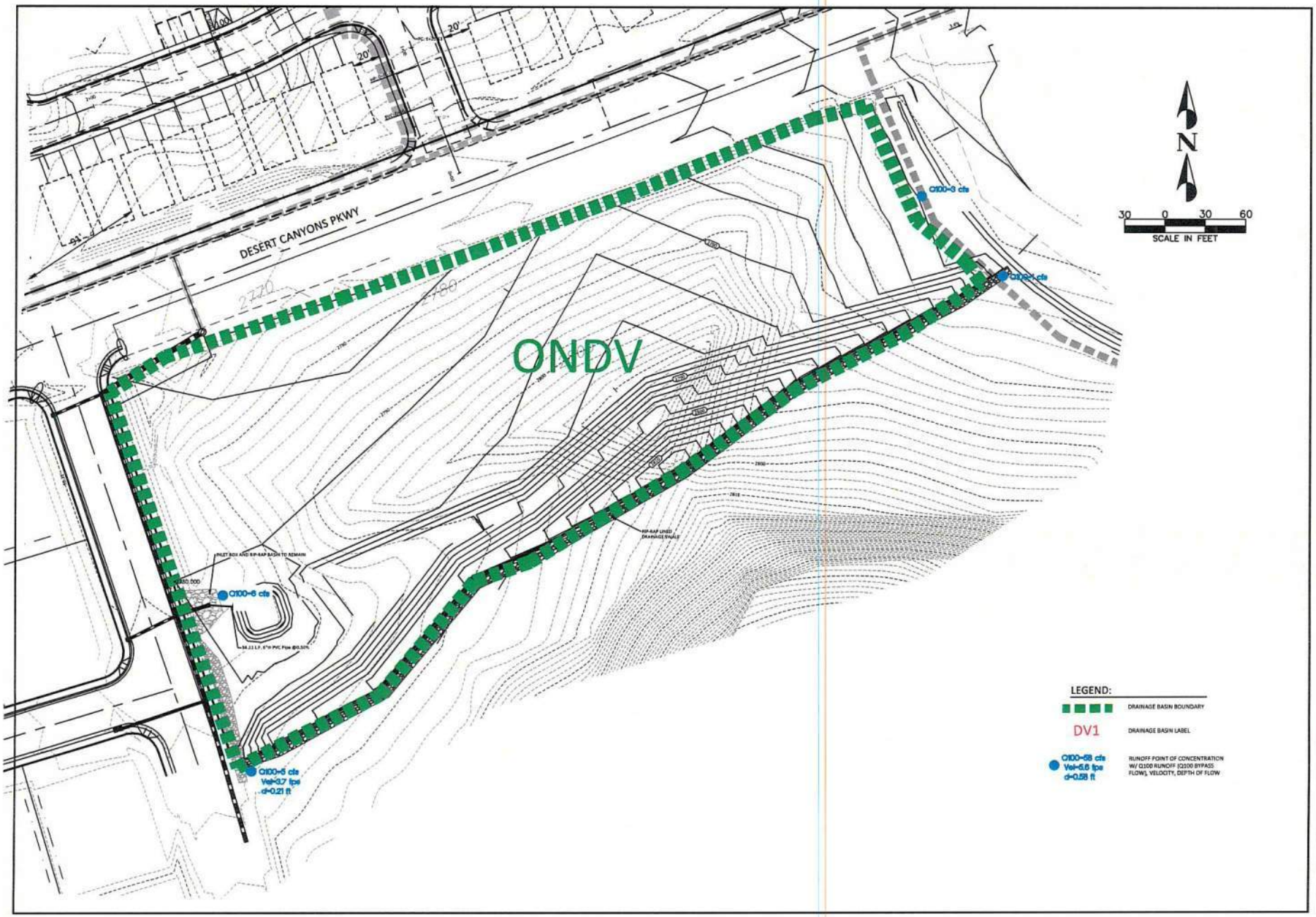
PROJECT NAME: DC EAST PARK AREA
AT DESERT CANYONS
ST. GEORGE, UTAH

SHEET NAME: EXISTING CONDITION HYDROLOGY

DEVELOPMENT SOLUTIONS, INC.
LAND PLANNERS, CIVIL ENGINEERS
113 East 200 North Suite #2
St. George, UT 84770
Office (435) 628-2121 - Fax (435) 674-3553
www.developmentsolutions.co

DATE:	5-28-20
PM:	KH
DRAWN BY:	KH
DESIGNED BY:	KH
CHECKED BY:	KH
PROJECT NO.	19-011
SCALE:	AS SHOWN
SHEET NUMBER:	3

OF TOTAL



NO.	DESCRIPTION	DATE	APP'D

PROJECT NAME: DC EAST PARK AREA
AT DESERT CANYONS
ST. GEORGE, UTAH

SHEET NAME: DEVELOPED CONDITION HYDROLOGY

DEVELOPMENT SOLUTIONS, INC.
LAND PLANNERS, CIVIL ENGINEERS
113 East 200 North Suite #2
St. George, UT 84770
Office (435)628-2121 - Fax (435) 674-3553
www.developmentsolutions.biz

DATE:	9-28-28
PM:	KM
DRAWN BY:	KB
DESIGNED BY:	KB
CHECKED BY:	KB
PROJECT NO.:	28-021
SCALE:	AS SHOWN

SHEET NUMBER: 4 OF TOTAL

Item #2

St.George
Community Development

Hillside Permit

HILLSIDE REVIEW BOARD AGENDA REPORT: **07/15/2020**

HILLSIDE DEVELOPMENT PERMIT
Hillside Professional
Case No. 2020-HS-010

Request: This is a request for a Hillside Development Permit to allow development of two 3-story offices buildings

Geotech Report: Project No. 2200879

Drainage Study: Civil Science Project No. 20166

Owner/Applicant: Cole Fowler and Sorensen

APN: SG-5-2-33-4102

Location: Approx. north of the intersection of Riverside and Riverbend Drive.

Acreage: Approx. 8.05 acres

Zoning: PD-AP

Adjacent zones: R-1-10

Applicable Ordinance(s):
(Selected portions)

The applicant is requesting a few areas not be considered as part of the slope analysis. According to the applicant, these areas are small washes or man-made features. The following is the applicable ordinance, which allows these to be considered:

C. Determination of Slope Areas: Using the contour map, natural slopes shall be calculated using points identified as natural slopes of twenty percent (20%), thirty percent (30%), and forty percent (40%), and shall be located on the contour map and connected by a continuous line. That area bounded by said lines and intersecting property lines shall be used for determining project density. Small washes or outcrops, which have slopes distinctly different from surrounding property, and are not part of the contiguous topography, may be excluded from the slope determination. (Ord. 2019-10-002, 10-10-2019)

SURFACE SLOPE DATA					
COLOR	% NATURAL SLOPE	TOTAL AREA	ALLOWED DISTURBANCE	PROPOSED DISTURBANCE AREA	PROPOSED DISTURBANCE %
	0 -19%	2.210 AC	100%	1.249 AC	57%
	20 - 29%	1.783 AC	30%	0.459 AC	26%
	30 - 39%	1.584 AC	5%	0.124 AC*	8%*
	40% +	2.473 AC	0	0.06 AC*	2%*
		8.05 AC		1.892 AC	

* AREAS OF INSIGNIFICANCE, SMALL WASH OR SLOPE FROM MANMADE DISTURBANCE.

Staff Comments: If the HSRB recommends approval of the hillside permit, then the permit request advances forward to the Planning Commission (PC) for review and recommendation and then on to the City Council (CC) for approval or denial.

1. Hillside Permit - A hillside permit is required per ordinance and the HSRB will make recommendations to the PC & CC.
2. Zoning – Currently the zoning is C-2, but the applicant will have to approach the city council with a zone change request in order to proceed with the development.
3. Development – It's proposed to grade the area as presented.
4. Geotechnical Investigation – All earthworks shall comply with the recommendations and mitigations presented in Geotech Report.
5. Drainage – Drainage shall comply with the Drainage Study.
6. Grading Permit - If approved, the applicant will work with staff for submittal of a Grading Permit with the required accompanying civil engineering plan set (for plan review).
7. Grading Permit – The applicant shall work with staff for submittal of a Grading Permit for "The Cove" with the required accompanying civil engineering plan set (for plan review).
8. Non-contiguous Areas – The non-contiguous, insignificant areas, and man-made spoils may be removed as per outlined in the ordinance.

9. Landscaping – All disturbed areas must be landscaped or revegetated.

HSRB Motion: The HSRB recommends approval of "Hillside Professional" with staffs recommended conditions and comments:

Hillside Narrative

Hillside Professional Offices

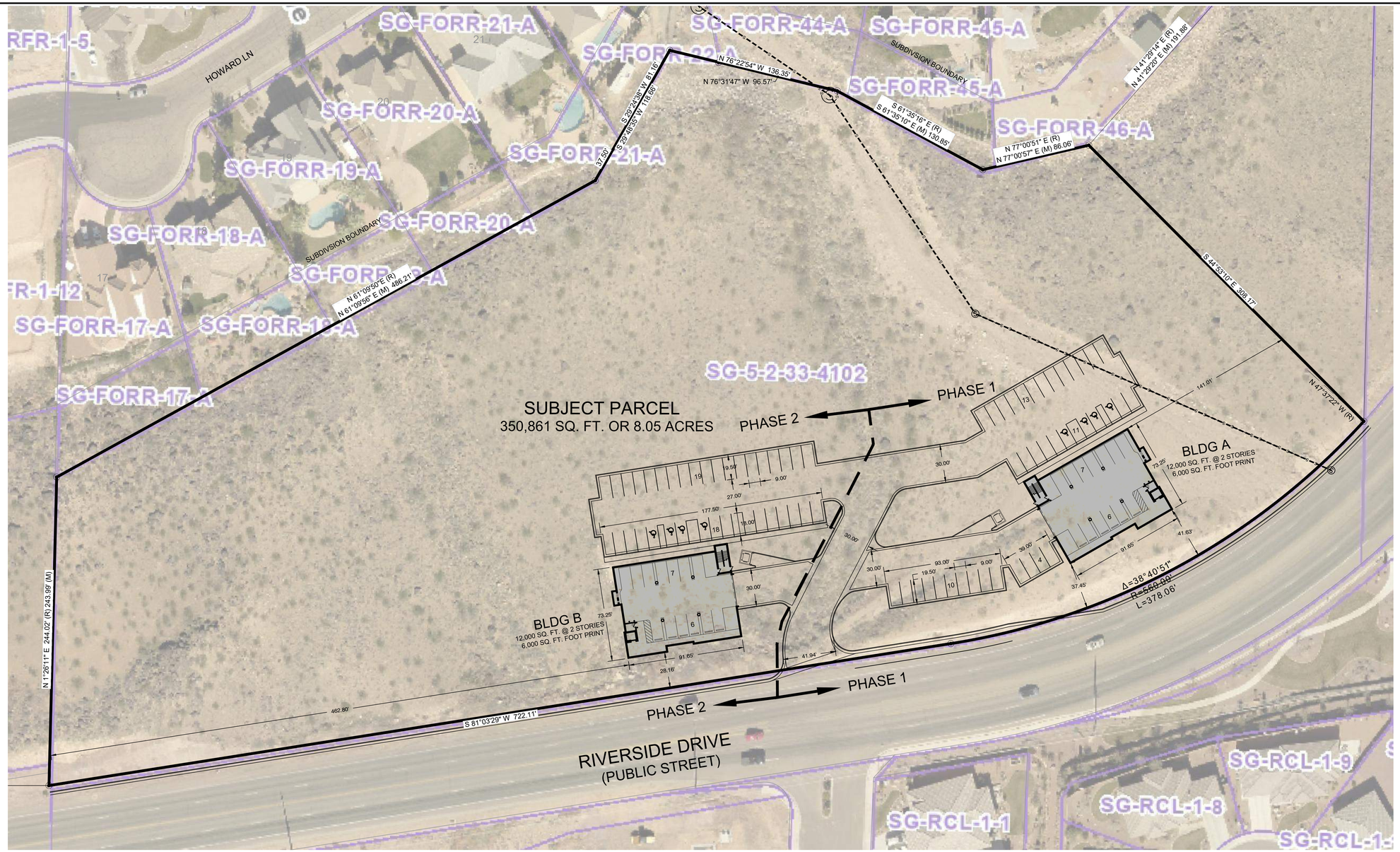
Hillside Review Application
Narrative

The proposed development, Hillside Professional Offices, is an approximately 8.05 acre parcel with 1.892 acres being proposed area of disturbance/development. The current zoning is PD-AP with the desired use to be two office buildings. Each building is proposing parking on the lower level with two stories of office space above. Each building totaling 12,000 square feet. The Conceptual Site Plan provided contains the site data information in further detail.

The parcel has a natural wash that is centered on the property which drainage will be piped through the proposed development. This small wash has created pockets of 30% or greater slope areas of which, we are proposing to fill with this development as they are noncontiguous areas. Additional man-made slopes have been created with the widening and development of Riverside Drive.

The intent of the grading and drainage is to leave the visible slope of the hillside natural. The size and placement of the buildings will hide the proposed rock retaining walls. The buildings are situated above Riverside Drive and the slope will be landscape with native plants and rock materials.

Conceptual Site Plan



SITE DATA:

ZONING - PDC MASTER PLAN - OS	
NEW BUILDING HEIGHT:	3 STORY SIDE: 46'-6" 2 STORY SIDE: 36'-6" AVERAGE: 41'-6"
OCCUPANCY TYPE: B	
CONSTRUCTION TYPE: V-B	
BUILDING WILL BE FIT W/AUTOMIATIC FIRE SPRINKLER	
BUILDING USE: OFFICE SPACE	
TOTAL SITE AREA	8.05 ACRES, 350,861 sq. ft.
BUILDING AREA (EACH BUILDING)	GARAGE: 6,000 SQ. FT. 1ST FLOOR: 6,000 SQ. FT. 2ND FLOOR: 6,000 SQ. FT. TOTAL: 18,000 SQ. FT.
TOTAL BUILDING AREA	TOTAL: 36,000 SQ. FT.
TOTAL FOOTPRINT RATIO TO PARCEL	3.4% OF PARCEL
PARKING/IMPERVIOUS AREA BOTH PHASES	34,900 SQ. FT. 10% OF PARCEL
LANDSCAPE/OPEN AREA BOTH PHASES	303,845 SQ. FT. 86.6% OF PARCEL
PARKING DATA BOTH PHASES @ 1 SPACE PER 250 SQ. FT.	SPACES REQUIRED - 96 SPACES PROVIDED - 101

NORTH
SCALE 1" = 40'

© COPYRIGHT 2020, MRW DESIGN ASSOCIATES INC.

6-2-20
DATE:

20037
JOB NUMBER:

1" = 40'
SCALE:

J.J.M.
DRAWN:

CHECKED:

DESIGN
ASSOCIATES INC.
ARCHITECTURE &
CONSULTING ENGINEERS

73 EAST 100 SOUTH
P.O. BOX 2775
ST. GEORGE UTAH 84770
(435) 628-2377 (435) 673-3580 fax
www.mrwdesign.com

CONCEPTUAL SITE PLAN

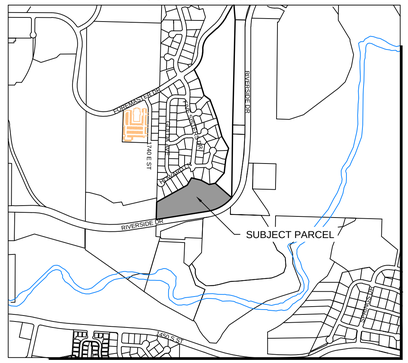
HILLSIDE PROFESSIONAL
1840 E RIVERSIDE DR.
ST. GEORGE, UTAH

CC2.1
OF SHEETS

Slope Analysis



VICINITY MAP



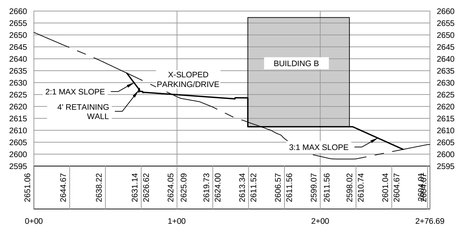
LEGEND

- FIRE HYDRANT
- WATER GATE VALVE
- EXISTING WATER GATE VALVE
- 3/4" WATER SERVICES WITH BOXES
- EXISTING WATER LINE
- C-900 CLASS 150 WATER LINE 8"Ø UNLESS SIZE NOTED OTHERWISE
- 60" SEWER MANHOLE
- 4" PVC SEWER LATERAL
- EXISTING SEWER LINE
- 8" SDR 35 PVC SEWER LINE
- EXISTING GROUND CONTOUR
- STORM DRAIN PIPE
- EXISTING CURB & GUTTER
- DRAINAGE FLOW DIRECTION
- SPOT ELEVATION
- NO BUILD/NO DISTURB AREA

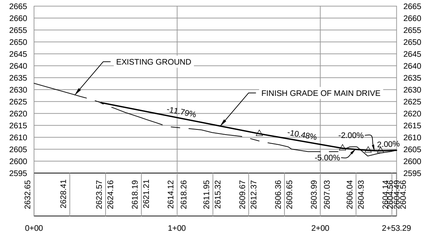
SURFACE SLOPE DATA

COLOR	% NATURAL SLOPE	TOTAL AREA	ALLOWED DISTURBANCE	PROPOSED DISTURBANCE AREA	PROPOSED DISTURBANCE %
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	20 - 29%	1.783 AC	30%	0.459 AC	26%
	30 - 39%	1.584 AC	5%	0.124 AC*	8%*
	40% +	2.473 AC	0	0.06 AC*	2%*
		8.05 AC		1.892 AC	

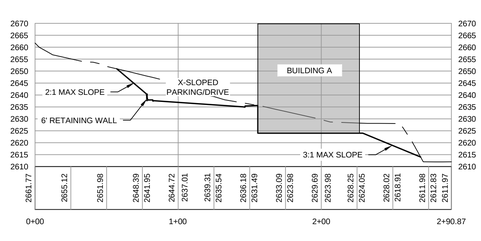
* AREAS OF INSIGNIFICANCE, SMALL WASH OR SLOPE FROM MANMADE DISTURBANCE.



CROSS SECTION 1



CROSS SECTION 2



CROSS SECTION 3



0 50
25 100

SCALE: 1" = 50' HORZ
SCALE: 1" = 30' VERT

(SCALE ONLY VALID FOR 24" x 36" PAPER)

1453 S. DIXIE DRIVE, SUITE 150
ST. GEORGE, UT 84770
435.986.0100

CivilScience

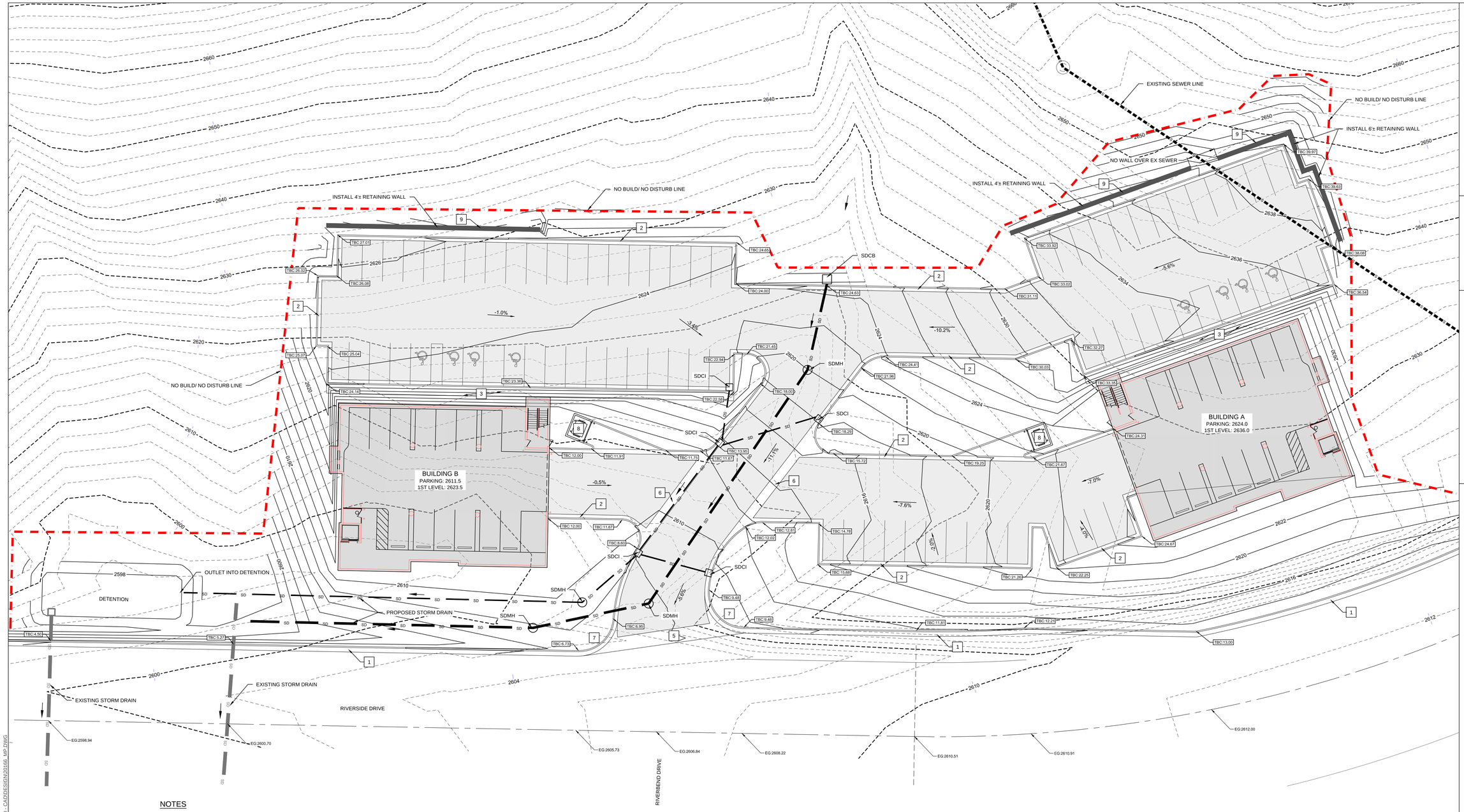
HILLSIDE DEVELOPMENT REVIEW

HILLSIDE PROFESSIONAL

LOCATED IN ST. GEORGE, UTAH

PROJ. #: FF20166.0
DRAWN BY: BLW
DATED: 6/16/2020
CHECKED BY: KCS
SCALE OF SHEET
HOR SCALE: 1" = 50'

SHEET 1 OF 2



NOTES

1. APPROXIMATELY 6,878 CU.YD. OF CUT 7,756 CU.YD. OF FILL FOR 878 CU.YD. OF IMPORT MATERIAL IS REQUIRED (FOR GRADING PERMIT ONLY) THE CONTRACTOR SHOULD VERIFY THE QUANTITIES FOR COMPLETION OF WORK. QUANTITIES ARE BASED ON FINISH GRADE OF DRIVE AREA, PARKING & FFE.

2. ALL IMPORTED STRUCTURAL FILL SHALL BE APPROVED BY THE GEOTECHNICAL ENGINEER PRIOR TO DELIVERY TO THE SITE. ALL IMPORTED STRUCTURAL FILL SHALL BE PLACED IN 8-INCH LOOSE HORIZONTAL LIFTS AND COMPACTED TO A MINIMUM OF 95 PERCENT OF MAXIMUM DRY DENSITY (ASTM D-1557).

3. ALL EXCAVATION, GRADING AND FILL OPERATIONS WITHIN THE BUILDING AREA SHOULD BE OBSERVED BY THE GEOTECHNICAL ENGINEER TO VERIFY SUB-SOIL CONDITIONS AND DETERMINE ADEQUACY OF SITE PREPARATION, SUITABILITY OF FILL MATERIALS AND COMPLIANCE WITH COMPACTION REQUIREMENTS.

4. THE CONTRACTOR SHALL PROVIDE SUITABLE EQUIPMENT TO CONTROL DUST AND AIR POLLUTION CAUSED BY CONSTRUCTION OPERATIONS. THE CONTRACTOR SHALL ALSO PROVIDE SUITABLE MUD AND DIRT CONTAINMENT TO MAINTAIN THE WORK SITE, ACCESS ROADWAYS AND ADJACENT PROPERTIES IN A CLEAN CONDITION.

5. ALL EXCAVATION AND GRADING SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE CITY OF ST. GEORGE ND APPENDIX J OF THE INTERNATIONAL BUILDING CODE AND THE SPECIFICATIONS AND REQUIREMENTS INCLUDED IN THE GEOTECHNICAL STUDY.

6. GEOTECHNICAL ENGINEER TO PROVIDE GRADING COMPLETION REPORT TO CONFIRM WORK HAS BEEN PERFORMED IN CONFORMANCE WITH THEIR RECOMMENDATIONS.

7. OWNER IS RESPONSIBLE FOR ALL ON-SITE DRAINAGE AND DETENTION.

LEGEND

- EXISTING SEWER LINE
- EXISTING 2' CONTOUR
- EXISTING 10' CONTOUR
- STORM DRAIN PIPE
- EXISTING CURB & GUTTER
- DRAINAGE FLOW DIRECTION
- ELEVATION — SPOT ELEVATION
- NO BUILD/NO DISTURB AREA

KEYED NOTES:

PROVIDE, INSTALL AND/OR CONSTRUCT THE FOLLOWING PER THE SPECIFICATIONS GIVEN OR REFERENCED AND THE DETAILS NOTED AND AS SHOWN ON THE CONSTRUCTION DRAWINGS AND PER CITY OF ST. GEORGE STANDARDS & SPECIFICATIONS:

1. INSTALL HB30-7 HIGHBACK CONCRETE CURB & GUTTER (PER CITY STD. #100)
2. INSTALL PR24 CONCRETE CURB & GUTTER (PER CITY STD. #101)
3. 5' CONCRETE SIDEWALK (PER CITY STD. #120)
4. 6' CONCRETE SIDEWALK (PER CITY STD. #120)
5. 6' WIDE CROSS GUTTER (PER CITY STD. #151)
6. 4' WIDE CROSS GUTTER (PER CITY STD. #150)
7. PEDESTRIAN RAMP (PER CITY STD. #121)
8. DUMPSTER LOCATION
9. RETAINING WALL (PER A.G.E.C. ROCK WALL DESIGN)

SCALE: 1" = 20'

(SCALE ONLY VALID FOR 24" x 36" PAPER)

Know what's **below.** **Call** before you dig.

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Engineers / Surveyors / Solutions
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ST. GEORGE, UT 84770
435.986.0100

PROFESSIONAL ENGINEER
KELVIN C. SMITH
No. 10255283
06/23/2020
STATE OF UTAH

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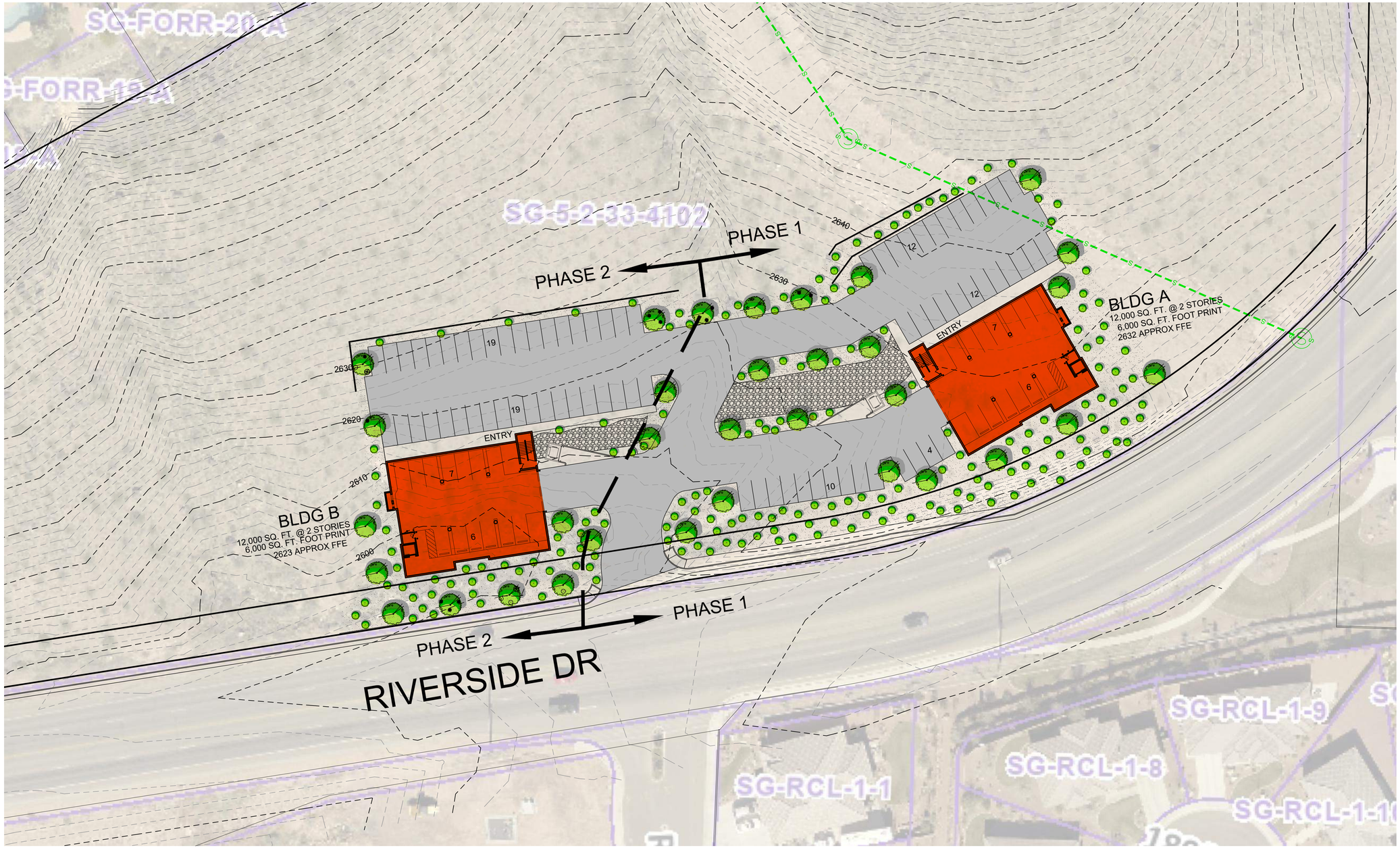
SITE & GRADING PLAN

HILLSIDE PROFESSIONAL
LOCATED IN ST. GEORGE, UTAH

PROJ. #:	Fx. 20166.00
DATE:	6/24/2020
DESIGN BY:	BLW
CHECKED BY:	KCS
SCALE OF SHEET	
HOR SCALE:	1" = 20'
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SHEET	2 OF 2

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Landscape Plan



NORTH
SCALE 1" = 30'

LEGEND:

- ASPHALT PAVING AREA
- NEW LANDSCAPING ROCK, ROCK LINED STEEP SLOPE
- CONCRETE AREA
- NEW BUILDING AREA
- NEW LANDSCAPING ROCK GROUND COVER
- NEW LANDSCAPING TREE, VARIETY TO BE DETERMINED BASED ON LOCAL CONDITIONS
- NEW LANDSCAPING SHRUBBERY, VARIETY TO BE DETERMINED BASED ON LOCAL CONDITIONS

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6-2-20
DATE:

20037
JOB NUMBER:

1" = 30'
SCALE:

J.J.M.
DRAWN:

CHECKED:

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AGEC Report & Drainage Memo

AGEC

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GEOTECHNICAL INVESTIGATION
& HILLSIDE EVALUATION

HILLSIDE PROFESSIONAL

ST. GEORGE, UTAH

PREPARED FOR:

VAUN BEAL
4443 W. 10600 N.
HIGHLAND, UTAH 84003

PROJECT NO. 2200879

JUNE 24, 2020

1420 South 270 East • St. George, Utah 84790 • (435) 673-6850 • FAX (435) 673-1044

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SUMMARY

1. The site was evaluated by drilling 4 borings and observing the excavation of 3 test pits at the approximate locations shown on Figure 2. The subsurface profile observed within the borings and test pits consisted of varied thicknesses of sand and gravel overlying mudstone bedrock.

   The mudstone bedrock is mapped as the Petrified Forest Member of the Chinle formation which is known to be expansive. Laboratory testing conducted on samples of the mudstone confirmed that the mudstone is moderately expansive.

2. Groundwater was not encountered in the subsurface investigation to the maximum depth investigated, 29 feet. Fluctuations in groundwater may occur over time. An evaluation of such fluctuations was beyond the scope of this report. Springs or seepages were not observed on the site. We do not anticipate excavations or grading will expose groundwater concerns.

3. The topography of the site consists of a moderately steep to more gentle hillside sloping down to the south. The site is proposed to be graded by small cuts on the north and filling to the south. There will be a moderate amount of import fill needed.

4. Based on the proposed grading, we anticipate that the majority of the cuts will be in the sands and gravels and will expose the mudstone. In order to maintain stable slopes in granular soils (silty sand or silty gravel), cut slopes should be graded no steeper than 2:1 (Horizontal:Vertical). Fill slopes should be graded no steeper than 2:1. Slopes in the underlying mudstone bedrock should be cut at slopes of 2:1 or retained.

5. Geologic hazard conditions are discussed and the results of our evaluation along with our professional opinions are stated within the report. The geologic conditions were evaluated based on recent available geologic literature and our site reconnaissance. The identified geologic hazards of significance identified at the site include the presence of expansive bedrock and clay soil layers and moderate to high landslide hazard according to Lund and others, 2008 where slopes exceed 15 percent. During our site investigation, evidence of landslides or debris flow were not observed. Additionally, there are no mapped ancient landslides on the site. Provided the proper drainage and landscape plans are implemented along with the proposed grading, it is our opinion that the landslide or slope instability hazard is very low.

6. The proposed structures may be supported on conventional spread footings bearing on a properly prepared subgrade. As an alternative, micropiles or deep foundations may be utilized. Based on the presence of expansive soils/bedrock, we recommend that a separation of at least 17 feet be provided between the pad grade and the expansive soil/bedrock. Due to the shallow mudstone in the areas of the proposed buildings, the subgrade will require removal of mudstone to provide the recommended separation for the proposed structures.

7. The on-site sand and gravel soils, free of organics and debris, are suitable for use as structural fill, site grading fill, and utility trench backfill. There are occasional surface cobbles and boulders along with limited subsurface materials that are oversized for use as fill materials. The oversized material will require processing to remove the larger particles such that the maximum particle size is 6 inches and at least 50 percent of the material passes the No. 4 sieve. Larger materials may be used on slopes for erosion protection or placed in deeper fills, provided they are properly nested. The on-site mudstone bedrock is not suitable for use as structural fill, but may be used as fill in non-structural areas or as trench backfill, wall backfill, or at least 4 feet below pavement areas.

8. Positive drainage of the surface soils within the development is critical and should be maintained throughout the development. We recommend (as much as possible) the piping of surface drainage and in no case should be ponding of water be allowed adjacent to or up-gradient of structures.

9. Detailed recommendations for subgrade preparation, pavements, materials, foundations, and drainage are included in the report.

10. The information provided in this summary should not be used independent of that provided within the body of this report.

SCOPE

This report presents the results of a geotechnical investigation and hillside evaluation for the proposed Hillside Professional development to be located in St. George, Utah, as shown in Figure 1. This report presents the subsurface conditions encountered, laboratory test results, and recommendations for the project.

A field exploration of 4 borings and 3 test pits were conducted to obtain information on the subsurface conditions and to obtain samples for laboratory testing. Information obtained from the field and laboratory was used to define conditions at the site and to develop recommendations for the proposed development. AGEC has also utilized the proposed grading plans and conceptual plans to develop our recommendations.

The study also included review of the geologic literature as noted below:

1. Geologic Hazard Evaluation Study, St. George-Hurricane Metropolitan Area, Washington County, Utah, UGS Special Study 127-2008, Lund et al.

2. Geologic Map of the St. George Quadrangle, Washington County, Utah, UGS Map 251DM, 2011, Willis and Hayden.

This report has been prepared to summarize the data obtained during the study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. The report is intended to meet the requirements for evaluation for St. George City Hillside developments. The findings, conclusions and recommendations for design and construction are included in this report.

SITE CONDITIONS

The subject site consists of the parcel shown on Figure 1. The property is located north of Riverside Drive and south of the Foremaster Ridge residential project. There is a utility easement along the central to eastern portion of the site that extends off of Foremaster Rridge down to Riverside Drive. The property is moderately steep with a flatter area at the base of the hillside. The property is sparsely covered with vegetation consisting of small brush and grasses. There is a basalt outcropping at the top of the slope.

FIELD STUDY

On June 3, 2020, an engineer from AGEC visited the site for a subsurface investigation. Four borings were drilled using both a truck mounted rig and 3 test pits were excavated with a rubber tire backhoe. The locations are shown on Figure 2.

SUBSURFACE SOIL CONDITIONS

The subsurface profile observed within the explorations consisted of varied thicknesses of sand, silt and gravel overlying mudstone bedrock. The mudstone bedrock is mapped as the Petrified Forest Member of the Chinle formation. Our experience and our laboratory testing indicates the mudstone is expansive when wetted. Approximately 2 feet of fill soil was encountered at the surface of boring B-3. Descriptions of the soil and bedrock types encountered follow.

Fill - The fill consists of silty sand and gravel, is poorly compacted (loose), dry and light brown in color. The fill is likely associated with the previous installation of the sewer line that is located on the north central to northeast portion of the property.

Clayey Sand - The clayey sand is medium dense, slightly moist, and light brown in color. The clayey portion is low to medium plastic.

Laboratory tests conducted on samples of the clayey sand indicate in-place moisture contents of 5 to 19 percent, in-place dry density value of 100 pounds per cubic foot (pcf). Gradation tests conducted indicate a fines contents of 42 to 47 percent. Atterberg Limits test indicate a liquid limits of 29 to 31 percent and plasticity index of 10 percent.

One-dimensional consolidation/swell test conducted on a sample of the clayey sand indicate the material is non moisture-sensitive when wetted under a constant pressure of approximately 1,000 psf.

Silty Sand - The silty sand contains varied amounts of gravel and is medium dense. The sand is dry to slightly moist and light brown in color.

Silty Gravel with Sand - The silty gravel with sand is medium dense to dense, dry, moist, and light brown in color. The gravel varies up to small cobble size and varies from angular to subrounded.

Mudstone Bedrock - The mudstone bedrock is soft to moderately hard, moist, and is red to purple to grey in color. The mudstone varies from medium to high plastic clay with varied amounts of sand.

Laboratory tests conducted on samples of the mudstone indicate in-place moisture contents ranging from 10 to 25 percent, in-place dry densities ranging from 90 to 102 pcf. Gradation tests conducted indicate a fines content ranging from 60 to 100 percent. Atterberg Limits test indicate liquid limits ranging from 43 to 63 percent and plasticity indexes ranging from 15 to 30 percent.

One-dimensional consolidation/swell tests conducted on samples of the mudstone indicate the material is slightly to moderately moisture-sensitive or expansive when wetted under a constant pressure of approximately 1,000 psf.

GEOLOGY

The geologic conditions at the site were evaluated based on a review of geologic literature, and a site geologic reconnaissance.

A. Geomorphology of the Area

The site is located north of the Virgin River in St. George, Utah as shown on Figure 1. The site is on the hillside of the south end of the Lava Ridge (Middleton Black Ridge) lava flow. The site is also located on the north side of the Virgin River Anticline. This area is part of the St. George Basin which is bound on the north by the Pine Valley Mountains, on the east by the Hurricane Cliffs, on the west by the Beaver Dam Mountains, and on the south by the Mount Trumball area.

Bedrock in the St. George basin mainly consists of Upper Permian and Lower Jurassic sandstone, shale, siltstone, limestone, gypsum, and conglomerate. These beds are folded to the southeast into the northeast trending Virgin anticline. Several north-trending faults are present within the St. George Basin, the most prominent of which is the Washington Fault (Christensen and Deen, 1983).

The St. George Basin is characterized by basalt capped buttes and cuestas that were once stream channels along which lava flowed. Erosion of the surrounding softer sedimentary rocks over time has resulted in an inverted topography of old stream channel becoming resistant basalt ridges such as the Middleton Black Ridge and the West Black Ridge (Christenson and Deen, 1983).

The geologic structure within the basin is dominated by the Virgin anticline which trends northwest to southeast and is located south of the site. The Virgin anticline is a broad, generally symmetrical fold with maximum flank dips of 25 to 30 degrees to the northwest and southeast (Christenson and Deen, 1983).

The geologic conditions at the site were evaluated based on a review of geologic literature, boring and test pit exploration and a reconnaissance of the site. Figure 5a indicates the most recent geologic mapping for the site.

B. Stratigraphy of the Area

The stratigraphy of the area consists of Lower Triassic - aged bedrock of the Chinle Formation. There is alluvium (Holocene to lower Pleistocene aged) deposits over the Chinle that cover the majority of the site. The top of the ridge is capped by the Lava Ridge lava flow, which consists of Basalt (Figure 5a).

The geologic descriptions of the various members or formations are described on Figure 5a along with the geologic map.

GEOLOGIC HAZARDS

Based on review of geologic literature and site reconnaissance, the following information is provided concerning geologic hazards.

A. Liquefaction

Relatively shallow bedrock was encountered on the south portion of the site and groundwater was not encountered within the deepest borings. Very dense gravel was encountered beneath the northern lots. Thus, based upon subsurface conditions encountered our experience in the area, the subsurface soils below the developed areas are considered to be a non-liquefiable during a severe seismic event to the depths investigated.

B. Flooding

The Virgin River is located further to the south across Riverside Drive. During the 2005 and 2010 floods, the subject property was not affected by flooding. Civil Science has provided a drainage study for the property.

C. Expansive Soil/Bedrock

The presence of potentially expansive layers of bedrock is identified by the geologic mapping hazard by Lund and others, 2008. The expansive bedrock is mapped as the Petrified Forest member of the Chinle Formation. Our subsurface investigation (4 borings and 3 test pits), laboratory testing by AGEC and our experience in the area also indicate that mudstone bedrock on the project site is moderately to highly expansive.

Our evaluation for the report has included analysis and recommendations to address this concern for expansive layers. Our grading and foundation recommendations have implemented methods to properly support structures.

D. Landslides

The site is mapped as having a Moderate to High Landslide Hazard according to Lund and others, 2008 where slopes exceed 15 percent. (Figure 5B) During our site investigation, evidence of landslides or debris flow was not observed in the area of the proposed buildings. The western portion of the site is mapped as an ancient landslide. Based upon our observations, geologic mapping and engineering analysis, it is our opinion the risk potential landslide is very low provided proper drainage, and grading that avoids cutting into and creating steeper slopes. Based on the profiles observed within the deeper borings and the proposed grading, the stability of the slopes is increased significantly by the proposed grading.

E. Rock Fall

Rockfall hazards generally occur with a rockfall source (such as a jointed caprock or cliff forming bedrock) and a slope or grade change to provide adequate energy for the rockfall to occur. This condition exists on the site. Based on a review of the geologic hazard map (Lund et al, 2008), the site has high to very high risk of rock fall. A professional geologist from AGEC has visited the site on June 8, 2020 and also reviewed low-sun-angle aerial photographs from 1981 and color aerial photographs from 2000. This was conducted along with observation of the rock runout to the south. The site contains rocks that could dislodge and roll off onto the site. The Colorado Rockfall Simulation Program (CRSP) was used along with the using a "Shadow Angle" technique to evaluate the potential runout zone. The CRSP was used to provide an understanding of the potential velocities, bounce heights and engergies of rocks, should rock fall occur. This data could be used for rockfall mitigation and barrier design. Figure 3C shows the Hazard Zone or estimated runout zone for the site. This zone was determined by identifying rockfall source areas, the potential sizes of rockfall source rock, the slope conditions below the rockfall source and considering locations of the rocks in the rockfall runout zone. Potential mitigation to reduce the rockfall risk may consist of removing the rocks that pose the greatest fall risk.

The rockfall evaluation was conducted using the current grading plan and the plan has provided parking on the uphill side of the proposed buildings in order to reduce the risk of damage to buildings or a life safety concern.

F. Faults

Based on previous work by Christenson and Deen (1983), Willis and Higgins (1995) Lund and others (2008), the inferred location of the St. George Fault is located further to the west of the site near River Road. Based on this literature, this fault poses less potential hazard to residential structures due to the low likelihood of surface fault rupture.

PROPOSED CONSTRUCTION

The Hillside Professional Development will consist of developing approximately 8 acres of property with two professional office buildings as shown on Figure 2. The project will likely be graded and constructed in two phases. The buildings will have a lower level floor that will walkout to the south and will have underground parking. The buildings will be two stories above the garage level and are anticipated to be constructed with reinforced concrete on the garage level and wood framing on the upper two levels. We anticipate wall loads on the order of 3 to 4 kips per lineal foot and column loads up to 100 kips.

There will be access to the site from Riverside Drive and we anticipate accel/decel lanes will be proposed as part of the site development. In addition, parking is planned adjacent to each building. The anticipated traffic for the different areas consists of a Traffic Index of 8 for Riverside Drive and 5 for the parking areas and the access road.

The proposed grading consists of cuts on the order of 6 to 8 feet and fills up to 14 feet. The cuts will be on the up hill side of the project and are proposed to be retained by rockery faced slopes. The fills will be located in walkout areas and in the lower area on the southwest side of the project.

If the proposed construction, or building loads are significantly different from those listed, we should be notified so that we can reevaluate our recommendations.

RECOMMENDATIONS

Based on our experience in the area, the subsurface conditions encountered, our engineering analysis, and the proposed construction, the following recommendations are provided:

A. Site Grading

Based on the subsurface conditions and proposed grading provided by Civil Science Engineering, the following recommendations are provided:

1. Subgrade Preparation

General: Prior to placing structural fill, site grading fill or concrete, the site should be grubbed to remove vegetation and soil containing roots and organics.

Expansive Bedrock Removal - Buildings and Structures: We recommend that a separation of 17 feet be provided between the expansive mudstone/clay layer and the building pad grades. The mudstone should be removed below structures, entry areas and canopies, extending at least 5 feet beyond the perimeter of the structure. The limits of removal should be determined by survey and documented following removal.

Expansive Bedrock Removal - Roadways and Flatwork: We recommend providing at least a separation of 4 feet below the proposed subgrade elevation and the surface of the expansive mudstone. The material should be removed a distance of at least 2 feet beyond the edge of roadway/flatwork improvements .

2. Excavation/Slopes

Based on the proposed grading, we anticipate that the majority of the cuts will be in the sands and gravels with portions of the parking cuts extending into the mudstone. In order to maintain stable slopes, they should be retained or slopes should be graded no steeper than 2:1 Horizontal to Vertical (H:V). Fill slopes should be graded no steeper than 2:1 (H:V).

Erosion/raveling of the exposed bedrock cut face should be anticipated due to weathering processes. This will be more evident where mudstone is exposed and less evident where sandstone is exposed. The mudstone will dry, shrink and shallow slumps will likely occur. This could result in accumulation of soil deposits at the toe of the cut slope and will require maintenance to remove the deposits throughout the life of the structures.

To control erosion and weathering, the bedrock cut slopes should be protected by erosion protection. This would be particularly critical where softer mudstone is exposed. Benches may also be cut into the slopes to assist in controlling drainage and erosion. Benches should be at least 5 feet in width and should be constructed at intervals in accordance with the 2018 IBC. In lieu of facing mudstone cuts, they could be flattened to a 3:1 (H:V) slope.

Fill slopes should be constructed by overbuilding the slope and then cutting back the slope face to the desired grade to provide a properly compacted slope face. Fill placed on existing slopes steeper than 3:1 (H:V) should be keyed into the existing slope using a benching procedure. Benches should be of sufficient width to allow for operation of compaction equipment.

Utility trenches excavated in the on-site soils should be excavated in accordance with OSHA requirements using a OSHA Soil Class C (1½:1 H:V) for overburden soils and Soil Class A (½:1 H:V) for trenches excavated into the bedrock. Steeper trenches may require the use of shoring or a trench box to provide as safe work environment. Safe trench excavation is the responsibility of the contractor.

3. Materials

Import materials should be non-expansive, non-gypsiferous, granular soil. Listed below are the materials recommended for imported fill.

Area	Fill Type	Recommendations
Foundations/slabs	Site grading/ structural fill	**-200** <35%, **LL** <30% Maximum size: 4 inches Solubility < 1%
Roadways	Base course	CBR>50%, **200** <12% Maximum size: ¾ inch
Underslab	Base course	**-200** <12% Maximum size: 1 inch

-200 = Percent Passing the No. 200 Sieve
LL = Liquid Limit

The on-site silt, sand and gravel soils and fill soils, free of organics and debris, are suitable for use as structural fill, site grading fill, and utility trench backfill. The on-site mudstone is not suitable for use as structural fill or site grading fill, but may be used as fill in non structural areas, trench backfill, wall backfill, or at least 4 feet below pavement areas. An AGEC engineer should observed the bedrock removal to determine suitability for its intended use.

4. Compaction

Compaction of fill materials placed at the site should equal or exceed the following percentages when compared to the maximum dry density as determined by ASTM D-698 or ASTM D-1557:

Area	Percent Compaction ASTM D-698*	Percent Compaction ASTM D-1557**
Subgrade	90	90
Footings/foundations	NA	95
Slabs/Pad Fill (over excavation)	100	95
Utility trench backfill (Structural Areas)	100	95
Wall Backfill (Structural Areas)	100	95

* Fine-grained or processed mudstone/clay.

** Granular site grading/structural fill

Fill should be placed in lifts which do not exceed the capability of the equipment used. Generally 6 to 8 inch lifts are adequate for heavy rubber tire equipment. Lift thicknesses should be reduced to 4 inches for hand compaction equipment. Fill placed at the site should be properly moisture conditioned prior to placement and should be tested to verify proper compaction.

Fill materials should be properly moisture conditioned prior to placement. Fine-grained should be moisture conditioned to 0 to 4 percentage points over the optimum moisture content as determined by ASTM D-698. Granular soil should be moisture conditioned to within 2 percentage points of the optimum moisture content as determined by ASTM D-1557.

5. Drainage

The following drainage recommendations should be implemented:

- Positive site drainage should be maintained during the course of construction. In no case should water be allowed to pond adjacent to buildings/foundations.

- After construction has been completed, positive drainage of surface water away from the structures should be maintained throughout the life of the structures. We recommend a minimum slope of 6 inches in the first 10 feet from the perimeter of the structures. Hard or impermeable surfaces may be used to direct water away from buildings.

- Roof gutters should also be utilized with downspouts which extend out away and down slope from buildings. Preferably, downspouts should discharge off-site.

- Landscaping that requires water (grass) should be limited to reduce the potential for wetting of foundation support soils and to reduce the potential future accumulation of perched water on top of the bedrock.

- We also recommend that desert landscaping, which requires little to no water, be used adjacent to concrete or masonry walls which will be backfilled to reduce salt migration of soluble salts and the subsequent salt weathering on cement containing elements. The below grade portions of walls/fences which are backfilled with soil should be protected with an impermeable membrane and a subsurface drain. A gravel covered, perforated PVC pipe should also be placed at the base of the wall to carry water to a discharge point. This is intended to reduce the potential for salt weathering and sulfate attack on concrete/masonry.

6. Subsurface Drainage Protection

A perimeter subsurface drain should be provided around the basement of each structure.

The drain system should consist of 1 foot of gravel adjacent the perimeter foundation supporting the building. A 4 inch perforated PVC pipe should be placed in the bottom of the gravel zone sloped at a 1% grade (minimum) to drain by gravity. Prior to backfilling, Mirafi 140N filter fabric should be placed over the gravel.

B. Foundation Recommendations

Based on the subsurface conditions, the proposed grading provided Civil Science Engineering, and that the proper separation from expansive soils has been provided as per the Subgrade Preparation section of this report, the following foundation recommendations are provided for support of slab on grade foundations. If the expansive soils are not removed to provide the proper separation, the use of micropiles or a deep foundation system should be used. Recommendations for deep foundation systems are not included in this report. If requested, those recommendations can be provided.

1. Foundations

   The proposed structures may be supported on conventional spread footings with slab-on-grade floors supported on a properly prepared subgrade as indicated in the Subgrade Preparation section of this report.

2. Bearing Material

   Footings should bear on properly compacted structural fill underlain by a properly prepared subgrade as recommended in the Subgrade Preparation section of this report.

3. Bearing Pressure

   Spread footings bearing on properly compacted structural fill may be designed for a net allowable bearing pressure of 2,000 pounds per square foot (psf). Spot footings supporting columns or footings with a width of greater than 3 feet may be designed for a net allowable bearing pressure of 2,500 psf.

4. Temporary Loading Conditions

   The bearing pressure indicated above may be increased by one-half for temporary wind and seismic loads.

5. Footing Width and Embedment

Spread footings should have a minimum width of 18 inches and exterior or unheated footings should be embedded at least 12 inches below the lowest adjacent grade.

6. Settlement/Heave

Based on the subsoil conditions encountered and the anticipated building loads, we estimate a total settlement/heave for the foundation designed as indicated above to be up to approximately 1 inch. Differential settlement is estimated to be approximately ½ inch.

C. Concrete Slab-on-Grade

1. Slab Support

Concrete slabs may be supported on a properly compacted subgrade as recommended in the Subgrade Preparation section of this report. Fill placed in slab areas should be tested to verify compaction meets the recommendations provided within this report.

2. Underslab Base Course

A 4-inch layer of properly compacted base course should be placed below slabs to provide a firm and consistent subgrade and promote even curing of the concrete.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

Lateral resistance for spread footings is controlled by sliding resistance developed between the footing and the subgrade soil. An ultimate friction value of 0.45 may be used in design for ultimate lateral resistance of footings bearing on properly compacted structural fill.

2. Retaining Structures

The following equivalent fluid weights are given for design of subgrade walls and retaining structures. The active condition is where the wall moves away from the soil. The passive condition is where the wall moves into the soil and the at-rest condition is where the wall does not move. We recommend the basement walls be designed in an at-rest condition.

The values listed below assume a horizontal surface adjacent the top and bottom of the wall.

Description	Active	At-Rest	Passive
Granular Backfill (Sand or Gravel)	35 pcf	55 pcf	350 pcf
Granular Backfill - Earth Pressure Coefficient	0.28	0.44	-
On-site Clay Soil/Processed Mudstone	50 pcf	65pcf	190 pcf
On-site Clay Soil/Processed Mudstone - Earth Pressure Coefficient	0.45	0.59	-

The above values account for the lateral earth pressures due to the soil and level backfill conditions and do not account for hydrostatic pressures or surcharge loads.

Lateral loading should be increased to account for surcharge loading using the appropriate earth pressure coefficient and a rectangular distribution if structures are placed above the wall and are within a horizontal distance equal to the height of the wall. If the ground surface slopes up away from the wall, the equivalent fluid weights should also be increased.

Care should be taken to prevent percolation of surface water into the backfill material adjacent to the retaining walls. The risk of hydrostatic buildup can be reduced by placing a subdrain behind the walls consisting of free-draining gravel wrapped in a filter fabric.

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weights should be modified as follows according to the Mononobe-Okabe method assuming a level backfill condition:

Lateral Earth Pressure Condition	Seismic Modification (2% PE in 50 yrs)
	Granular Backfill
Active	7 pcf increase
At-rest	no increase
Passive	18 pcf decrease

The resultant of the seismic increase should be placed up ⅓ from the base of the wall.

4. Safety Factors

The given values assume mobilization of the soil to achieve the assumed soil strength. Conventional safety factors used for structural analysis for such items as overturning and sliding resistance should be used in design.

E. Seismicity

Listed below is a summary of the site parameters as required by the 2018 International Building Code and ASCE 7, Chapter 20:

Description	Seismic Event - 2% PE in 50 Yrs
	Value
2018 IBC Site Class	C
PGA	0.23g
S_s (0.2 second period)	0.527g
S_1 (1 second period)	0.171g
F_{PGA}	1.2
F_a	1.289
F_v	1.5

The values provided above were generated using the ASCE 7-16 Siesmic Hazard tool.

Based on the observed subsurface conditions, a ground motion hazard analysis (GMHA) as per ASCE 7-16 is not required by the 2018 International Building Code. A 10-percent decrease in design seismic load might be achieved if shear wave velocities are measured on site. If this is requested, we propose to perform a Refraction Microtremor (ReMi) survey to measure subsurface shear wave velocity.

F. Soil Corrosion

Our experience has shown that portions of the on-site soil/bedrock and many imported soils may contain sulfates in sufficient concentration to be corrosive to concrete. Therefore, we recommend concrete elements that will be exposed to the on-site soils be designed in accordance with provisions provided in the American Concrete Institute Manual of Concrete Practice (ACI) 318-14. Tables 19.3.1.1 and 19.3.2.1 of ACI 318-14 should be referenced for design of concrete elements utilizing a Sulfate Exposure Class of S2.

Consideration should also be given to cathodic protection of buried metal pipes. We recommend utilizing PVC pipes where local building codes allow.

G. Pavement

Based on the subsoil conditions encountered and the laboratory test results, the following recommendations are given:

1. Analysis

   Asphaltic Concrete: The flexible pavement analysis is based on UDOT and AASHTO design methods and a 20 year design life. The following parameters were considered for our analysis:

   - Base course that meets specifications which would correspond to a Structural Coefficient (a_2) of at least 0.12. Asphalt that provides a Structural Coefficient (a_1) of at least 0.40.
   - Drainage Coefficient = 1.0.

- The subgrade support soils consists generally of silty sand to gravel. Based on the on-site soils, a M_R value of 15,000 psi was used for the subgrade based upon an estimated California Bearing Ratio (CBR) value of 10 percent and the relationship between CBR and Resilient Modulus (M_R).
- Serviceability Index: $P_o = 4.2$, $P_t = 2.5$.
- Reliability of 90 percent.
- Standard Deviation (S_o) = 0.45.

2. Subgrade Support

We anticipate the subgrade materials will consist of compacted on-site silty sand to gravel. Our design assumes a properly compacted subgrade. Prior to placing base course or pavement area grading fill, the subgrade should be prepared as recommended in the Subgrade Preparation section of this report.

3. Pavement Thickness

Based on the anticipated traffic, a 20 year design life, PCC and AASHTO design methods, the following pavement sections are recommended.

	Flexible Pavement	
Area	Asphaltic concrete (inches)	Base Course (inches)
Riverside Drive Widening	4	12
Entrance Road	2.5	8
Parking areas	2.5	6

4. Pavement Materials

The pavement materials should meet AASHTO and City of St. George Specifications for gradation and quality. The pavement thicknesses indicated above assume that the base course is high quality material with a CBR of at least 60 percent. Asphalt material should have a Marshall stability of at least 1,800 pounds.

5. Drainage

The collection and diversion of drainage away from the pavement surface is extremely important to the satisfactory performance of the pavement section. Proper drainage should be provided. We further recommend a yearly maintenance program including crack sealing and a surface treatment such as a "slurry seal" to extend the pavement life and reduce water infiltration into the subsurface soils.

H. Construction Testing and Observations

We recommend testing fill, concrete, and asphalt materials at a frequency which meets or exceeds St. George City minimum testing frequency requirements for city improvements.

We also recommend the following:

1. Verify the subgrade is properly prepared/compacted in accordance with the recommendations provided in the Subgrade Preparation section of this report.

2. Verify that foundation subgrade is properly compacted prior to placement of concrete.

3. Conduct compaction testing on fill placed below foundations, in building pads, and paved areas. We recommend testing each foot of fill placed.

4. Conduct construction materials testing of soils, concrete and asphalt materials and special inspections as required for the proposed construction by St. George City and the structural engineer.

5. Conduct special inspections on the proposed building as required by the 2018 International Building Code and the structural engineer.

I. Geotechnical Recommendation Review

The client should familiarize themselves with the information contained in this report. If specific questions arise or if the client does not fully understand the conclusions/recommendations provided, AGEC should be contacted to provide clarification.

LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices in the area for the use of the client for design purposes. The conclusions and recommendations included within the report are based on the information obtained from the subsurface investigation, laboratory test results and our experience in the area. Variations in the subsurface conditions may not become evident until excavation is conducted. If the subsurface conditions or groundwater level are found to be significantly different from those described above, we should be notified to reevaluate our recommendations.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.



G. Wayne Rogers, P.E.

Reviewed by: Jon Russell Hanson, P.E.

P:\2020 Project Files\2200800\2200879 - GT Medical Office Buildings\Report.wpd

REFERENCES:

Christenson, G.E. and Deen, R.D., 1983, Engineering Geology of the St. George area Washington County, Utah: Utah Geological and Mineral Survey Special Studies 58, 32 p., scale 1:24,000.

Lund, W.R., Knudsen, T.R., Vice, G.S., and Shaw, L.M., 2008, Geologic hazards and adverse construction conditions, St. George-Hurricane Metropolitan Area, Washington County, Utah, Utah Geological Survey Special Study 127, 14 plates, scale 1:24,000.

Hayden, Janice, M and Willis, Grant C. UGS Map 251DM. 2011, Geologic Map of the St. George Quadrangle, Washington County, Utah, Utah Geological Survey.



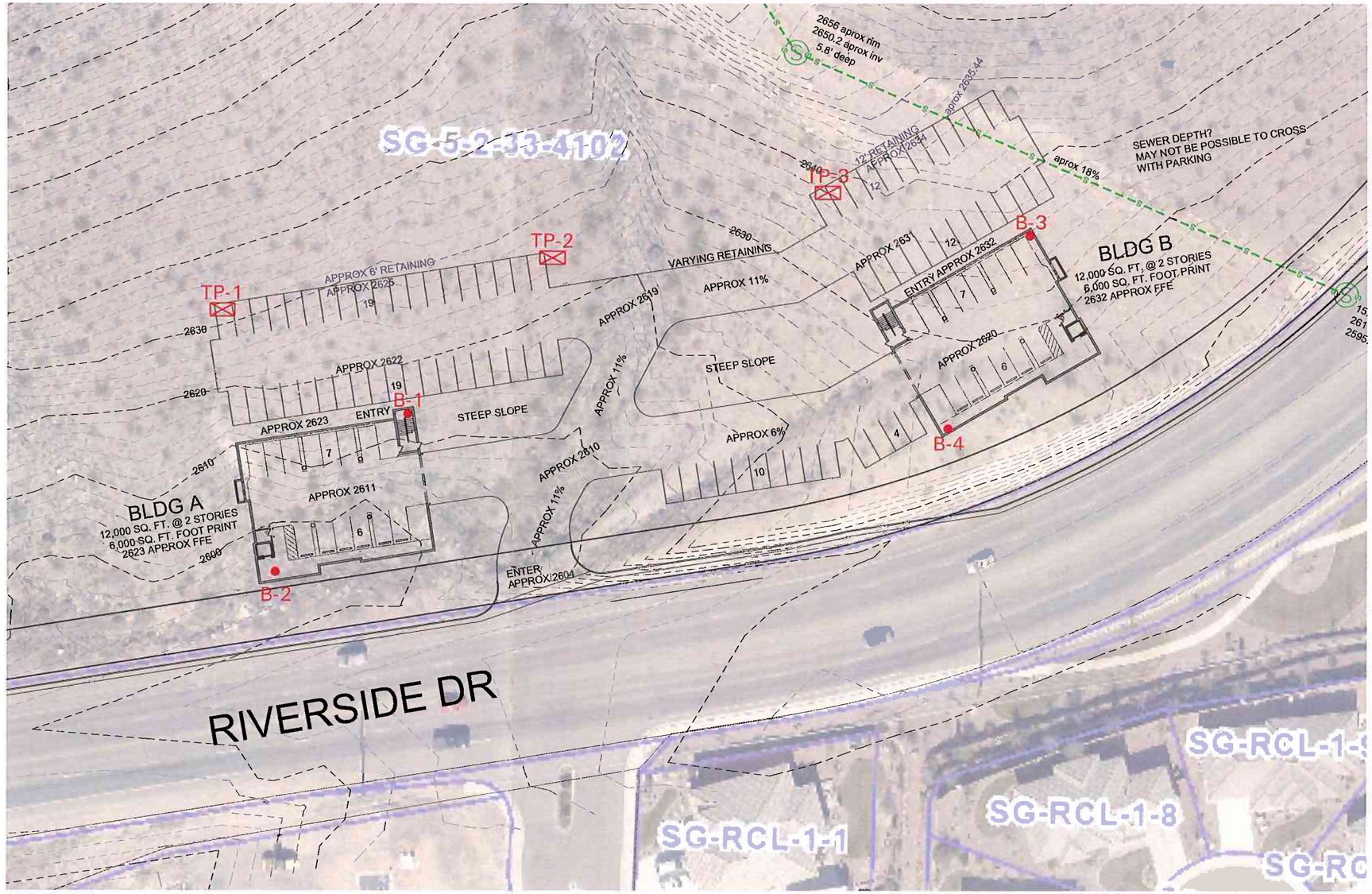
HILLSIDE PROFESSIONAL
ST. GEORGE, UTAH

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Not to Scale

2200879	AGEC	Vicinity Map	Figure 1

HILLSIDE PROFESSIONAL
ST. GEORGE, UTAH



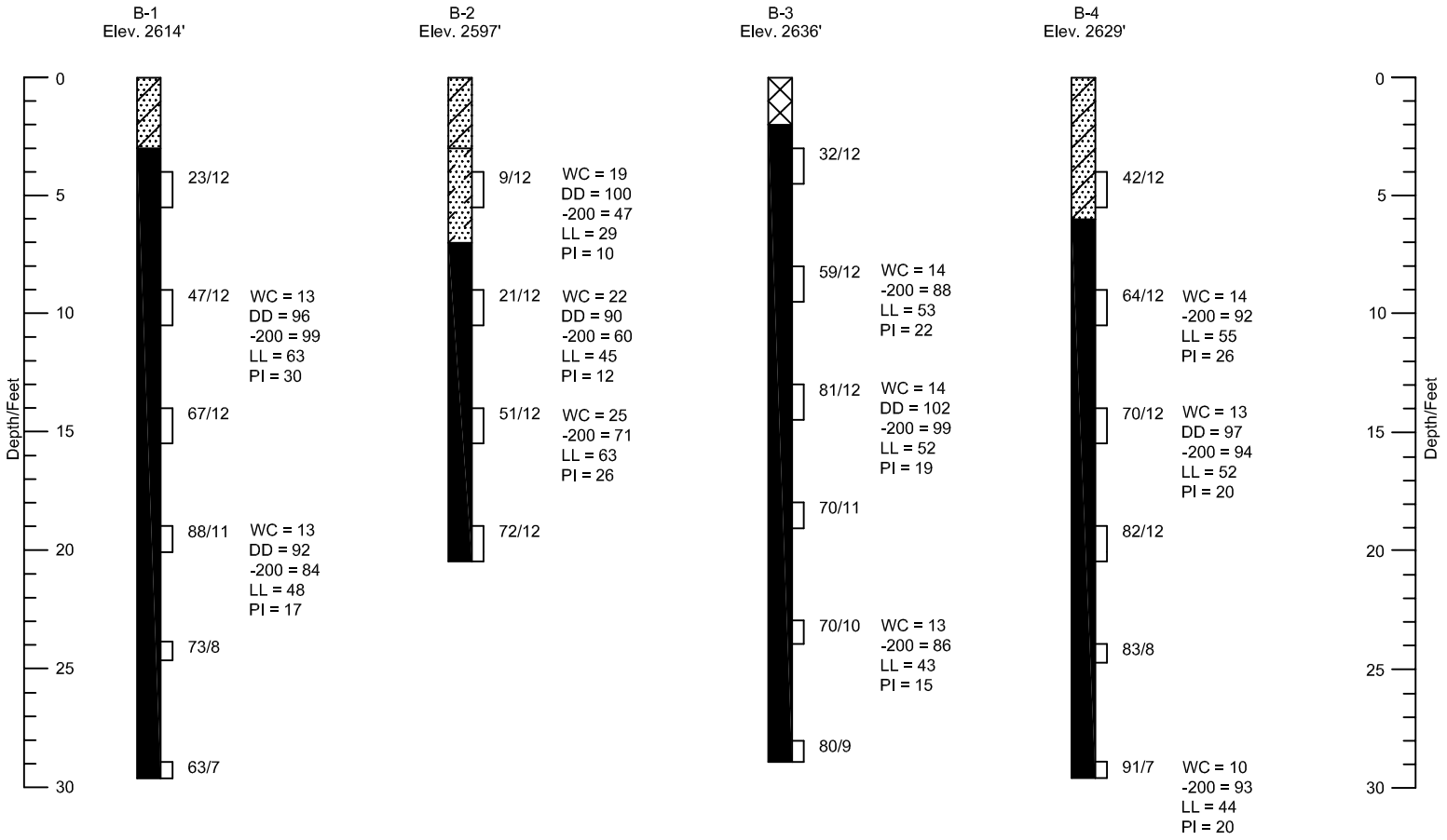
- Approximate boring location
- Approximate test pit location

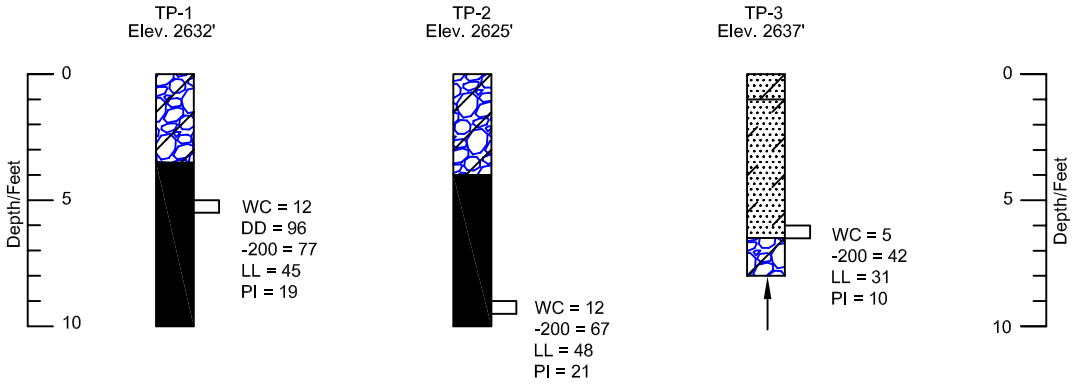
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0 50 100 feet

Approximate Scale

2200879	AGEC	Site Plan	Figure 2


B-1
Elev. 2614'
B-2
Elev. 2597'
B-3
Elev. 2636'
B-4
Elev. 2629'
Depth/Feet
0
5
10
15
20
25
30
23/12
47/12
WC = 13
DD = 96
-200 = 99
LL = 63
PI = 30
67/12
88/11
WC = 13
DD = 92
-200 = 84
LL = 48
PI = 17
73/8
63/7
9/12
WC = 19
DD = 100
-200 = 47
LL = 29
PI = 10
21/12
WC = 22
DD = 90
-200 = 60
LL = 45
PI = 12
51/12
WC = 25
-200 = 71
LL = 63
PI = 26
72/12
32/12
59/12
WC = 14
-200 = 88
LL = 53
PI = 22
81/12
WC = 14
DD = 102
-200 = 99
LL = 52
PI = 19
70/11
70/10
WC = 13
-200 = 86
LL = 43
PI = 15
80/9
42/12
64/12
WC = 14
-200 = 92
LL = 55
PI = 26
70/12
WC = 13
DD = 97
-200 = 94
LL = 52
PI = 20
82/12
83/8
91/7
WC = 10
-200 = 93
LL = 44
PI = 20



LEGEND:

Fill; consists of Silty Sand with Gravel, poorly compacted, dry, and light brown in color.

Clayey Sand (SC); medium dense, slightly moist, and light brown in color.

Silty Sand (SM); occasional gravel, medium dense, dry to slightly moist, and light brown in color.

Silty Gravel with Sand (GM); medium dense to dense, dry, and light brown in color.

Mudstone Bedrock; soft to moderately hard, moist, and red to purple to grey in color.

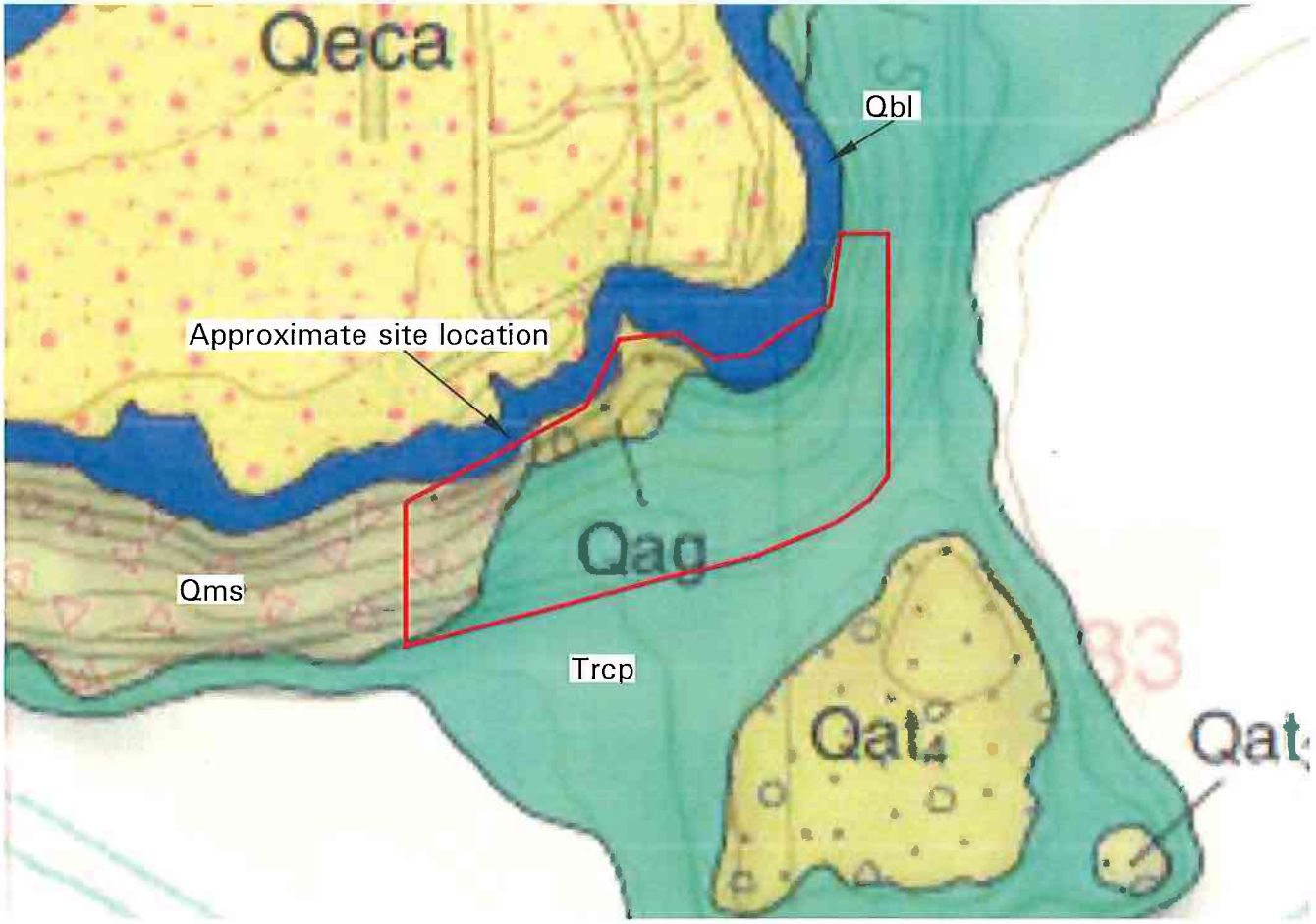
10/12 California drive sample taken. The symbol 10/12 indicates that 10 blows from a 140 pound hammer falling 30 inches were required to drive the sampler 12 inches.

Indicates relatively undisturbed block sample taken.

Indicates practical backhoe refusal on boulders, sandstone bedrock, or limestone bedrock.

NOTES:

1. The borings were drilled on June 3, 2020 with a truck mounted drill rig equipped with 8-inch hollow-stem augers. The test pits were excavated on June 2, 2020 with a trackhoe.
2. The locations of the borings and test pits were measured by pacing from features shown on Figure 2.
3. The elevations of the borings and test pits were interpolated between the contours shown on the site plan, Figure 2.
4. The boring and test pit locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between the materials shown on the logs represent the approximate boundaries between material types and the transitions may be gradual.
6. Free water was not encountered in the borings and test pits at the time of drilling/ excavation.
7. WC = water content (%);
   DD = dry density (pcf);
   -200 = percent passing No. 200 sieve;
   LL = liquid limit (%);
   PI = plasticity index (%).



Key:

Qbl - Lava Ridge lava flow (Lower Pleistocene) - moderate- to dark-gray to dark-brownish-gray basaltic trachyandesite with prominent euhedral plagioclase phenocrysts up to 0.4 inch (1cm) wide, common quartz and pyroxene phenocrysts, and small olivine phenocrysts; moderately jointed; previously called Middle lava flow (Willis and Biek, 2001)

Qms - Landslide deposits (Holocene to middle Pleistocene) - Extremely poorly sorted, clay-to boulder-sized, chaotic debris with blocks of rotated strata up to several hundred feet across that form chaotic, hummocky mounds; form primarily on steep slopes capped by basalt flows; basal detachments are in the Petrified Forest Member of the Chinle Formation

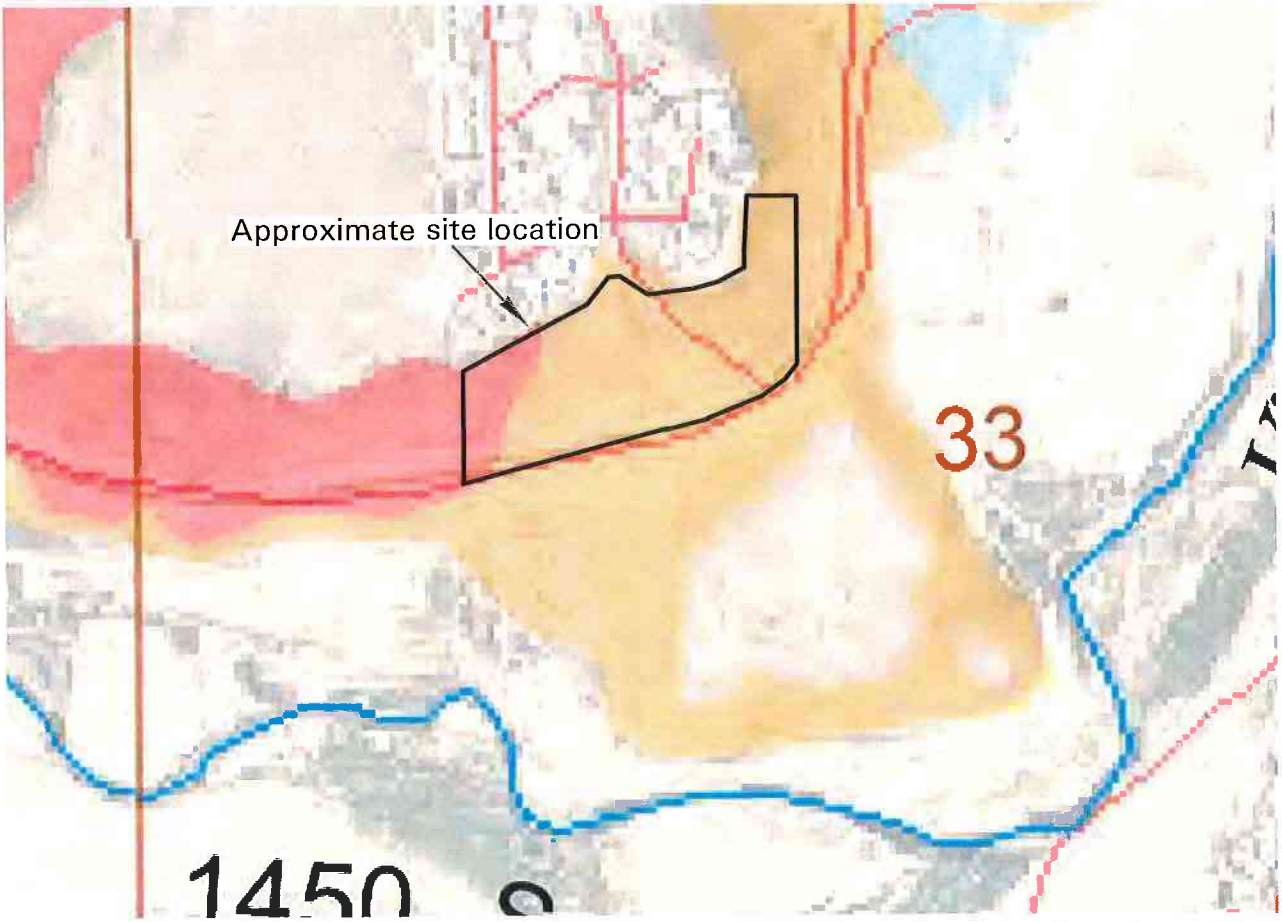
Qag - Alluvial gravel beneath lava flows (Lower Pleistocene) - poorly to moderately sorted, clay- to boulder- size, stream-deposited sediment exposed as small, isolated outcrops beneath lava flows; most clasts are well-rounded cobbles and small boulders exotic to the quadrangle, including igneous rocks derived from the Pine Valley Mountains

Trcp - Petrified Forest Memeber (Upper Triassic) - Highly variegated, light brownish gray, pale-greenish- gray, to grayish-red-purple, bentonitic shale, mudstone, siltstone, and claystone, with several lenticular interbeds of pale yellowish brown, cross-bedded, resistant sandstone up to 10 feet (3m) thick; pebble to small-cobble conglomerate near base; clasts are primarily chert and quartzite; contains minor chert, nodular limestone, very thin coal seams and lenses as much as 0.5 inch (1 cm) thick, and locally abundant, brightly colored fossilized wood; shale and mudstone weather to a "popcorn" surface with abundant mudcracks due to expansive clays and cause road and building foundation problems; weathers to badland topography; prone to landsliding along steep hillside; local primary source for radon (Solomon, 1992a, b)

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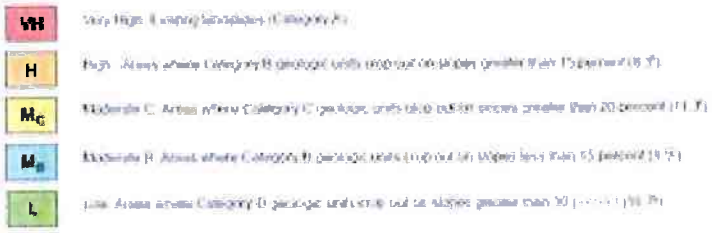
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Not to Scale

2190879	AGEC	Geologic Map	Figure 5a



Landslide-Hazard Map for the St. George-Hurricane Metropolitan Area, Washington County, Utah, UGS Special Study 127 2008, W.R. Lund, T.R. Knudson, G.S. Vice and L.M. Shaw

EXPLANATION



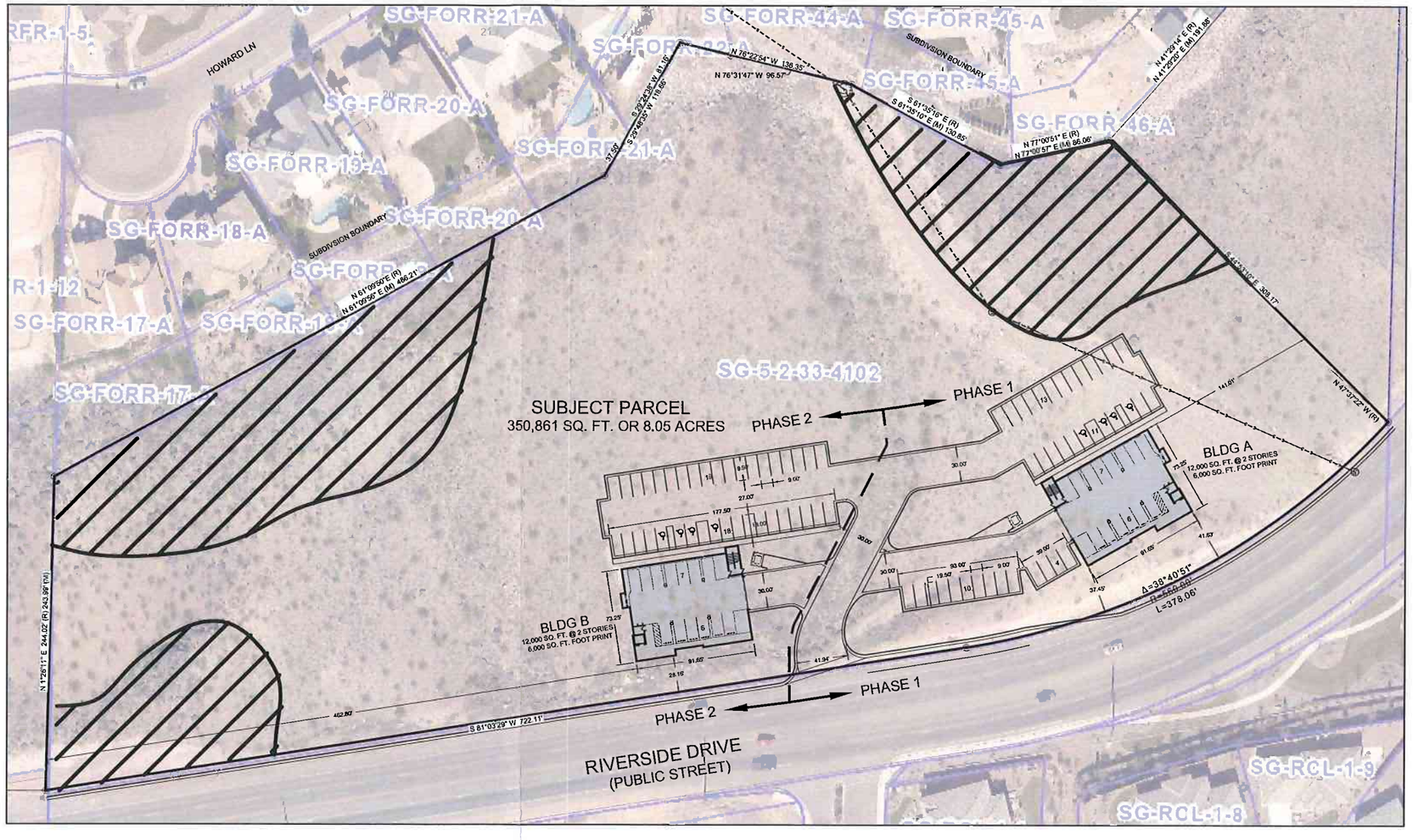


Not to Scale

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2200879	AGEC	Landslide Hazard Map	Figure 5b

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ST. GEORGE, UTAH



Area of estimated potential rockfall zone

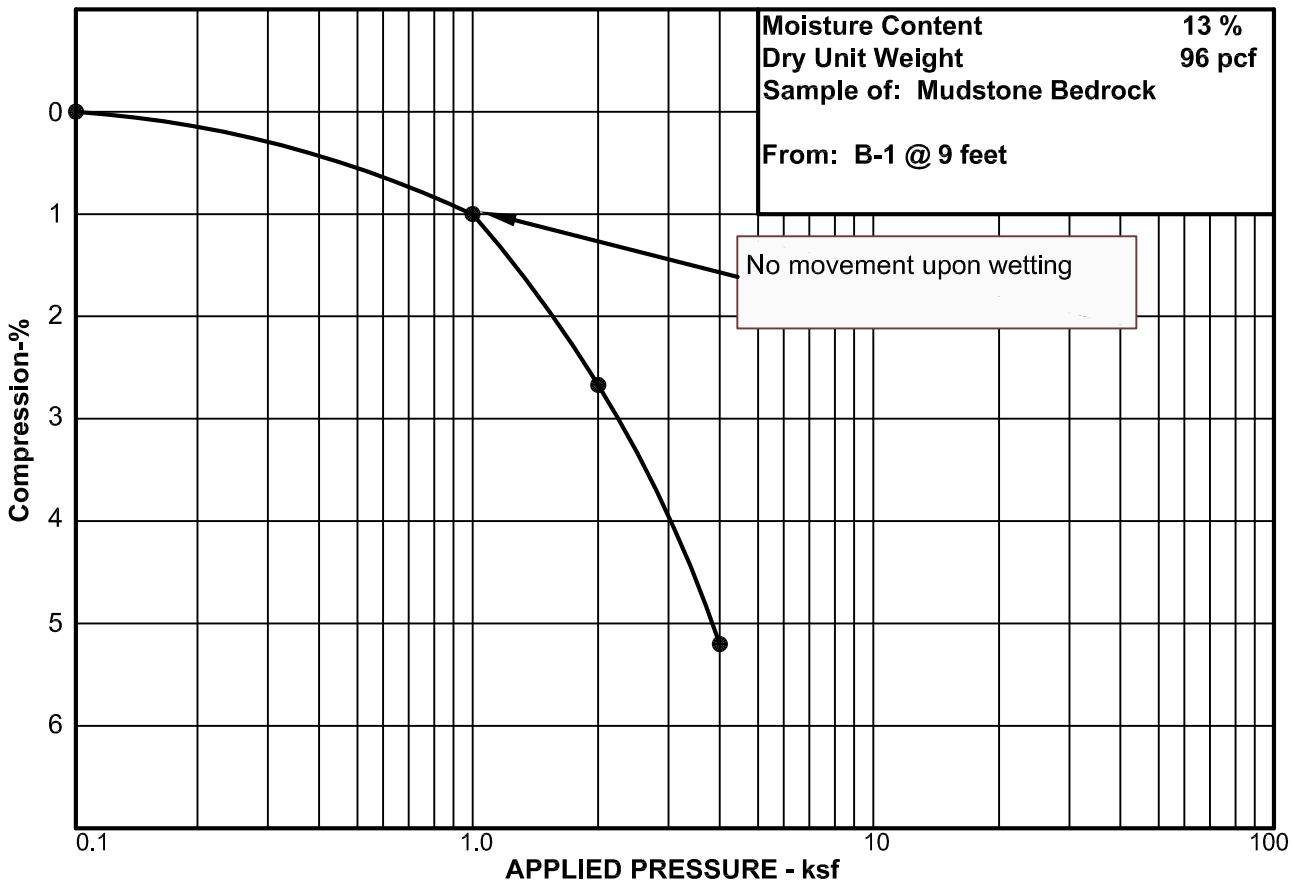
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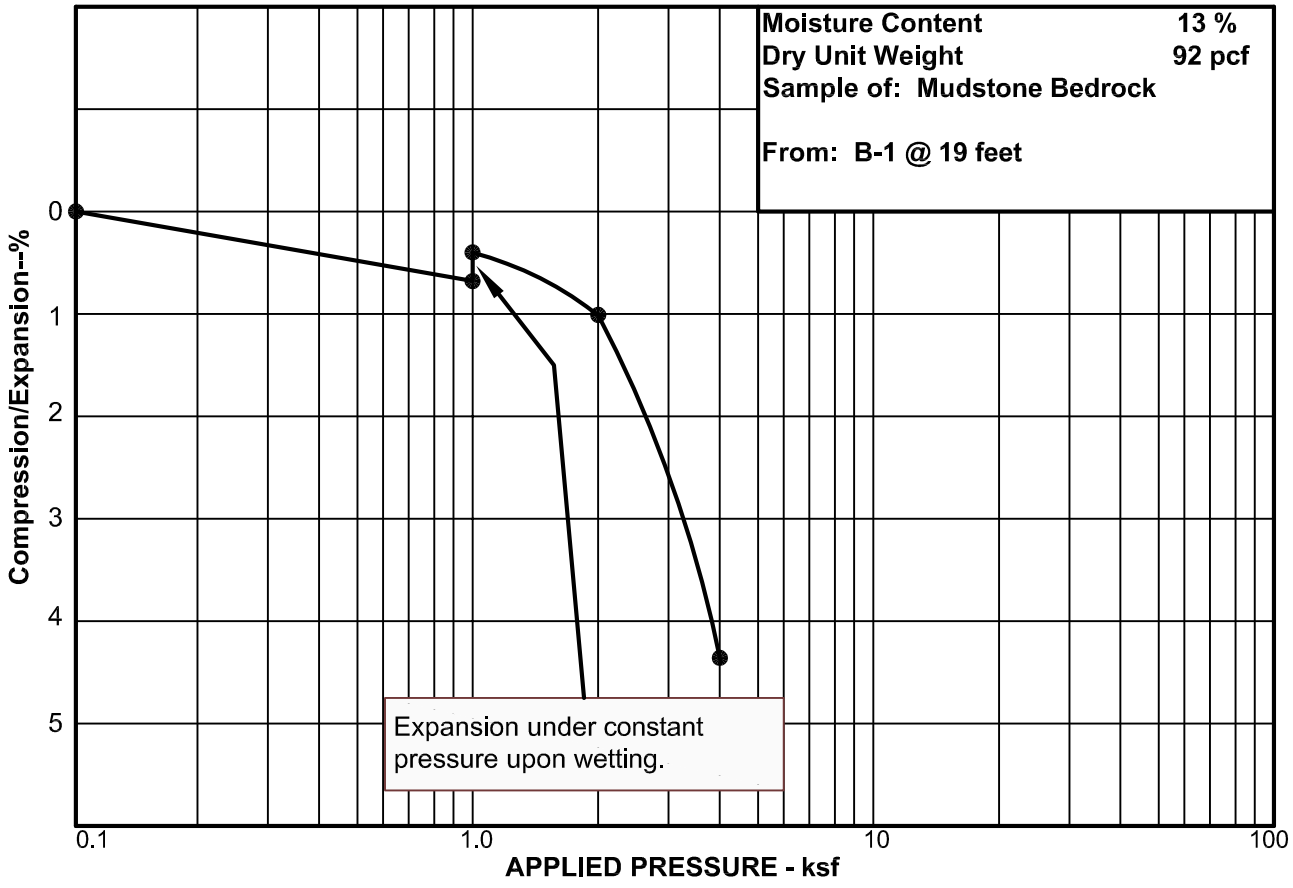
0 100 200 feet

Approximate Scale

2200879	AGEC	Rockfall Runout Line	Figure 5c

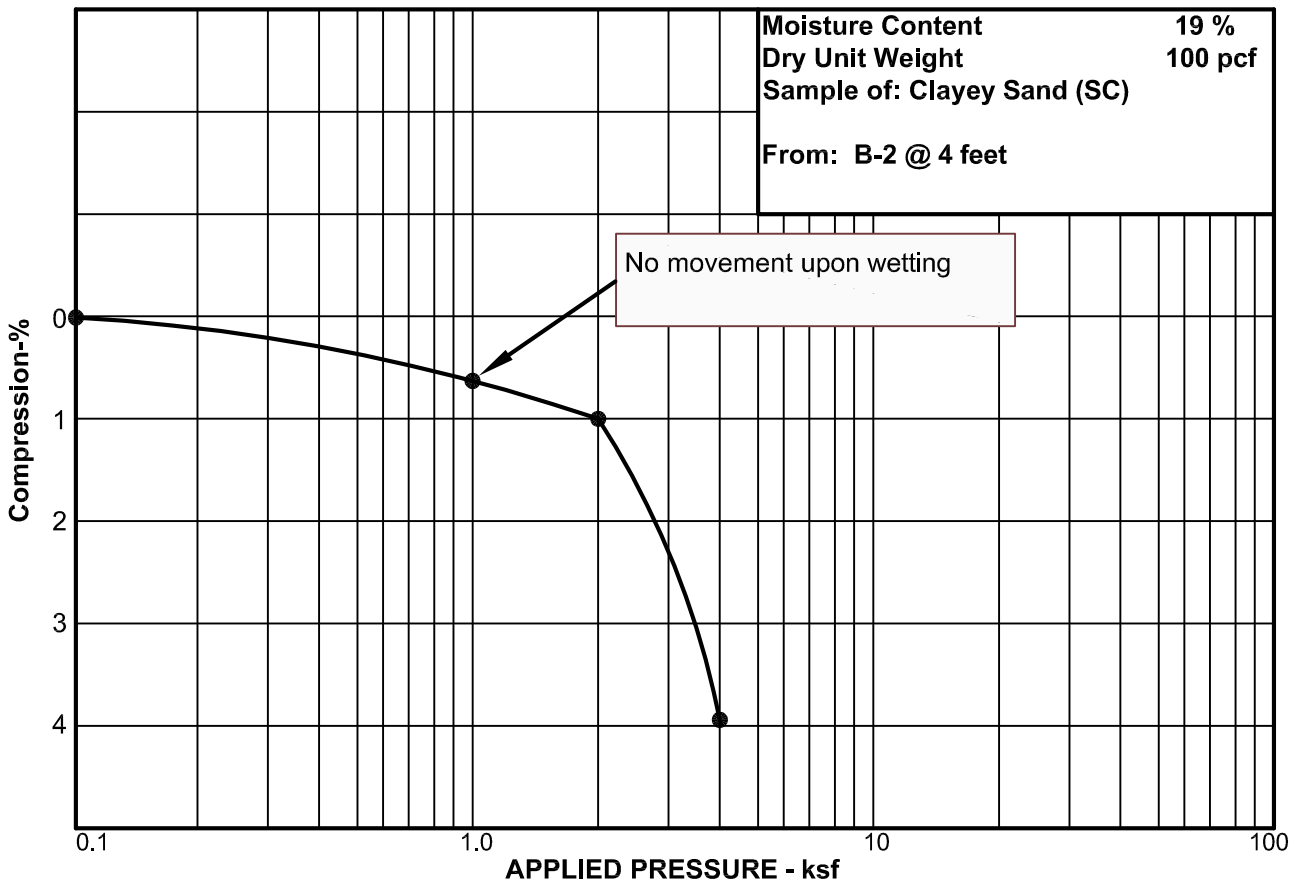
Applied Geotechnical Engineering Consultants, Inc.

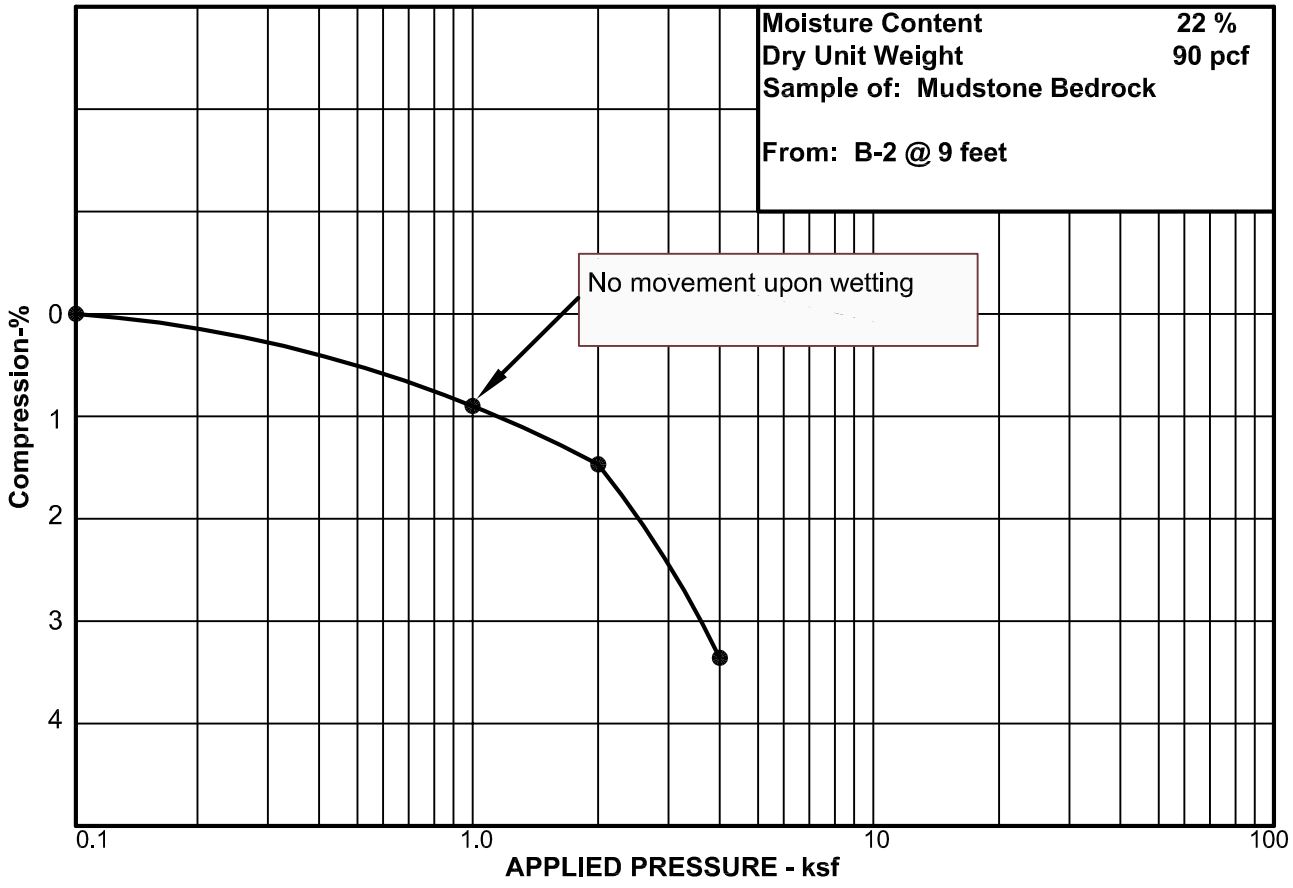




Project No. 2200879 **CONSOLIDATION TEST RESULTS** **Figure 6**

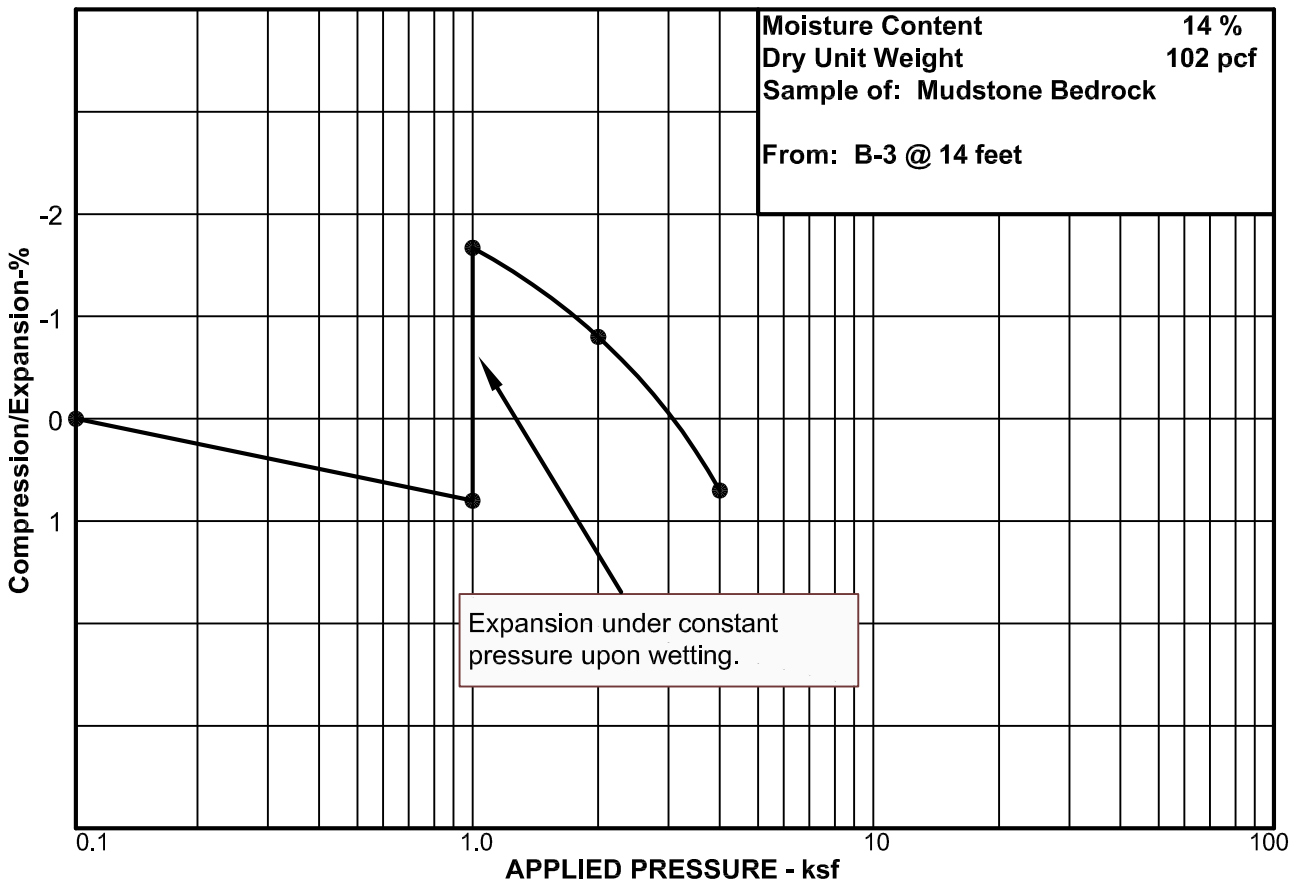
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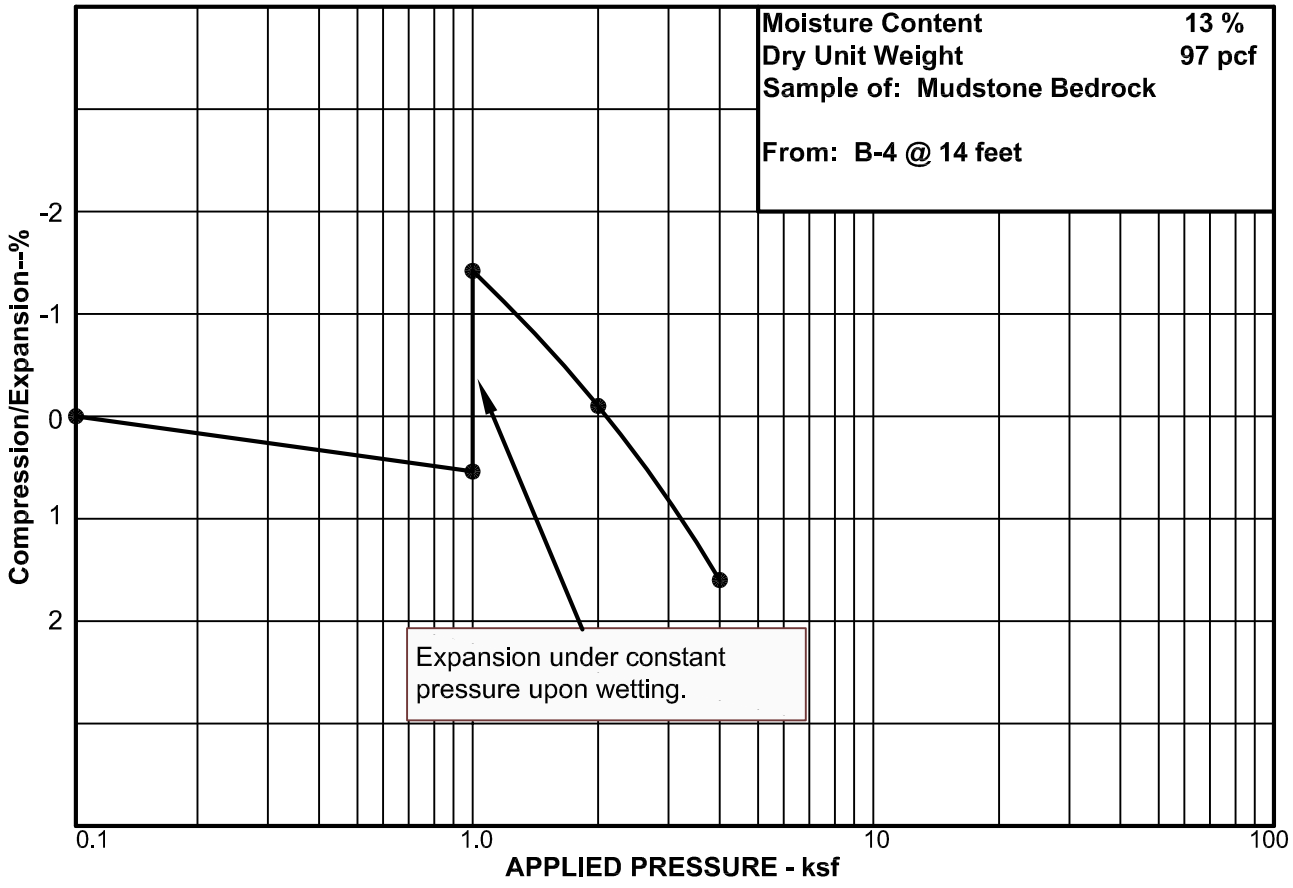




Project No. 2200879 **CONSOLIDATION TEST RESULTS** **Figure 7**

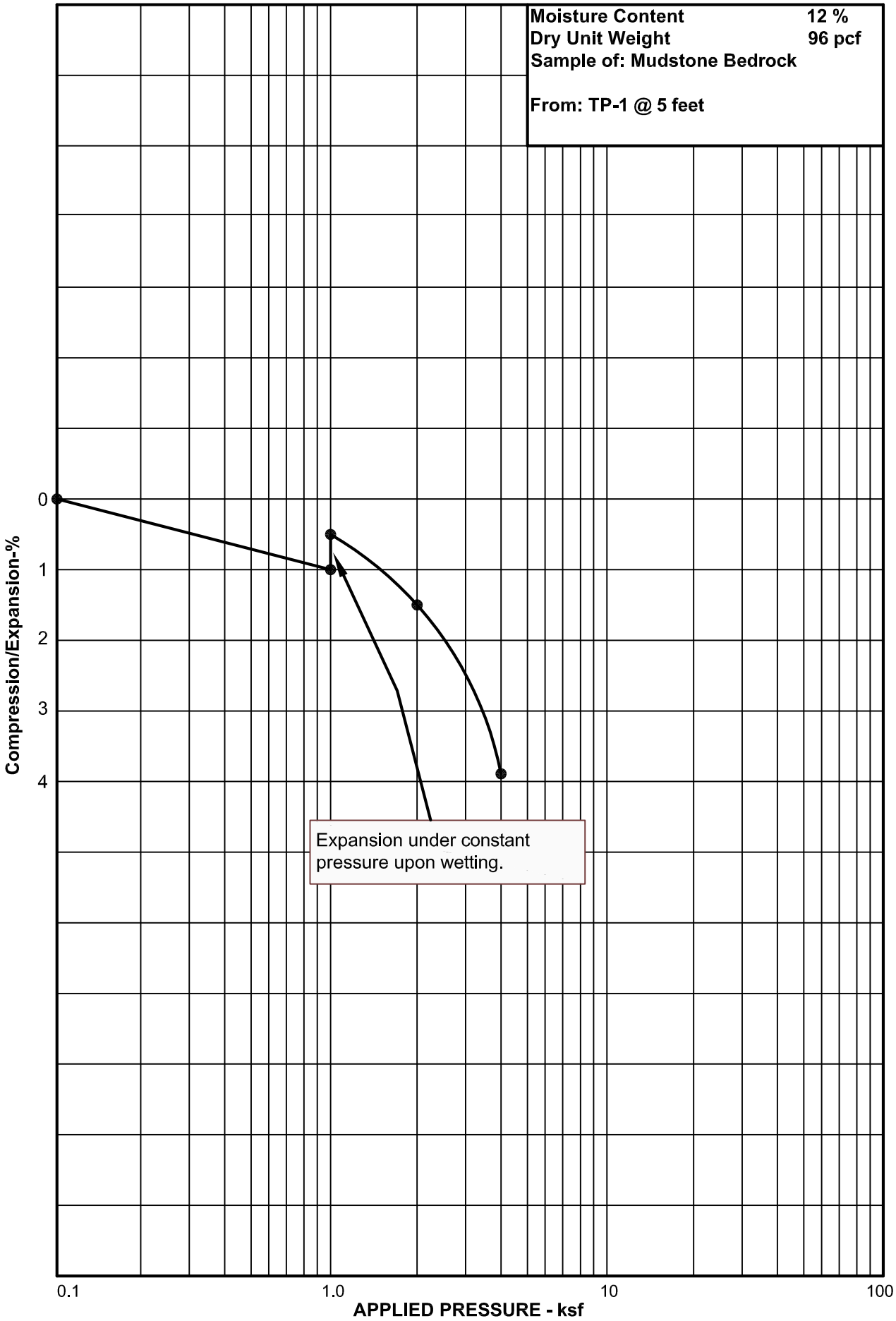
Applied Geotechnical Engineering Consultants, Inc.





Project No. 2200879 **CONSOLIDATION TEST RESULTS** **Figure 8**

Applied Geotechnical Engineering Consultants, Inc.



Project No. 2200879 **CONSOLIDATION TEST RESULTS** **Figure 9**

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

Riverside Medical Office Building — Project Number 2200879

Sample Location		Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg Limits		Sample Classification
Boring/ Test Pit No.	Depth (feet)			Gravel (%)	Sand (%)	Silt/ clay (%)	Liquid Limit (%)	Plasticity Index (%)	
B-1	9	13	96			99	63	30	Mudstone Bedrock
B-1	19	13	92			84	48	17	Mudstone Bedrock
B-2	4	19	100			47	29	10	Clayey Sand (SC)
B-2	9	22	90			60	45	12	Mudstone Bedrock
B-2	14	25				71	63	26	Mudstone Bedrock
B-3	8	14				88	53	22	Mudstone Bedrock
B-3	14	14	102			99	52	19	Mudstone Bedrock
B-3	23	13				86	43	15	Mudstone Bedrock
B-4	9	14				92	55	26	Mudstone Bedrock
B-4	14	13	97			94	52	20	Mudstone Bedrock
B-4	29	10				93	44	20	Mudstone Bedrock
TP-1	5	12	96			77	45	19	Mudstone Bedrock
TP-2	9	12				67	48	21	Mudstone Bedrock
TP-3	6	5				42	31	10	Clayey Sand (SC)

Elevations



MRW DESIGN ASSOCIATES INC.

Hillside Professional Offices



RW DESIGN ASSOCIATES INC.

Hillside Professional Offices



FRONT ELEVATION

Scale: 1/8" : 1'-0"



LEFT ELEVATION

Scale: 1/8" : 1'-0"



RIGHT ELEVATION

Scale: 1/8" : 1'-0"



REAR ELEVATION

Scale: 1/8" : 1'-0"

EXTERIOR MATERIALS KEY

1. STUCCO, MEDIUM GREY
2. STUCCO, LIGHT GREY
3. MANUFACTURED STONE VENEER, CORONADO STONE PRO-LEDGE WHITE
4. ACM PANELS, ALUMINUM COLOR
5. PAINTED BLACK METAL ACCENTS & PARAPET DETAILS

© COPYRIGHT 2017, MRW DESIGN ASSOCIATES INC.

DATE: 06/22/20

JOB NUMBER:

SCALE: 1/8"=1'

DRAWN:

CHECKED:

MRW DESIGN ASSOCIATES INC.
ARCHITECTURE & CONSULTING ENGINEERS

251 W. HILTON DR # 202
P.O. BOX 2775
ST. GEORGE UTAH 84770
(435) 628-2377 (435) 673-3580 fax
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COLORED EXTERIOR ELEVATIONS
NEW OFFICE BUILDINGS
HILLSIDE PROFESSIONAL
ST. GEORGE CITY, UTAH

OF SHEETS

PowerPoint Presentation

2020-HS-010

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Vicinity Map

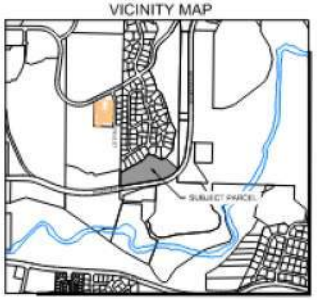


Zoning





VICINITY MAP



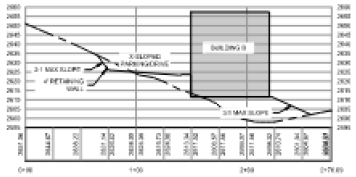
LEGEND



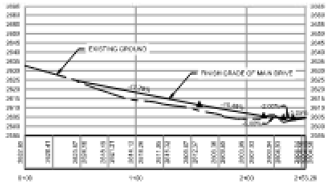
SURFACE SLOPE DATA

COLOR	% NATURAL SLOPE	TOTAL AREA	ALLOWED DISTURBANCE	PROPOSED DISTURBANCE AREA	PROPOSED DISTURBANCE %
	0 -19%	2.210 AC	100%	1.249 AC	57%
	20 - 29%	1.783 AC	30%	0.459 AC	26%
	30 - 39%	1.584 AC	5%	0.124 AC*	8%*
	40% +	2.473 AC	0	0.06 AC*	2%*
		8.05 AC		1.892 AC	

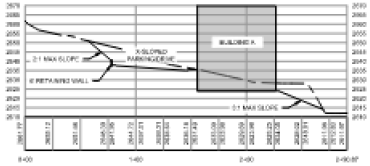
* AREAS OF INSIGNIFICANCE, SMALL WASH OR SLOPE FROM MANMADE DISTURBANCE.



CROSS SECTION 1



CROSS SECTION 2



CROSS SECTION 3



SCALE: 1" = 50' HORIZ
SCALE: 1" = 30' VERT
(SCALE ONLY VALID FOR 24" x 36" PAPER)

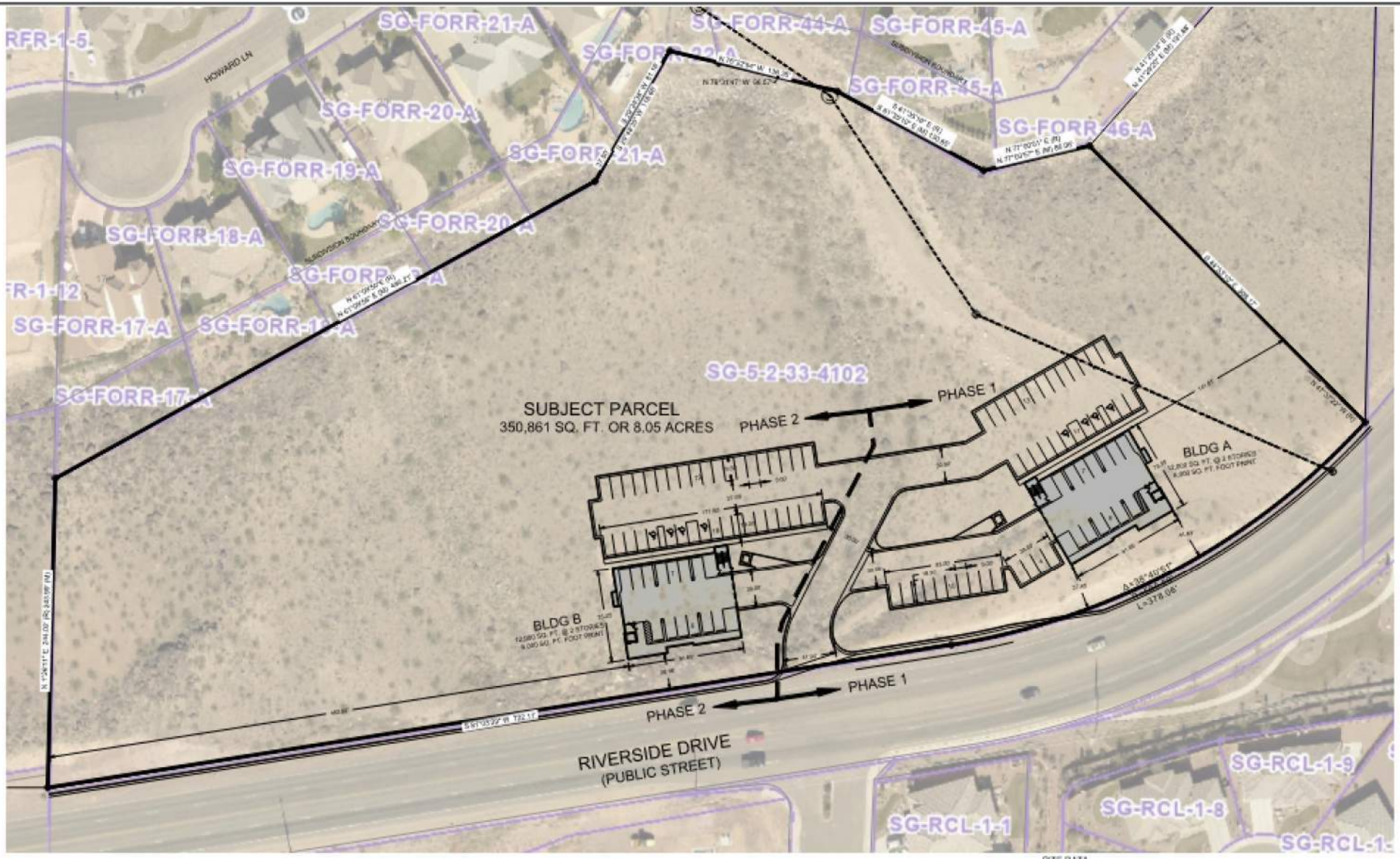
1453 S. DIXIE DRIVE, SUITE 150
ST. GEORGE, UT 84770
435.986.0100
CivilScience

HILLSIDE DEVELOPMENT REVIEW

HILLSIDE PROFESSIONAL
LOCATED IN ST. GEORGE, UTAH

PROJ. # HILLSIDE
DRAWN BY: BLDR
DATED: 8/12/2020
CHECKED BY: KZD
SCALE OF SHEET
HOR SCALE: 1" = 50'

SHEET
1
OF
2


SG-FORR-21-A
SG-FORR-44-A
SG-FORR-45-A
SG-FORR-20-A
SG-FORR-45-A
SG-FORR-46-A
SG-FORR-19-A
SG-FORR-18-A
SG-FORR-17-A
SG-5-2-33-4102
SUBJECT PARCEL
350,861 SQ. FT. OR 8.05 ACRES
PHASE 1
PHASE 2
BLDG A
BLDG B
PHASE 2
PHASE 1
RIVERSIDE DRIVE
(PUBLIC STREET)
SG-RCL-1-9
SG-RCL-1-8
SG-RCL-1-1



LEGEND:

- ASPHALT PAVING AREA
- NEW LANDSCAPING ROCK, ROCK LINED STEEP SLOPE
- CONCRETE AREA
- NEW BUILDING AREA
- NEW LANDSCAPING ROCK GROUND COVER
- NEW LANDSCAPING TREE, VARIETY TO BE DETERMINED BASED ON LOCAL CONDITIONS
- NEW LANDSCAPING SHRUBBERY, VARIETY TO BE DETERMINED BASED ON LOCAL CONDITIONS



Hillside Professional Offices



FRONT ELEVATION



LEFT ELEVATION



RIGHT ELEVATION



REAR ELEVATION

EXTERIOR MATERIALS KEY

1. STUCCO, MEDIUM GREY
2. STUCCO, LIGHT GREY
3. MANUFACTURED STONE VENEER, CORONADO STONE PRO LEDGE WHITE
4. ACM PANELS, ALUMINUM COLOR
5. PAINTED BLACK METAL ACCENTS & PARAPET DETAILS

Item #3

St.George
Community Development

Hillside Permit

HILLSIDE REVIEW BOARD AGENDA REPORT: **07/15/2020**

HILLSIDE DEVELOPMENT PERMIT
The Cove
Case No. 2020-HS-007

Request: This is a request for a Hillside Development Permit for "The Cove"

Location: The property is generally located west of Bluff Street at approximately 300 West and 900 South.

APN: SG-6-2-36-110

Proposed: The property is proposed to be developed into a multi-family residential project.

Background: On March 5, 2020 the City Council approved a general plan amendment to change a portion of OS (Open Space) and COM (Commercial) land use designations to HDR (High Density Residential) and areas of OS (Open Space) to COM (Commercial). This was Case No. 2020-GPA-006. The applicant next intends to submit a zone change application after the hillside permit process. The applicant will need to submit all requirements for the zone change prior to being put on an agenda.

Owner: Cove Towers LLC

Applicant: Brent Holdaway

Engineer: Bush & Gudgell, Inc.

Geological Hazards: AGEC has provided a letter dated January 6, 2020 titled "Geological Hazard Assessment" and it was submitted with the hillside application. The hazards discussed in the letter include: 1) Rockfall Evaluation, 2) Landslide Evaluation, 3) Debris Flow, and 4) Fault Rupture

Geotech: Produced by AGEC, July 1, 2020 is attached to this report.

Drainage: A preliminary drainage study prepared by Bush & Gudgell and dated April 29, 2020 Job # 191258 was submitted with the hillside application.

Current Zoning: The current zoning on the property is primarily C-2. There is a small sliver of OS (Open Space) designated at the top of the bluff as well. Now that the General Plan amendment was approved by council, zoning will have to be changed in the future to conform to how the applicant would like to develop the property.

General Plan: The General Plan Land Use Map was changed on 3/5/2020 by the City Council (*reference 'Background' section above*).

Area: The area is just approximately 16 acres.

Surrounding: The surrounding properties to the south and east are commercial businesses. Properties to the north and west are currently undeveloped hillside.

Staff Comments: If the HSRB recommends approval of the hillside permit, then the permit request advances forward to the Planning Commission (PC) for review and recommendation and then on to the City Council (CC) for approval or denial.

1. Hillside Permit - A hillside permit is required per ordinance and the HSRB will make recommendations to the PC & CC.
2. Zoning – Currently the zoning is C-2 and OS, but the applicant will have to approach the city council with a zone change request in order to proceed with the development.
3. Development – It's proposed to grade the area as presented.
4. Geotechnical Investigation – All earthworks shall comply with the recommendations and mitigations presented in Geotech Report.
5. Drainage – Drainage shall comply with the Drainage Study by Bush & Gudgell dated April 29, 2020.
6. Grading Permit - If approved, the applicant will work with staff for submittal of a Grading Permit with the required accompanying civil engineering plan set (for plan review).

HSRB Motion: The HSRB recommends approval of "The Cove" and the following are recommended conditions and comments:

1. Grading Permit – The applicant shall work with staff for submittal of a Grading Permit for "The Cove" with the required accompanying civil engineering plan set (for plan review).
2. Non-contiguous Areas – The non-contiguous, insignificant areas, and man-made spoils over 40% may be removed.

3. Geotechnical Investigation – All earthworks shall comply with the recommendations and mitigations presented in the AGEC Report Project No. 2192092 dated July 1, 2020.
4. Drainage – Drainage shall comply with the recommended mitigations presented in the 'Preliminary Drainage Study" by Bush & Gudgell dated April 29, 2020.

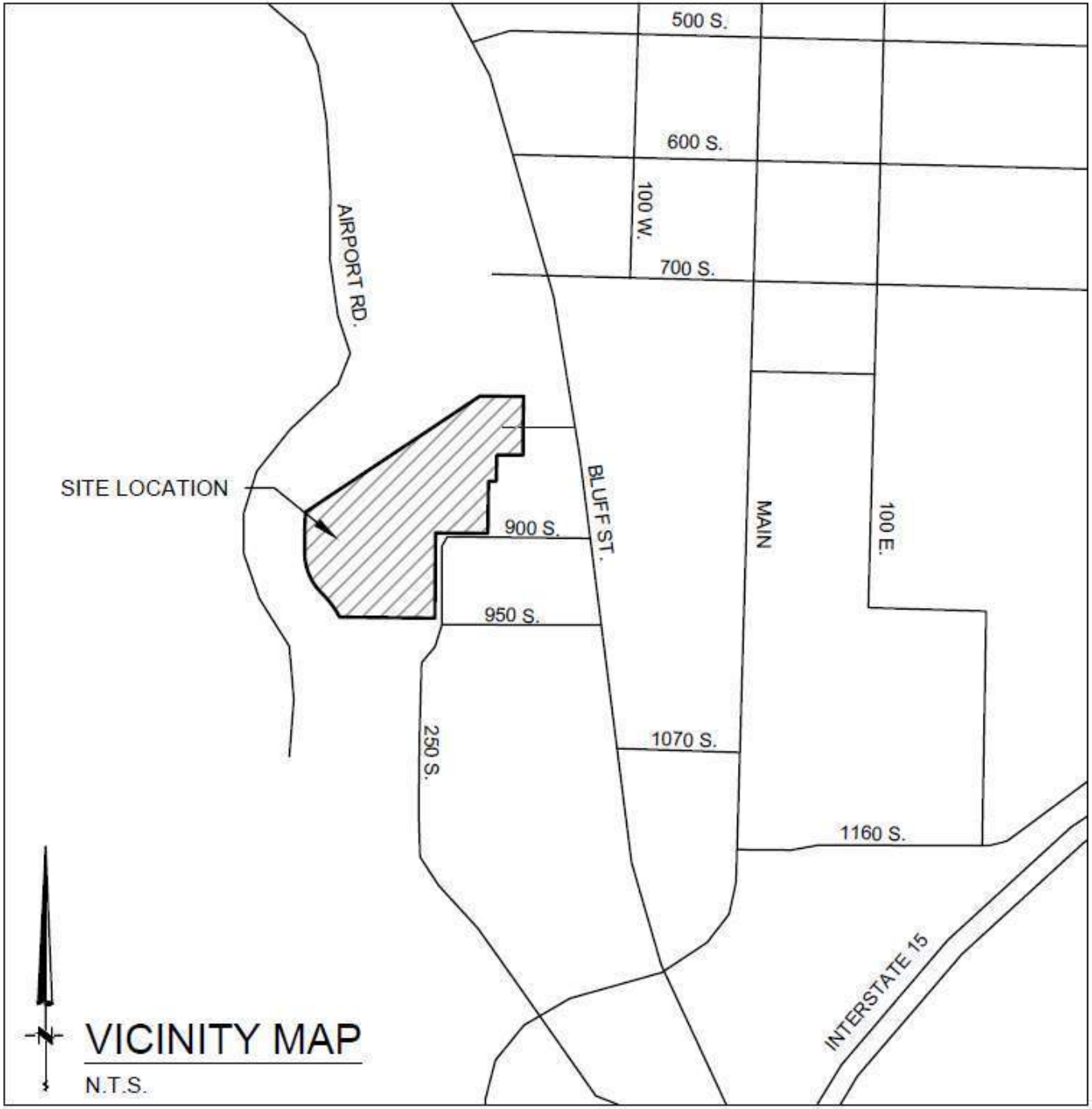
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St. George, Utah
www.bushandgudgell.com

The Cove
Hillside Review Narrative

The purpose for this hillside review to allow multifamily development in the area approximately located West of 900 S. and 250 W. St George, Utah. The Cove is a proposed 16-acre multi-family residential project. The property is noted on the General Plan as Multifamily or Commercial. The proposed use is multifamily consisting of 5 buildings for approximately 138 units.

The surrounding properties currently to the South and East are commercial business, properties North and West are currently undeveloped hillside but where possible have commercial business.

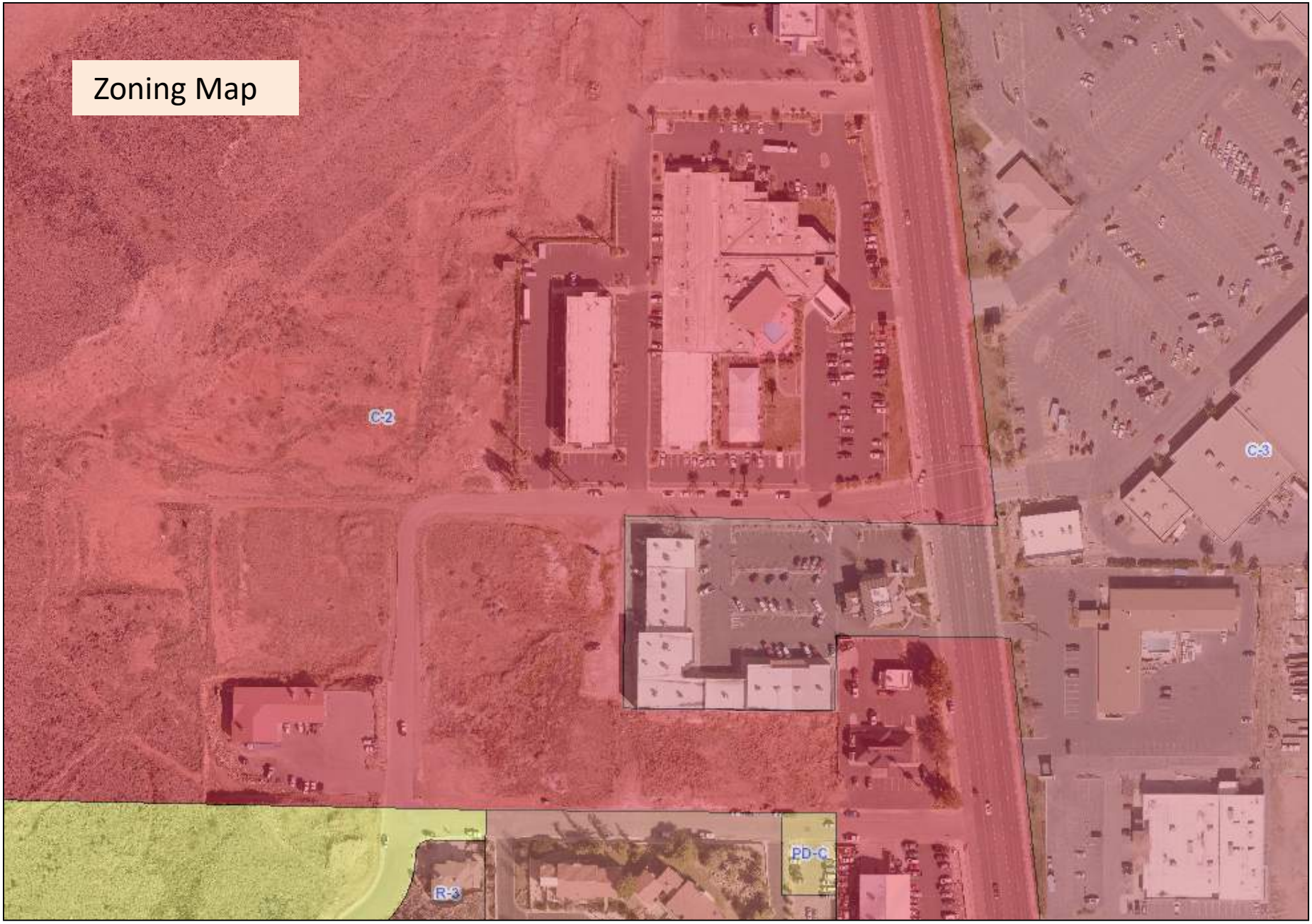
Powerpoint Presentation

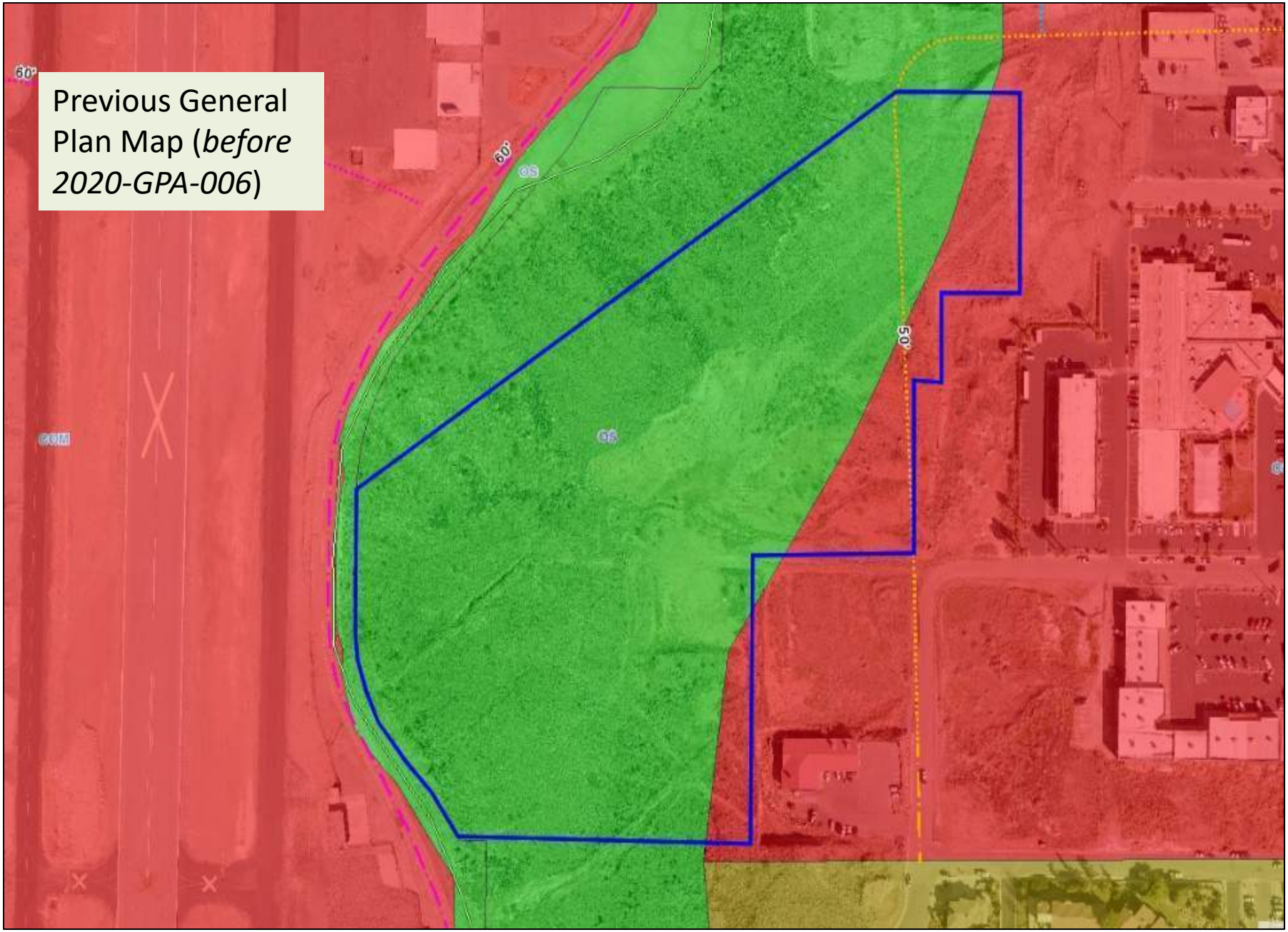


VICINITY MAP

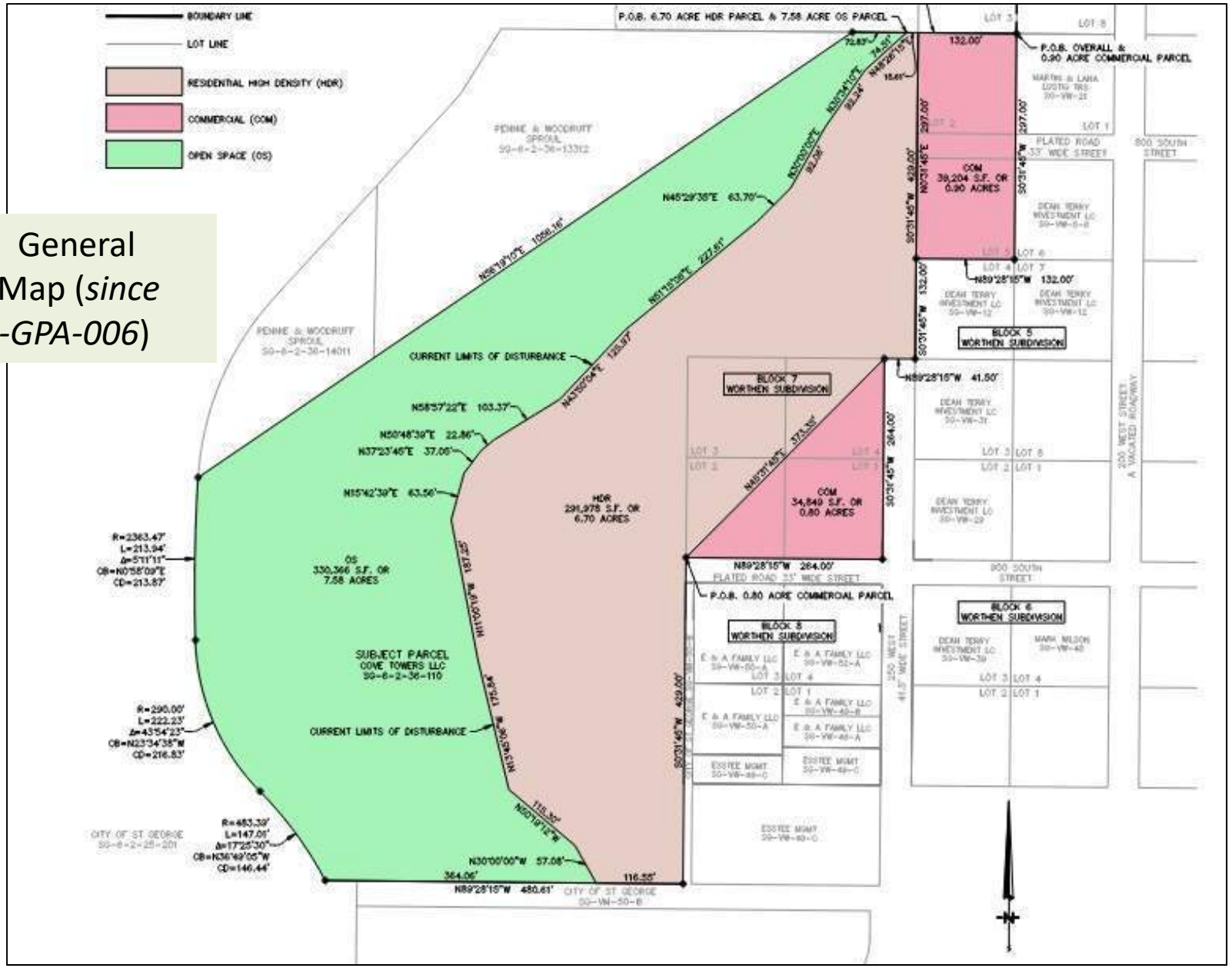
N.T.S.

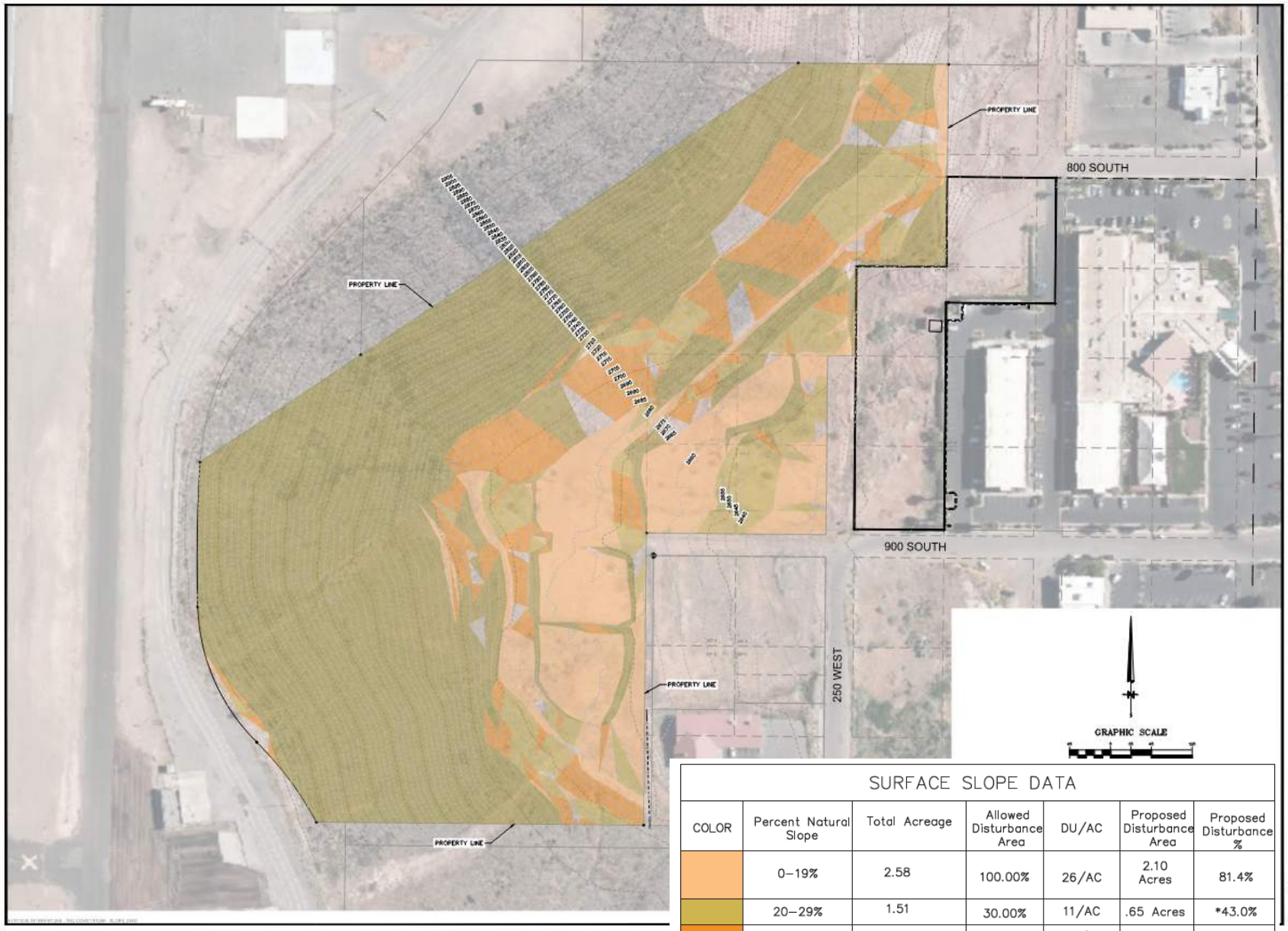
800 S ST
900 S ST
900 S ST
950 S ST
950 S ST


Zoning Map
C-2
C-3
R-3
PD-C


Previous General Plan Map (*before 2020-GPA-006*)

New General Plan Map (*since 2020-GPA-006*)





SURFACE SLOPE DATA

COLOR	Percent Natural Slope	Total Acreage	Allowed Disturbance Area	DU/AC	Proposed Disturbance Area	Proposed Disturbance %
	0–19%	2.58	100.00%	26/AC	2.10 Acres	81.4%
	20–29%	1.51	30.00%	11/AC	.65 Acres	*43.0%
	30–39%	1.93	10.00%	9.6/AC	.41 Acres	*21.2%
	40+%	9.52	0.00%	3.5/AC	.61 Acres	*6.4%

*Area contains previously distrubed or man made dirt piles.

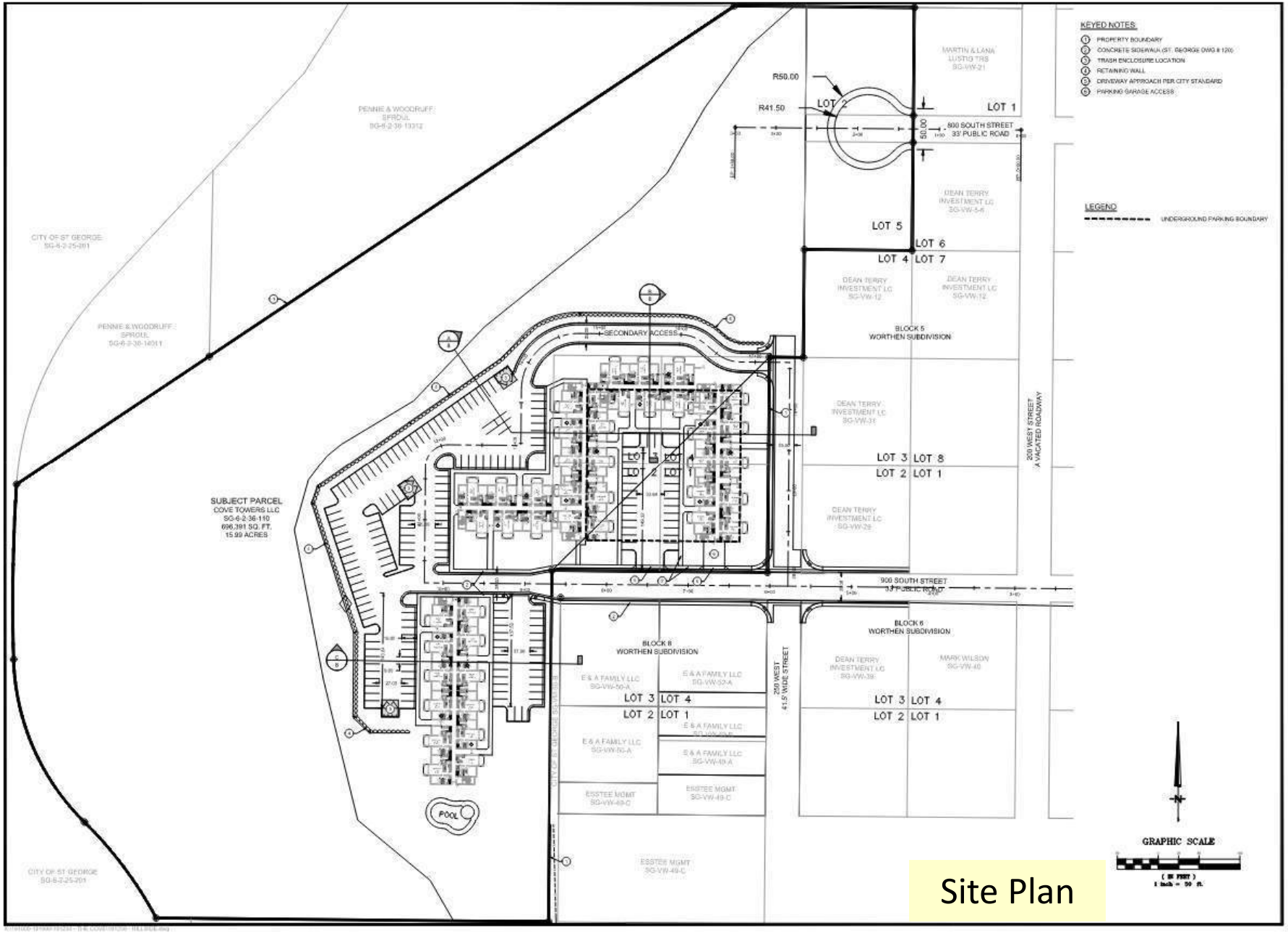
BUSH & GUDGELL, INC.
Engineers - Planners - Surveyors
265 East Tabernacle Suite #4
St. George, UT 84770
Phone (435) 673-2037 / Fax (435) 673-3161
www.bushandgudgell.com

SLOPE ANALYSIS
THE COVE
ST GEORGE, UTAH

SHEET 4 OF 10 SHEETS


Auto Parts


CREW
486.229.3522

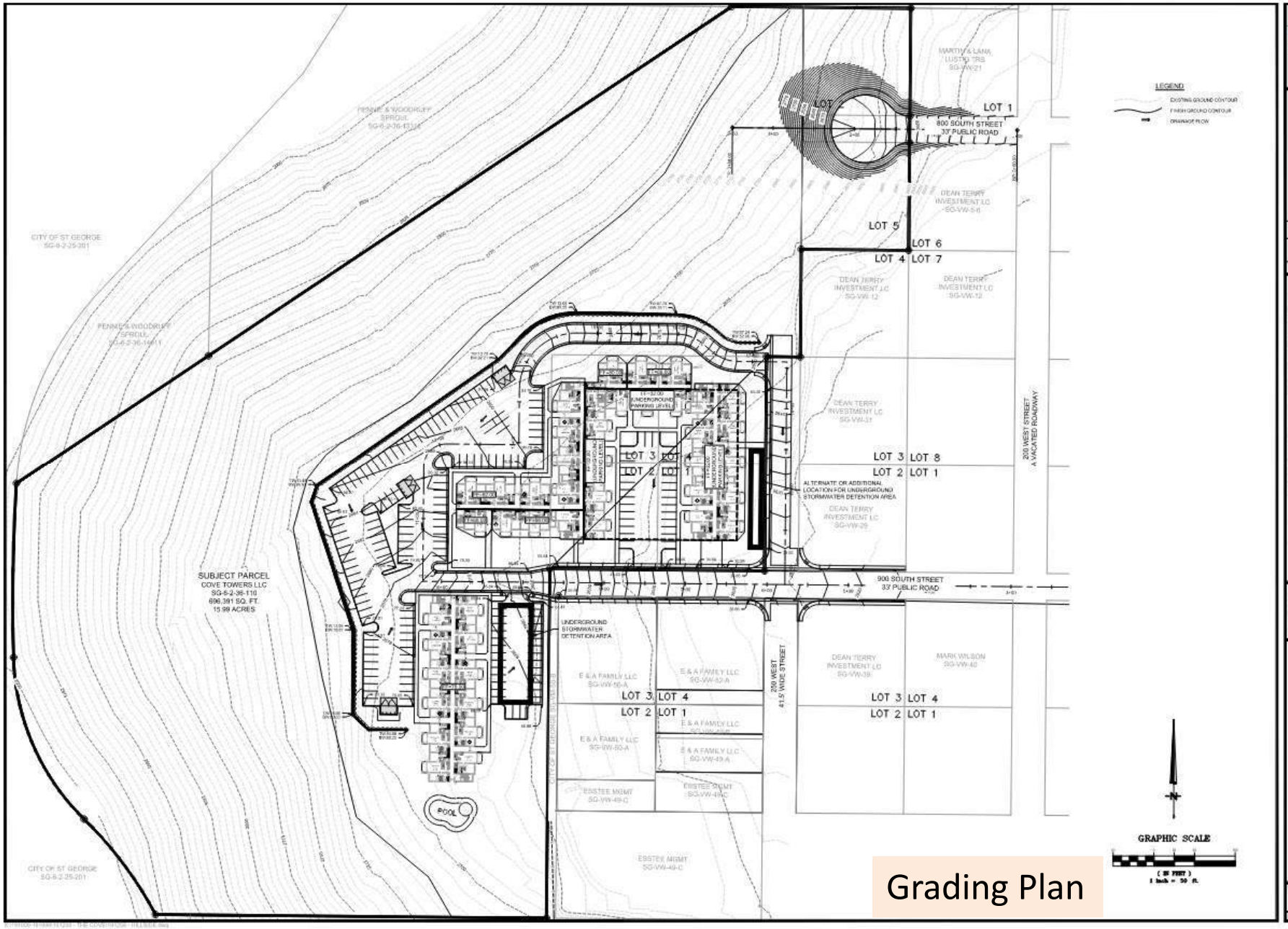


Site Plan

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SITE PLAN
THE COVE
ST. GEORGE, UTAH

SHEET 2 OF 10 SHEETS

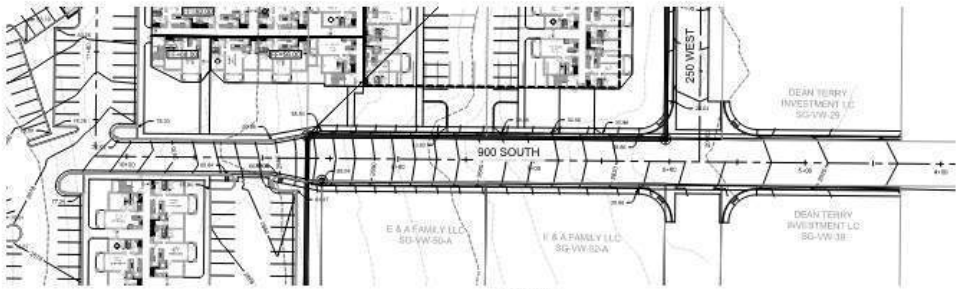


Grading Plan

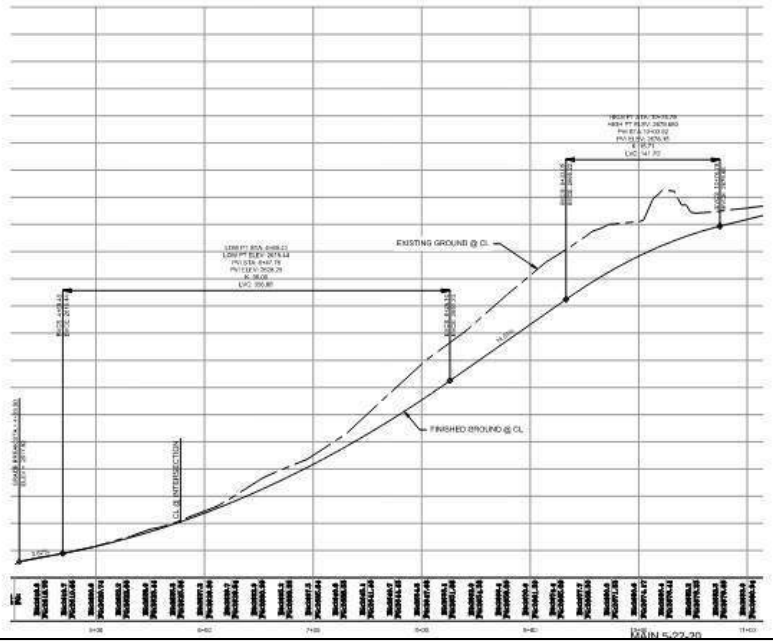
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GRADING PLAN
THE COVE
ST. GEORGE, UTAH

3 of 10



900 SOUTH

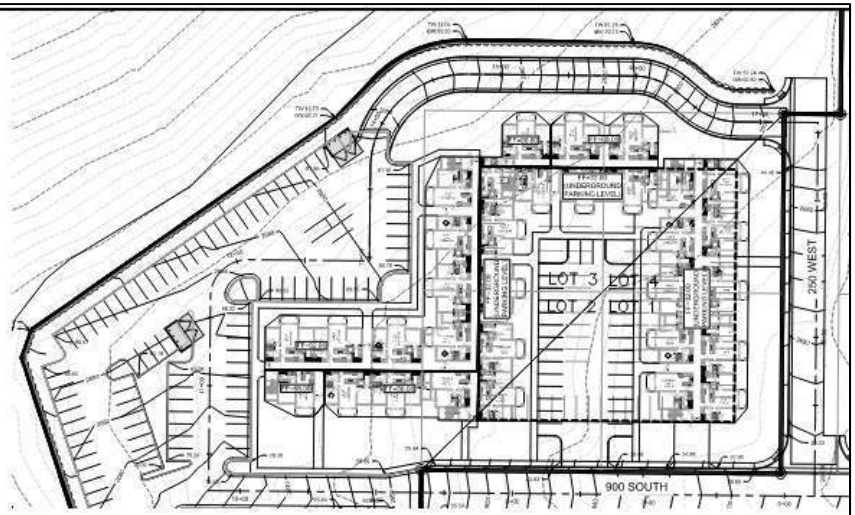


GRAPHIC SCALE

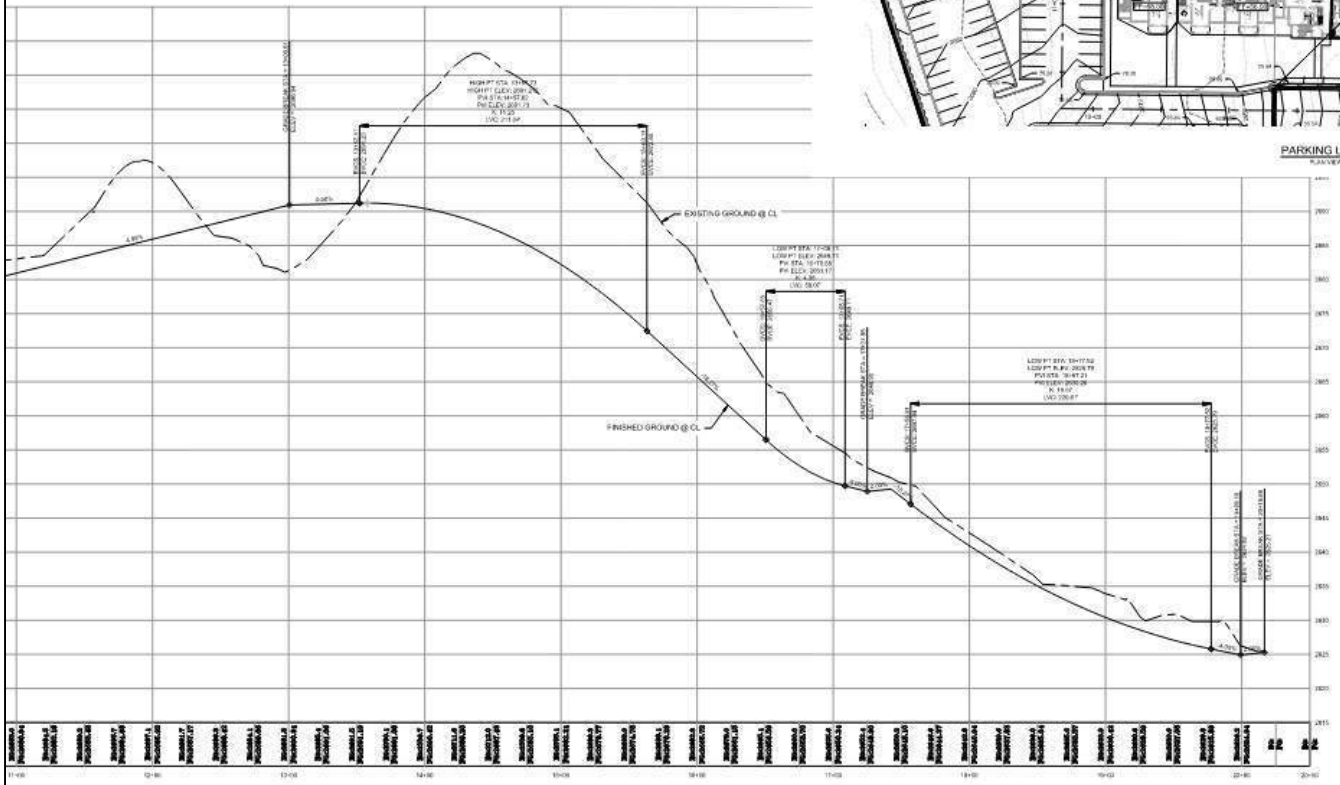
LEGEND

EXISTING GROUND CONTOUR

FINISH GROUND CONTOUR



PARKING LOT & 250 WEST



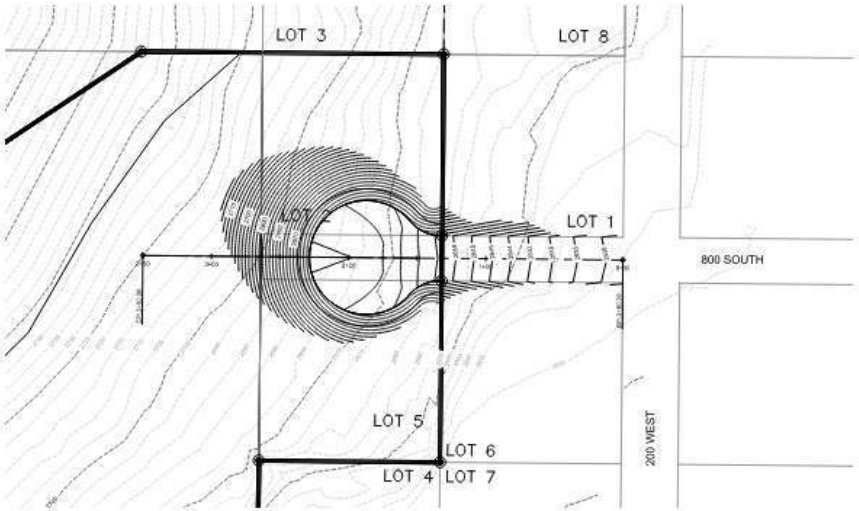
MAIN 5-22-20
H: 1"=50'
V: 1"=10'

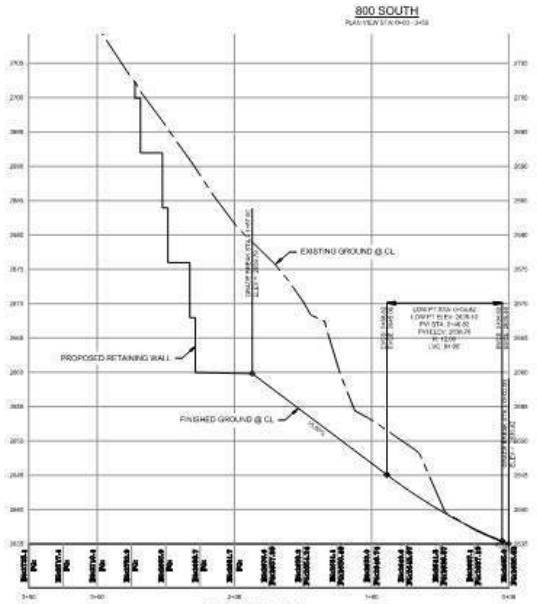
GRAPHIC SCALE

(IN FEET)
1 inch = 40 ft.

LEGEND

EXISTING GROUND CONTOUR
FINISH GROUND CONTOUR





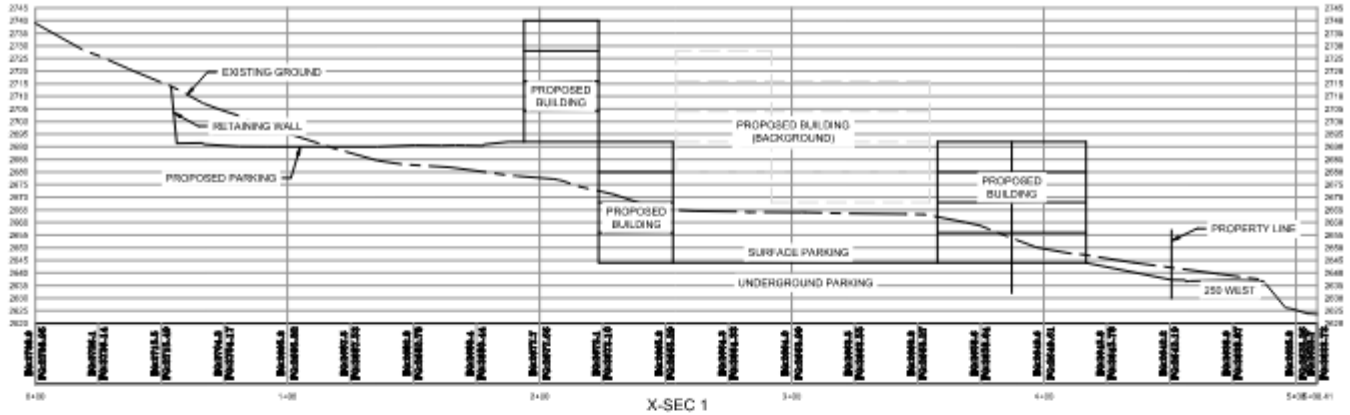
800 SOUTH 7-13-20
H: 1"=50'
V: 1"=10'

GRAPHIC SCALE

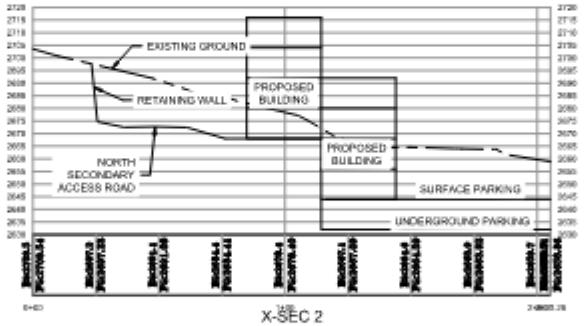
(IN FEET)
1 inch = 40 ft.

LEGEND

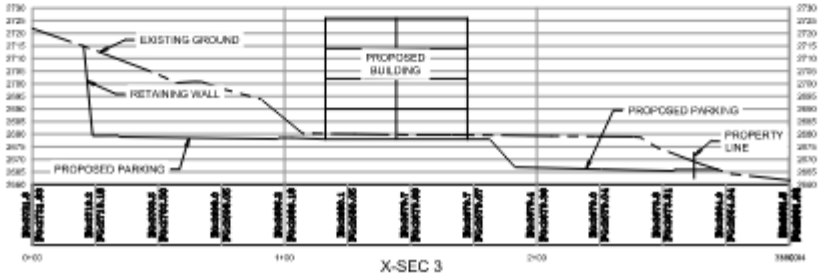
EXISTING GROUND CONTOUR
FINISH GROUND CONTOUR



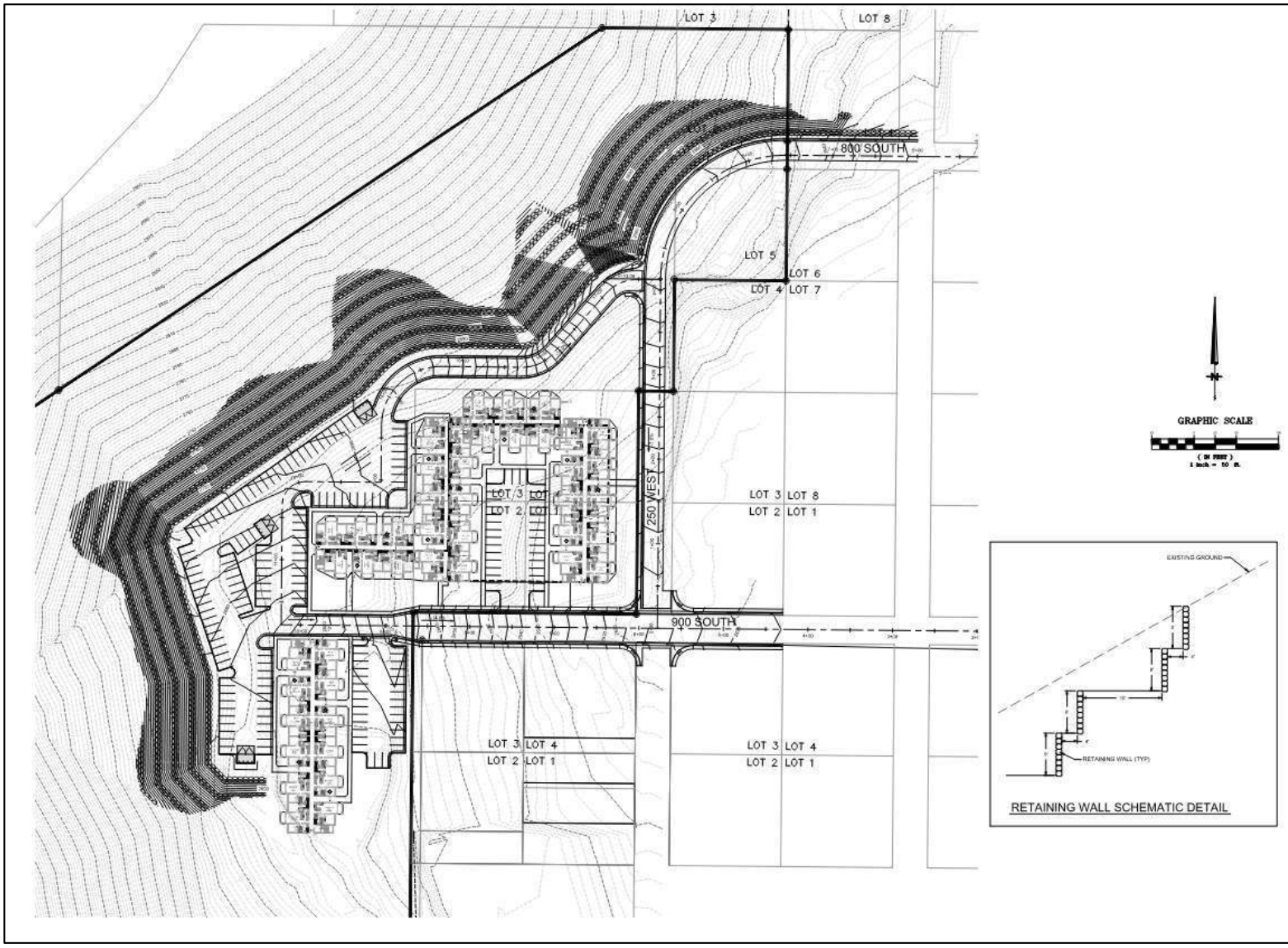
X-SEC 1

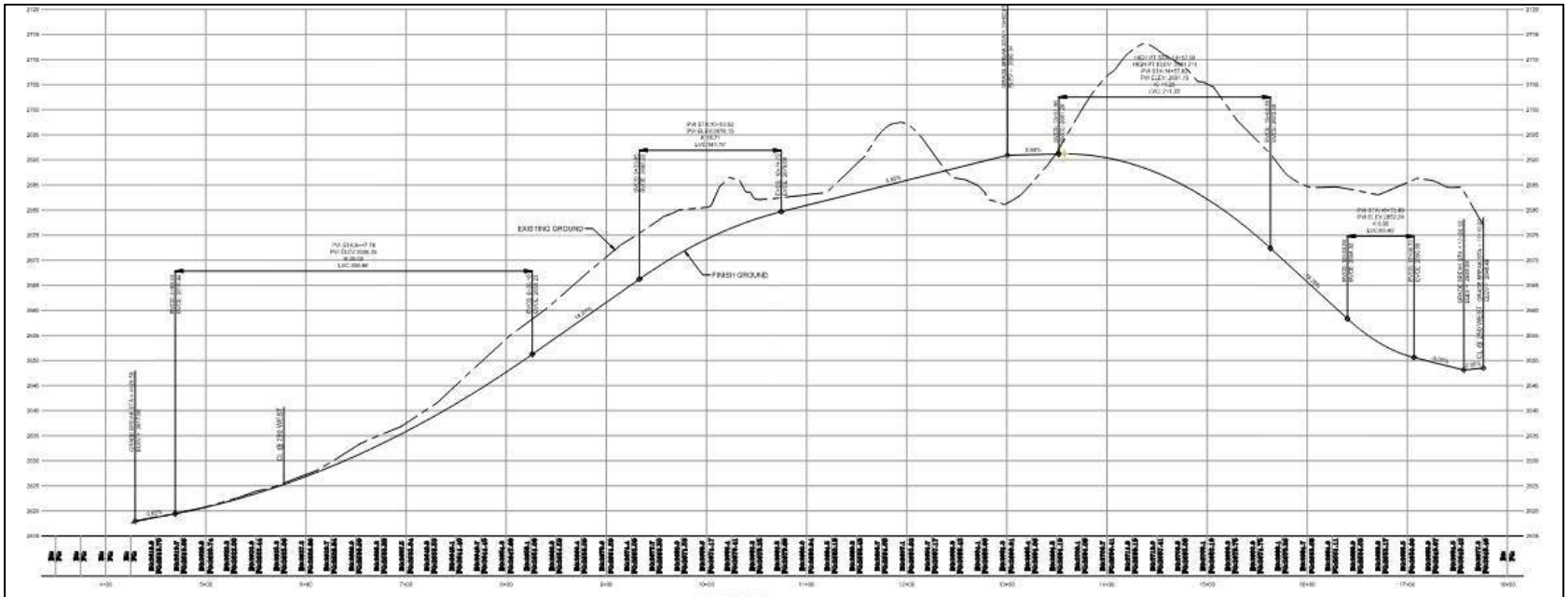


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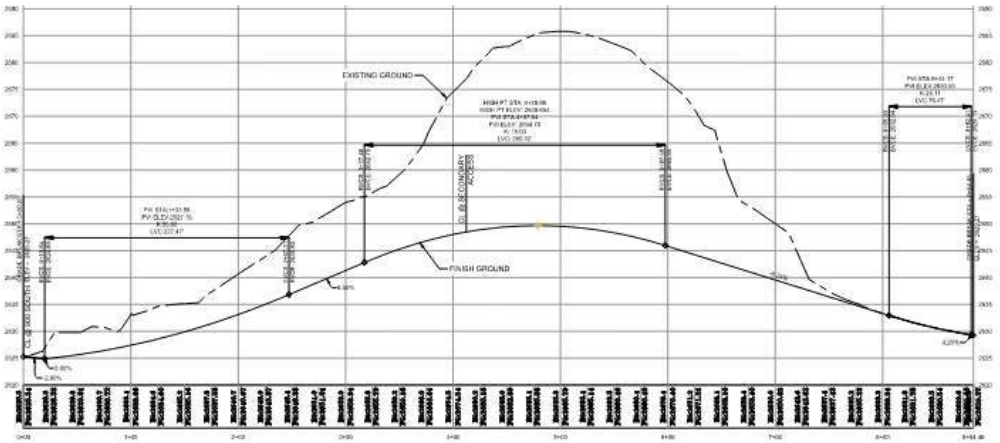


X-SEC 3


LOT 3
LOT 8
800 SOUTH
LOT 5
LOT 6
LOT 4
LOT 7
250 WEST
LOT 3
LOT 2
LOT 1
LOT 3
LOT 8
LOT 2
LOT 1
900 SOUTH
LOT 3
LOT 4
LOT 2
LOT 1
LOT 3
LOT 4
LOT 2
LOT 1
GRAPHIC SCALE
1 inch = 50 ft.
EXISTING GROUND
RETAINING WALL (TYP)
RETAINING WALL SCHEMATIC DETAIL



MAIN 5-22-20
H: 1"=50'
V: 1"=10'
STA: 0+00 TO STA: 20+50



250 WEST
H: 1"=50'
V: 1"=10'
STA: 0+00 TO STA: 8+84

Hillside Submittal Plans

B&G PROJECT NUMBER 191258

THE COVE

HILLSIDE SUBMITTAL

LOCATED IN ST. GEORGE, UTAH

SECTION 36, T 42 S, R 16 W, SLB&M

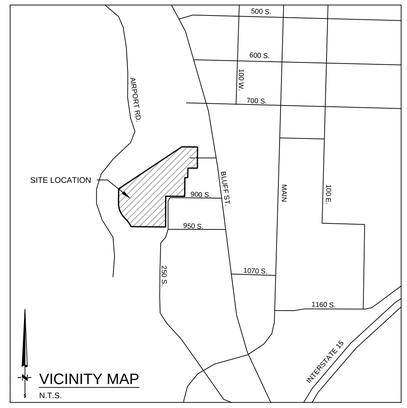
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BLUE STAKES LOCATION CENTER (UTAH)

SHEET NO.	DESCRIPTION
1	COVER SHEET
2	SITE PLAN
3	GRADING & DRAINAGE PLAN
4	SLOPE PLAN
5	PLAN & PROFILE - 900 SOUTH
6	PLAN & PROFILE - PARKING LOT & 250 WEST
7	PLAN & PROFILE - 800 SOUTH
8	CROSS SECTIONS
9	OPTION 2 PLAN VIEW
10	OPTION 2 PROFILES



OWNER / DEVELOPER

COVE TOWERS LLC
1347 HARBOR DR.
MESQUITE, NEVADA 89027

BRENT HOLDAWAY
(435) 467-3744

ENGINEERING CONTACT

BUSH AND GUDGELL, INC.
205 EAST TABERNACLE #4
ST GEORGE, UT 84770

ADAM ALLEN - PROJECT MANAGER
(435)-673-2337

MAY 2020

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Engineers - Planners - Surveyors
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St. George, Utah 84770
Phone (435) 673-2337

PROFESSIONAL ENGINEER
No.5567007
WILLIAM F. MEYER, JR
07/13/2020
STATE OF UTAH

No	Date	By	Revision

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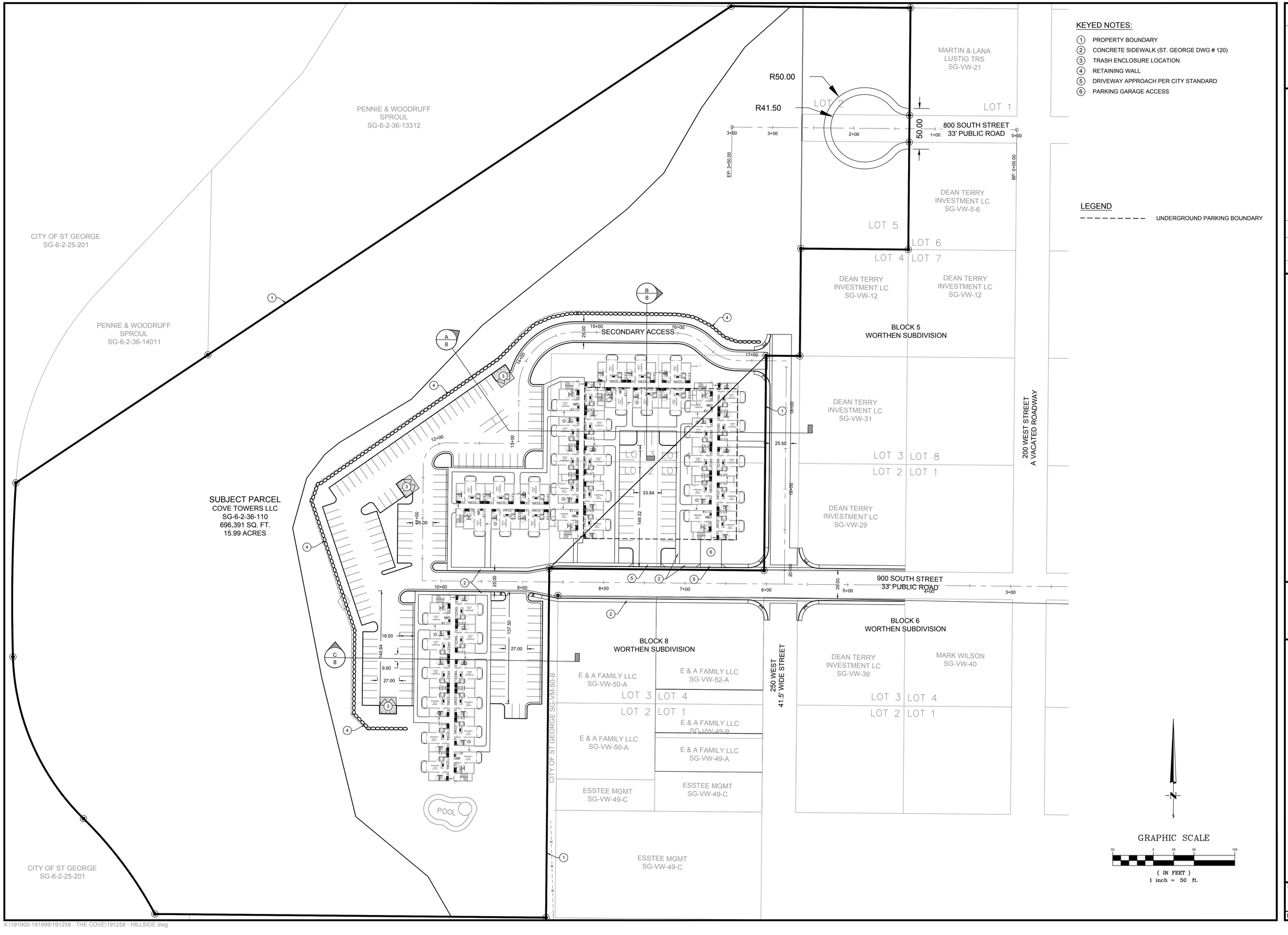
DATE: MAY 2020
DRAWN: CBW
APPROVED: WFM
SCALE: NOTED
JOB NO.: 191258

COVER SHEET
THE COVE, HILLSIDE SUBMITTAL
ST. GEORGE, UTAH

SHEET 1 OF 10 SHEETS

FILE: 191258 - HILLSIDE

X:\191000-191999\191258 - THE COVE\191258 - HILLSIDE.dwg



KEYED NOTES:

1. PROPERTY BOUNDARY
2. CONCRETE SIDEWALK (ST. GEORGE DWG # 120)
3. TRASH ENCLOSURE LOCATION
4. RETAINING WALL
5. DRIVEWAY APPROACH PER CITY STANDARD
6. PARKING GARAGE ACCESS

LEGEND

UNDERGROUND PARKING BOUNDARY

PROFESSIONAL ENGINEER
No.5567007
WILLIAM F. MEYER, UT
07/13/2020
STATE OF UTAH

No	Date	By	Revision

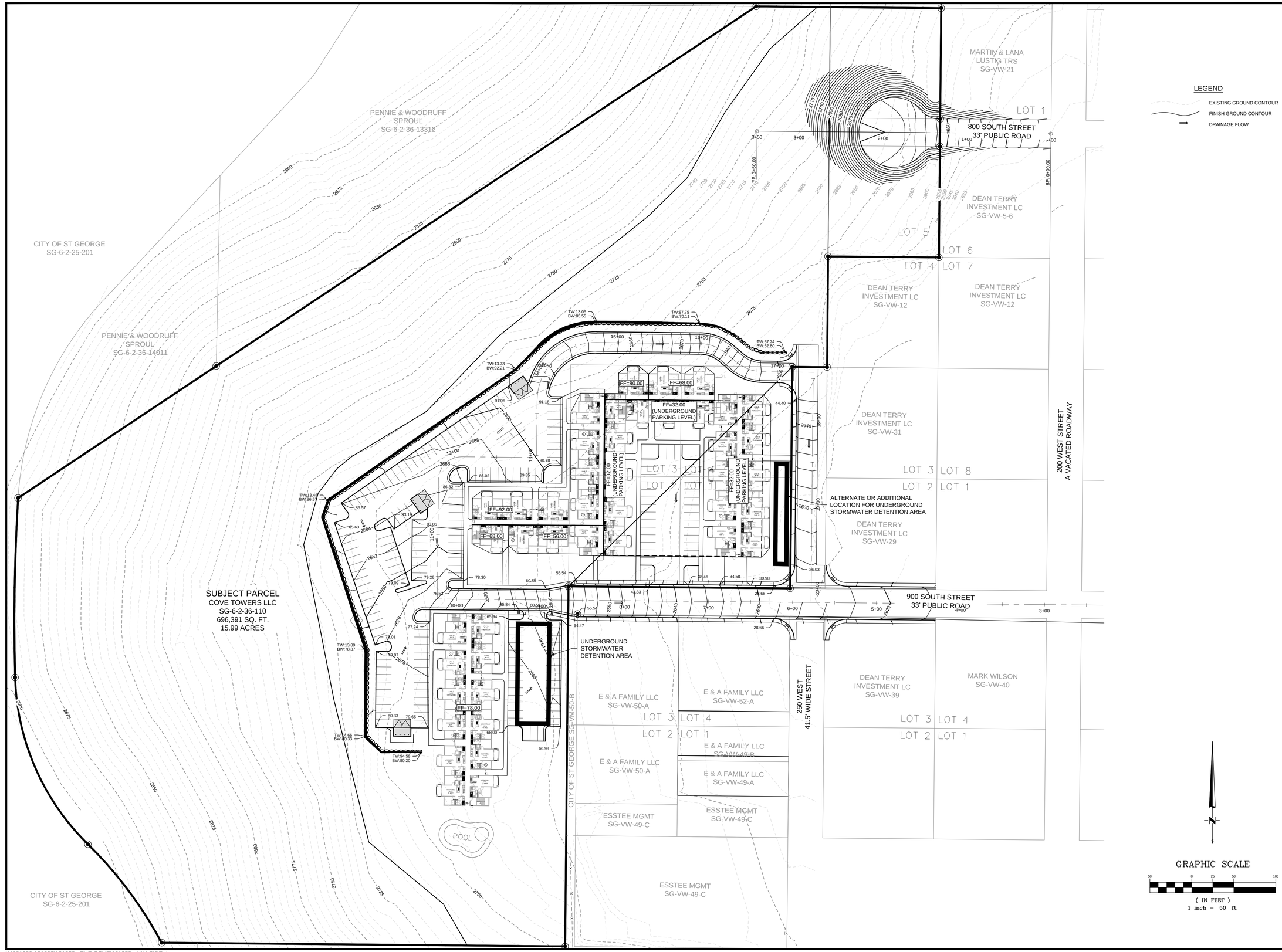
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DATE: MAY 2020
DRAWN: CBW
APPROVED: WFM
SCALE: 1" = 50'
JOB NO.: 191258

SITE PLAN
THE COVE
ST. GEORGE, UTAH

SHEET 2 OF 10 SHEETS
FILE: 191258 - FG OPT 3

X:\191000-191999\191258 - THE COVE\191258 - HILLSIDE.dwg



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PROFESSIONAL ENGINEER
No.5567007
WILLIAM F. MEYER, OR
07/13/2020
STATE OF UTAH

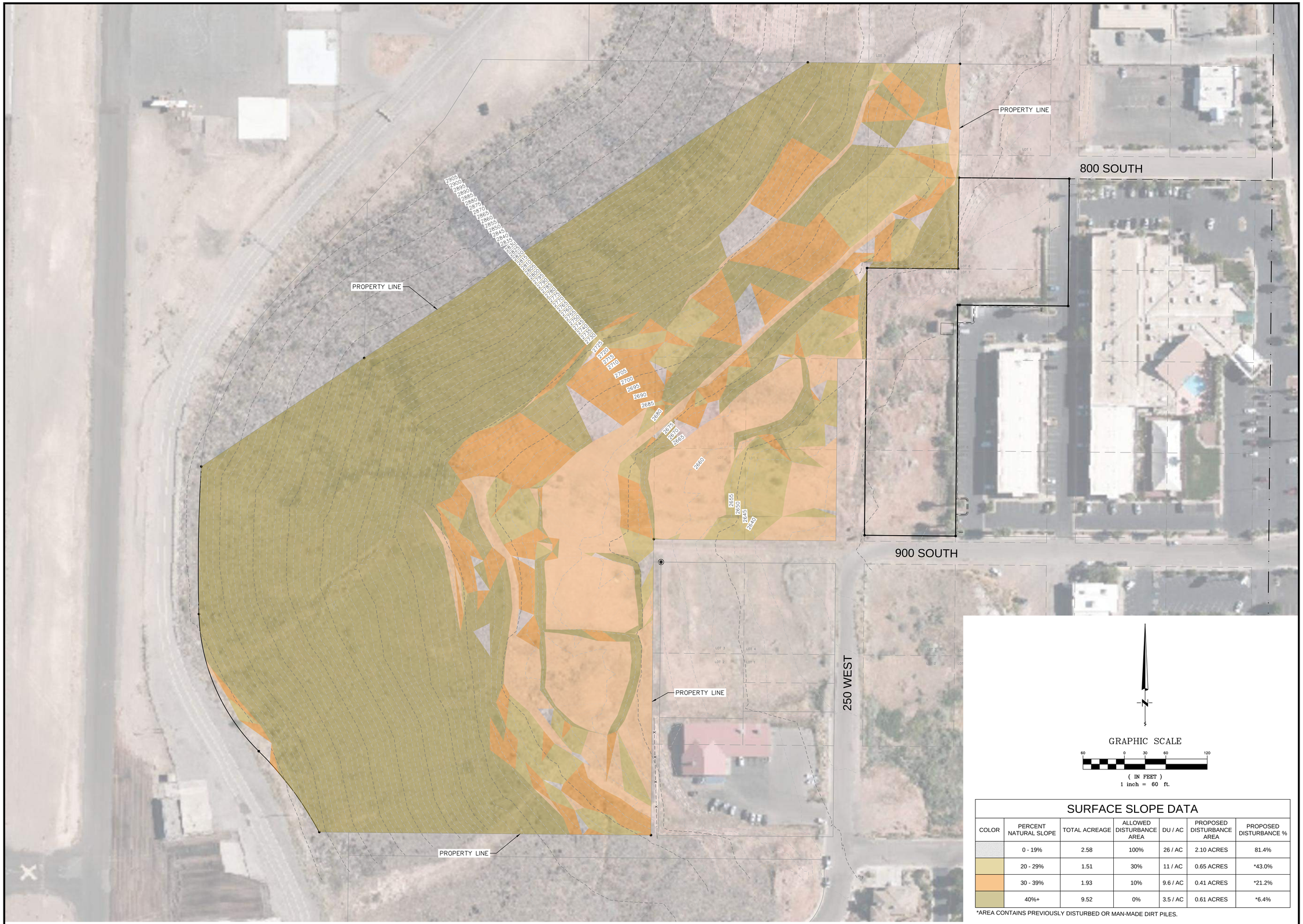
No	Date	By	Revision

DATE: MAY 2020
DRAWN: CBW
APPROVED: WFM
SCALE: 1" = 50'
JOB NO.: 191258

GRADING PLAN
THE COVE
ST. GEORGE, UTAH

SHEET 3 OF 10 SHEETS
FILE: 191258 - FG OPT 3

X:\191000-191999\191258 - THE COVE\191258 - HILLSIDE.dwg



GRAPHIC SCALE

60 0 30 60 120

(IN FEET)
1 inch = 60 ft.

SURFACE SLOPE DATA

COLOR	PERCENT NATURAL SLOPE	TOTAL ACREAGE	ALLOWED DISTURBANCE AREA	DU / AC	PROPOSED DISTURBANCE AREA	PROPOSED DISTURBANCE %
	0 - 19%	2.58	100%	26 / AC	2.10 ACRES	81.4%
	20 - 29%	1.51	30%	11 / AC	0.65 ACRES	*43.0%
	30 - 39%	1.93	10%	9.6 / AC	0.41 ACRES	*21.2%
	40%+	9.52	0%	3.5 / AC	0.61 ACRES	*6.4%

*AREA CONTAINS PREVIOUSLY DISTURBED OR MAN-MADE DIRT PILES.

X:\191000-191999\191258 - THE COVE\191258 - SLOPE.DWG

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WILLIAM F. MEYER, GR
STATE OF UTAH
07/13/2020

No.	Date	By	Revision

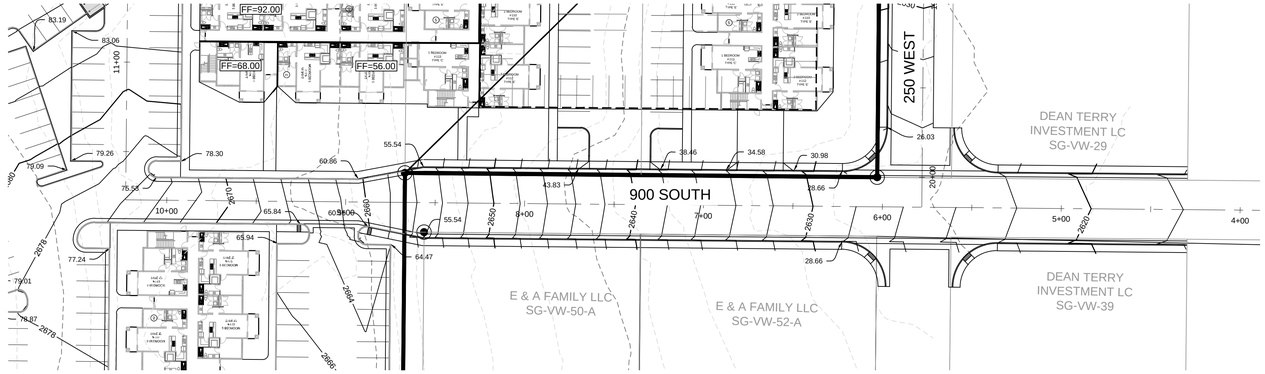
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DATE: MAY 2020
DRAWN: RM
APPROVED:
SCALE: NOTED
JOB NO. 191258

SLOPE ANALYSIS
THE COVE
ST GEORGE, UTAH

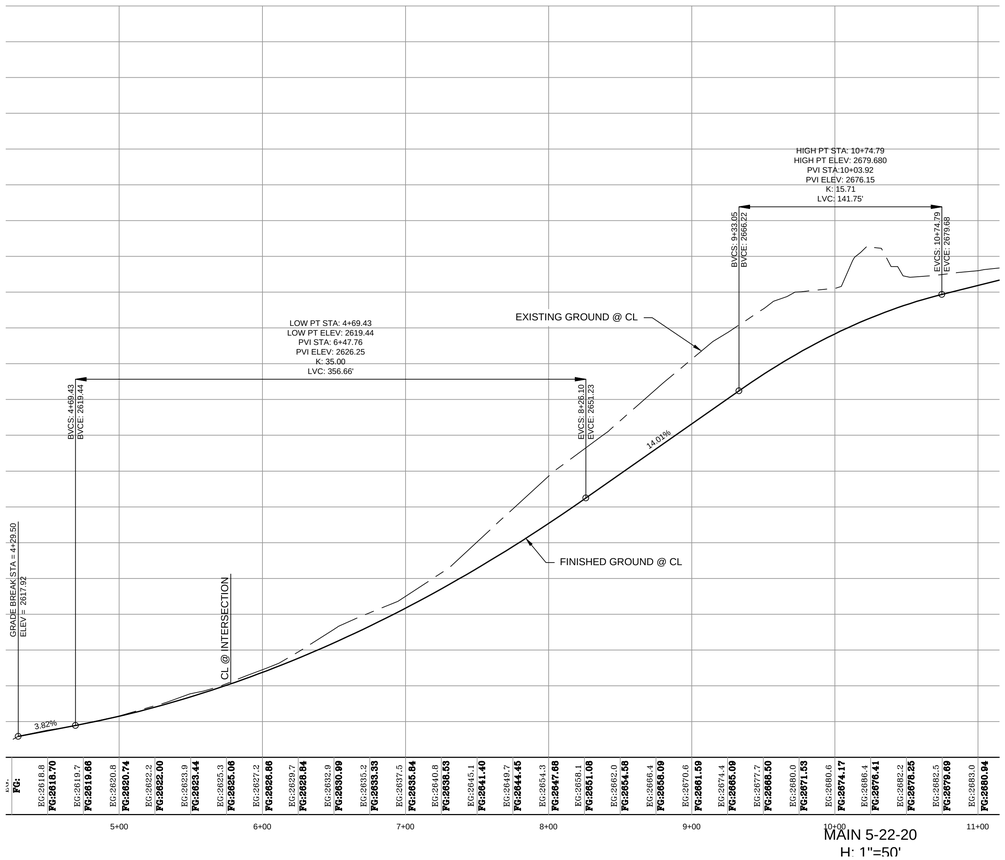
SHEET 4 OF 10 SHEETS

FILE: 191258 SLOPE

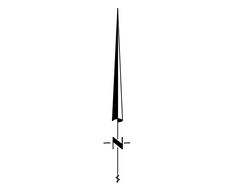


900 SOUTH

PLAN VIEW STA: 4+30 - 11+00



MAIN 5-22-20
H: 1"=50'



LEGEND

2600 EXISTING GROUND CONTOUR

2600 FINISH GROUND CONTOUR

PROFESSIONAL ENGINEER
No.5567007
WILLIAM F. MEYER, UT
STATE OF UTAH
07/13/2020

No	Date	By	Revision

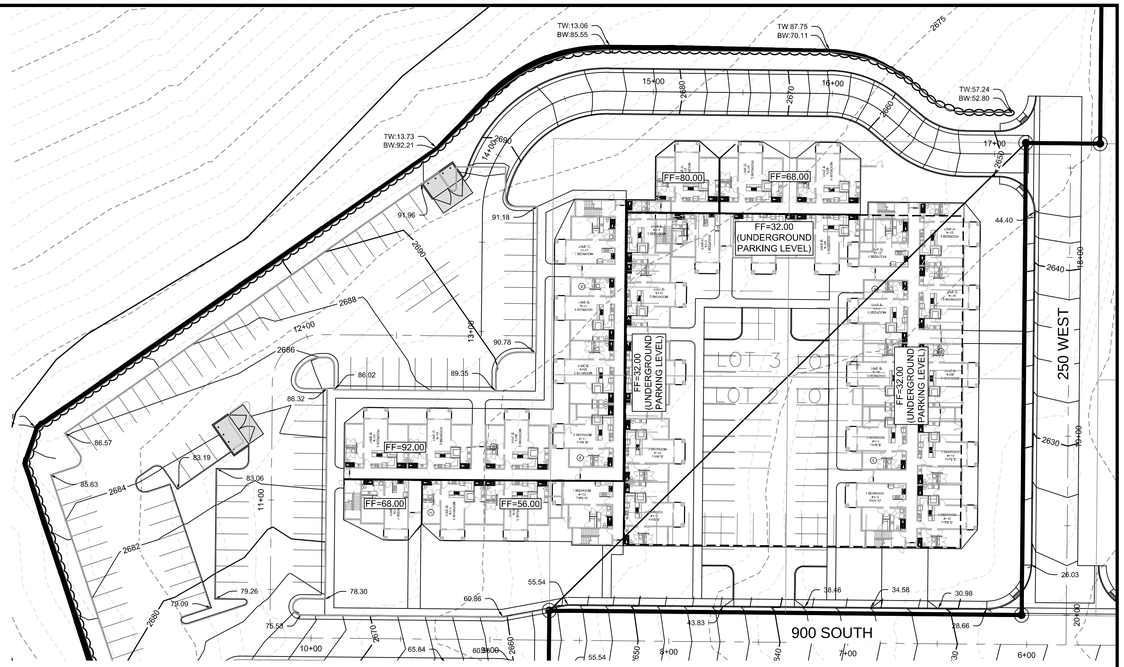
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St. George, Utah 84770
Phone (435) 673-2337 / Fax (435) 673-3161
www.bushandgudgell.com

DATE: MAY 2020
DRAWN: CBW
APPROVED: WFM
SCALE: 1" = 40'
JOB NO.: 191258

900 SOUTH PLAN & PROFILE
THE COVE
ST. GEORGE, UTAH

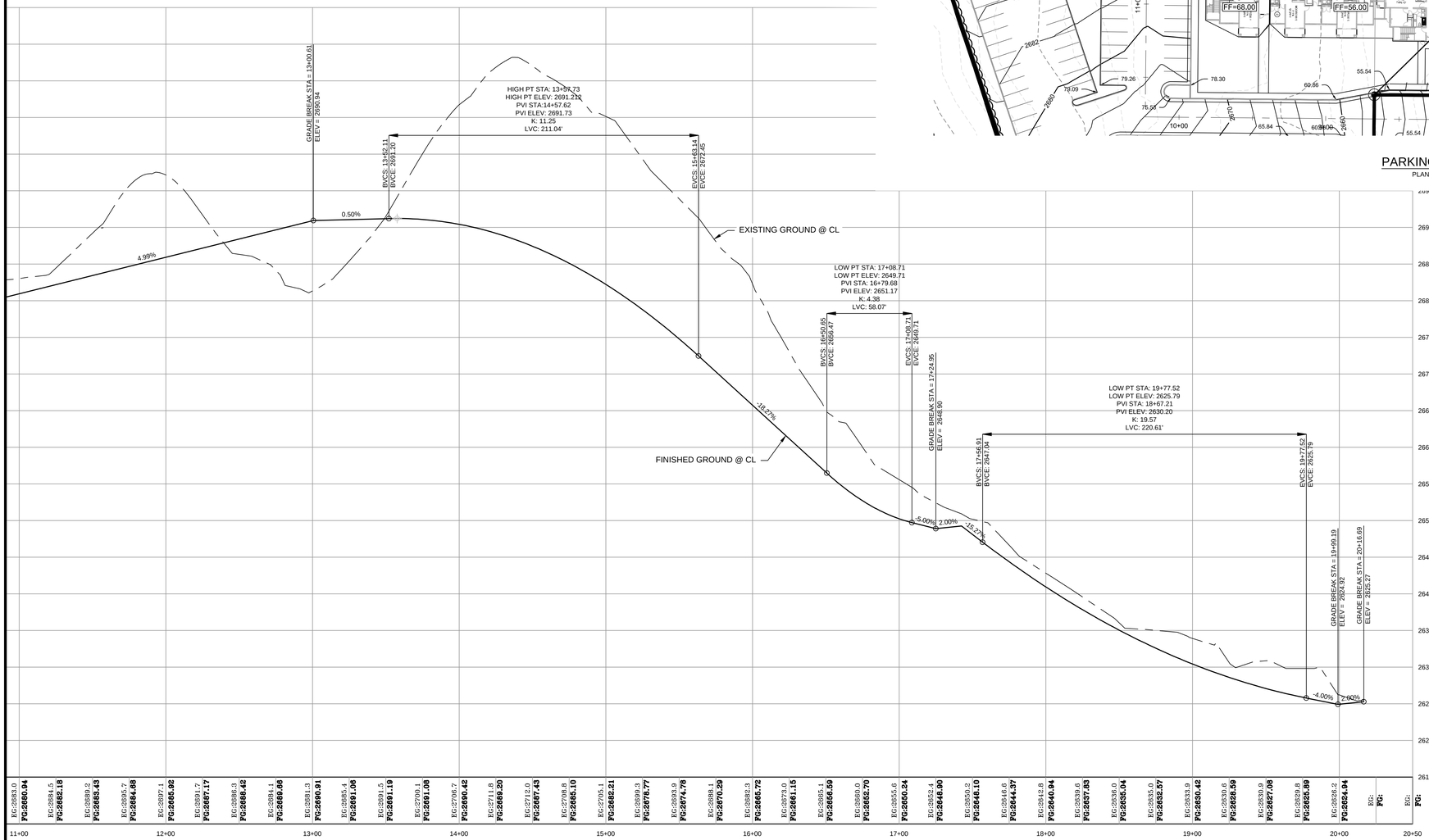
SHEET 5 OF 10 SHEETS

FILE: 191258 - FG OPT 3

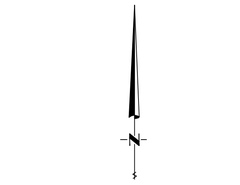


PARKING LOT & 250 WEST

PLAN VIEW STA: 11+00 - 20+20



MAIN 5-22-20
H: 1"=50'
V: 1"=10'



GRAPHIC SCALE

40 0 20 40 80

(IN FEET)
1 inch = 40 ft.

LEGEND

2690 EXISTING GROUND CONTOUR

2690 FINISH GROUND CONTOUR

PROFESSIONAL ENGINEER
No.5567007
WILLIAM F. MEYER, UT
07/13/2020
STATE OF UTAH

No	Date	By	Revision

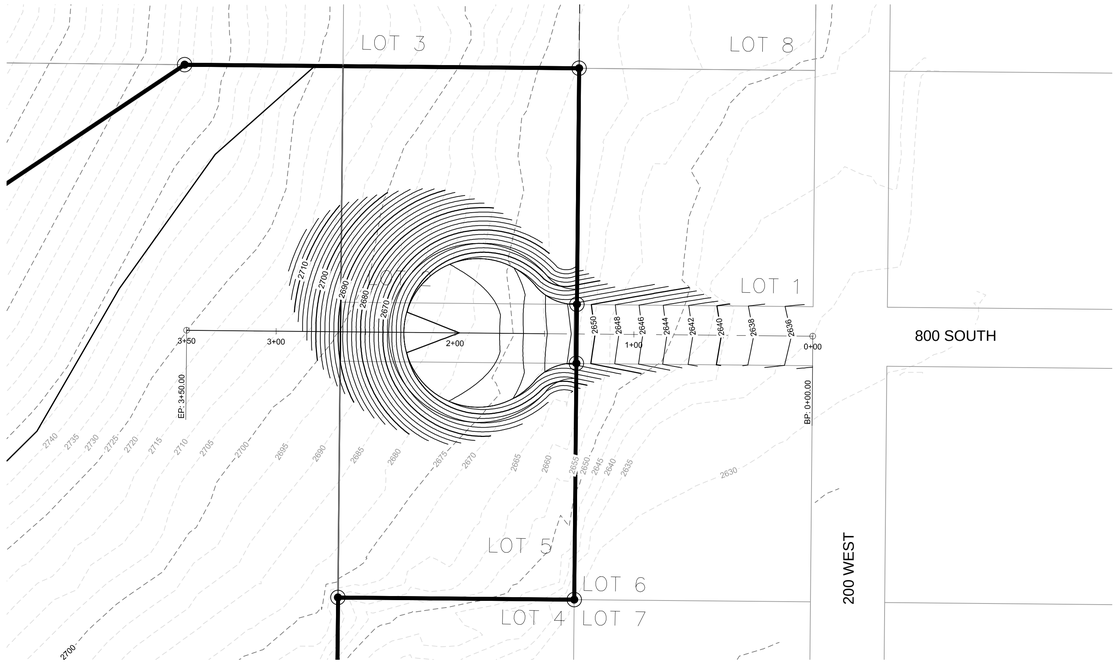
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Phone (435) 673-2337 / Fax (435) 673-3161
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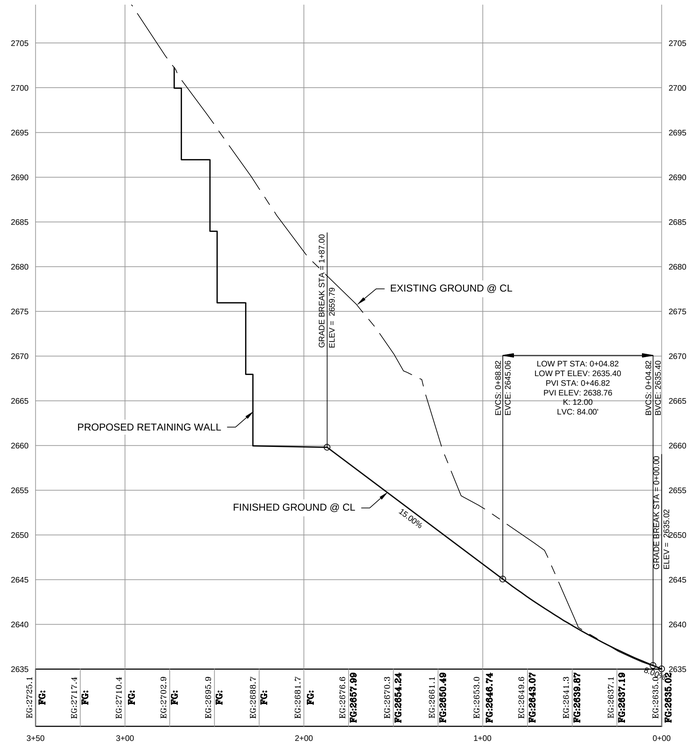
PARKING PLAN & PROFILE
THE COVE
ST. GEORGE, UTAH

SHEET 6 OF 10 SHEETS

FILE: 191258 - FG OPT 3



800 SOUTH
PLAN VIEW STA: 0+00 - 3+50



800 SOUTH 7-13-20
H: 1"=50'
V: 1"=10'



GRAPHIC SCALE

40 0 20 40 80

(IN FEET)
1 inch = 40 ft.

LEGEND

2600 EXISTING GROUND CONTOUR

2600 FINISH GROUND CONTOUR

PROFESSIONAL ENGINEER
No.5567007
WILLIAM F. MEYER, JR
07/13/2020
STATE OF UTAH

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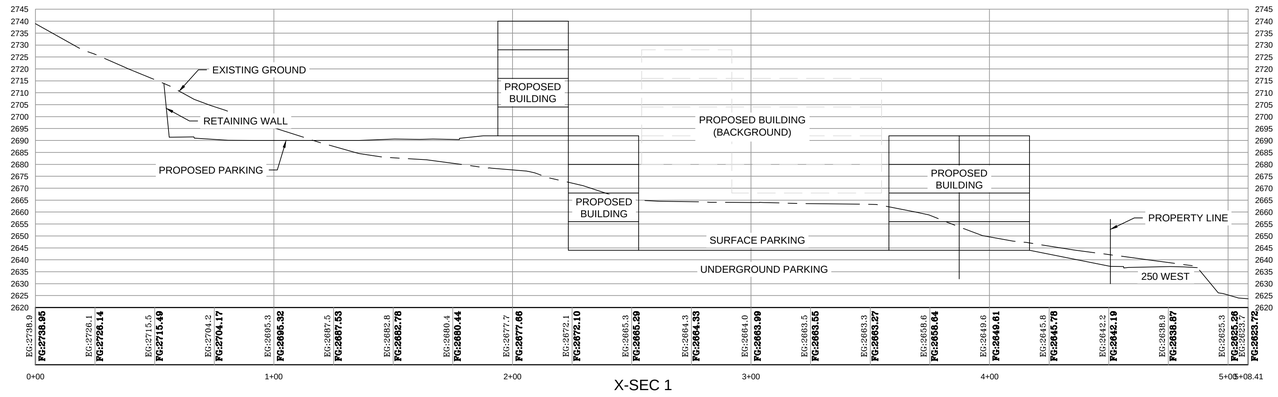
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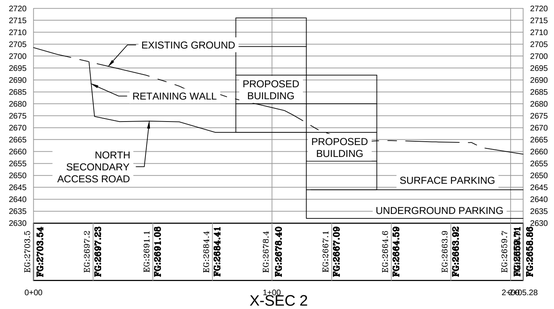
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THE COVE
ST. GEORGE, UTAH

SHEET 7 OF 10 SHEETS

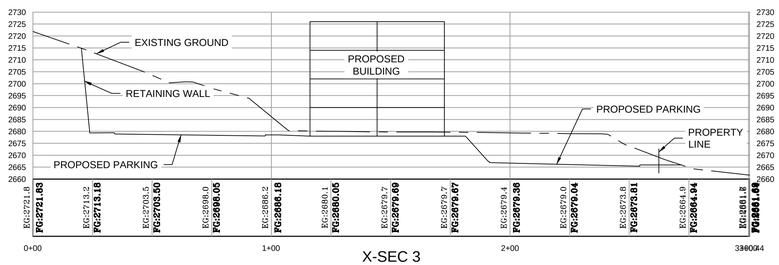
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X-SEC 1



X-SEC 2



X-SEC 3

PROFESSIONAL ENGINEER
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WILLIAM F. MEYER, JR
07/13/2020
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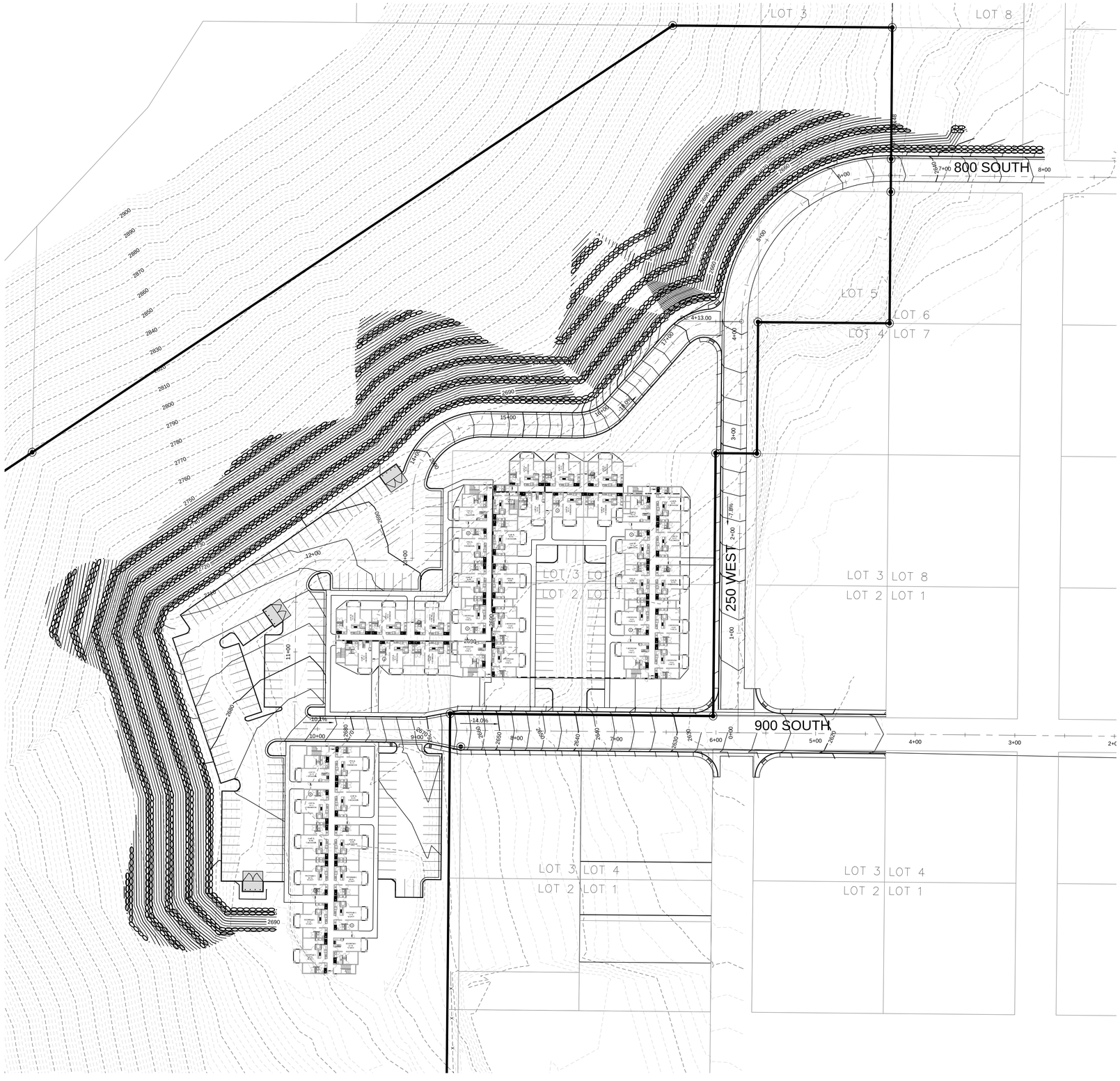
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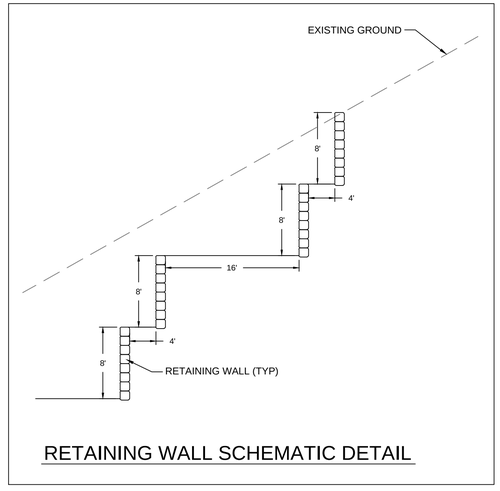
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CROSS SECTIONS
THE COVE
ST. GEORGE, UTAH

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RETAINING WALL SCHEMATIC DETAIL

X:\191000-191999\191258 - THE COVE\191258 - FG2.DWG

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No.5567007
WILLIAM F. MEYER, GR
STATE OF UTAH
07/13/2020

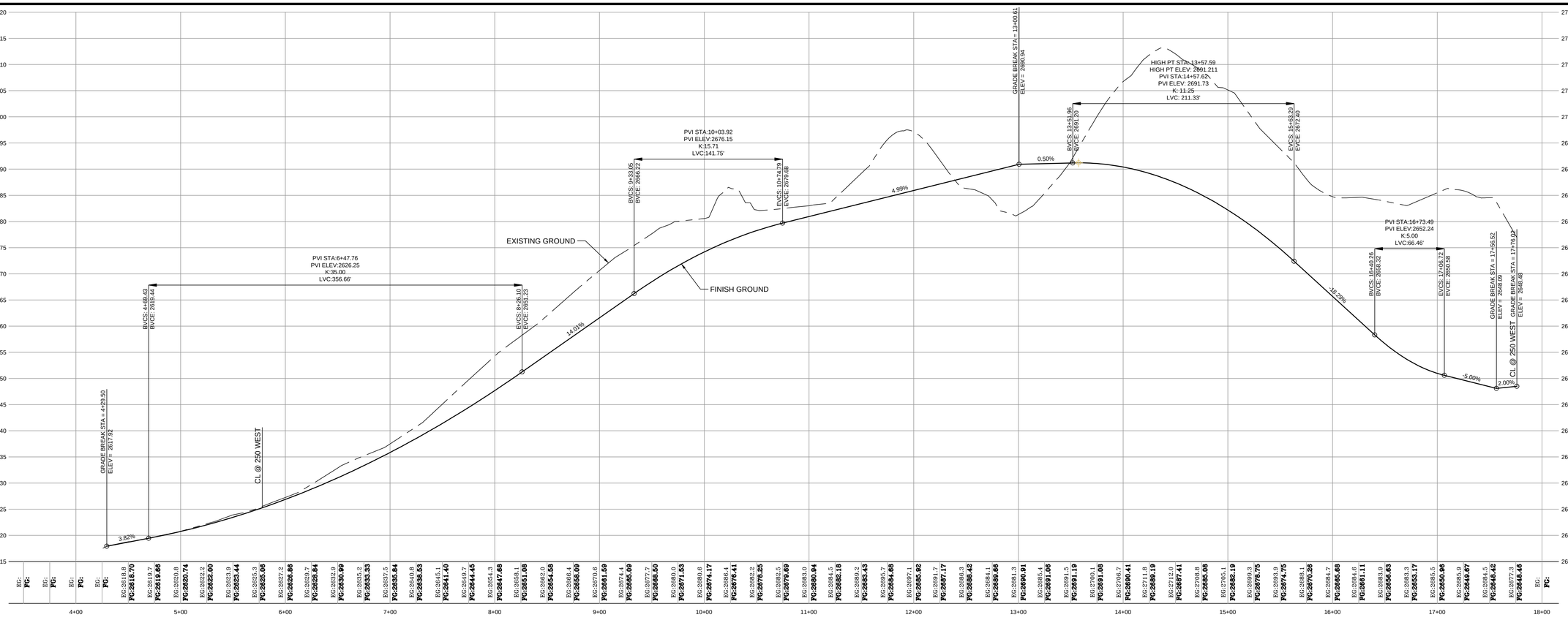
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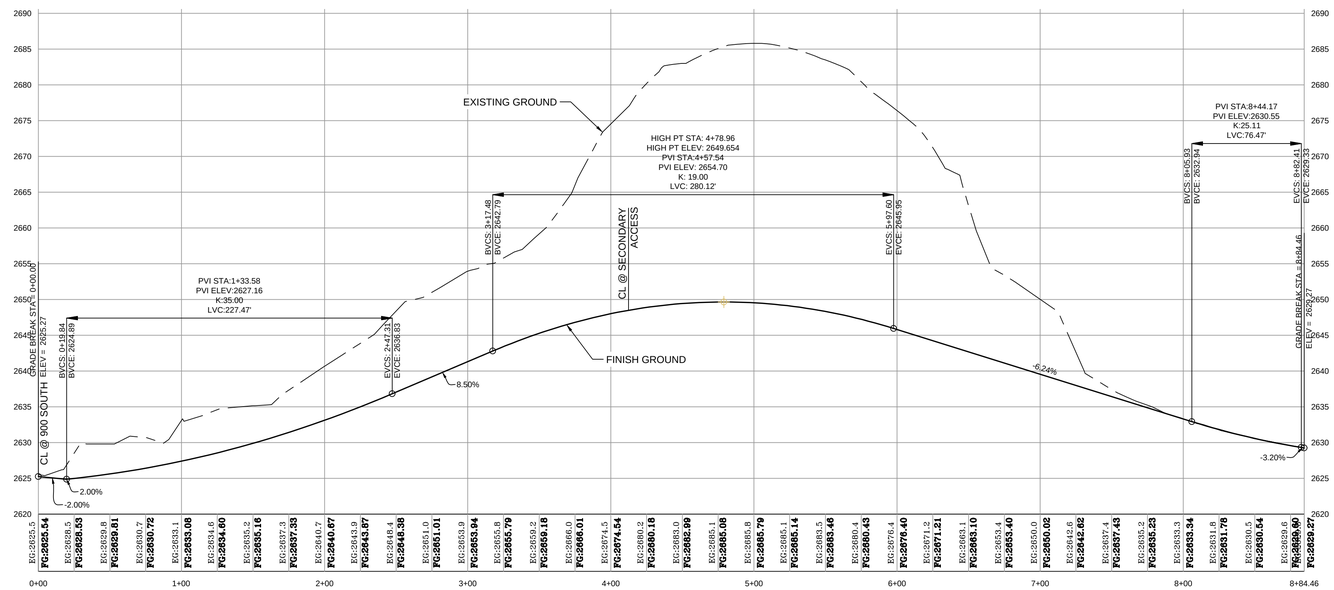
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JOB NO.

OPTION 2 PLAN VIEW
THE COVE
ST GEORGE

SHEET 9 OF 10 SHEETS
FILE:



MAIN 5-22-20
H: 1"=50'
V: 1"=10'
STA: 0+00 TO STA: 20+50



250 WEST
H: 1"=50'
V: 1"=10'
STA: 0+00 TO STA: 20+50

X:\191000-191999\191258 - THE COVE\191258 - FG2.DWG

PROFESSIONAL ENGINEER
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07/13/2020
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OPTION 2 PROFILES
THE COVE
ST GEORGE, UTAH

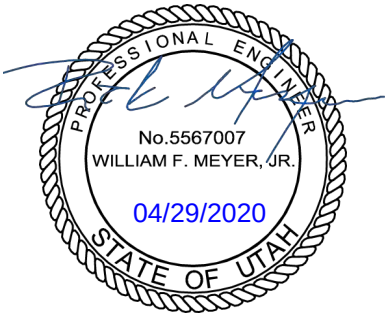
SHEET 10 OF 10 SHEETS
FILE:

Drainage Report

PRELIMINARY DRAINAGE STUDY
FOR

THE COVE

A Residential Subdivision located in St. George, Utah



PREPARED BY:

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Project Engineer	Rick Meyer, P.E.
Date	April 29, 2020
Job Number	B&G #191258

Introduction

The Cove is a proposed 16-acre multi-family residential project. The project is located in St George at the end of 900 South, just west of Bluff Street. It is pushed against the hillside below the old airport. It is located in the northeast quarter of section 36, township 42 south, range 16 west SLB&M. Approximate latitude and longitude coordinates are 37°05'33" N and 113°35'24" W (from Google Earth). The project will include multiple apartment buildings and parking lots.

The site generally slopes from west to east. The site is located within the hillside overlay zone. About 8 acres of the site is not developable due to slopes being greater than 40%. The land is currently undeveloped except for some grading that was done several years ago.

Drainage calculations were performed for this site. Pre-development and post-development runoff was calculated and the required detention volume was estimated. The purpose of this study is to discuss how these calculations were performed and discuss the data that backs them up.

Site Runoff

Autodesk Storm and Sanitary Analysis is the software that was used for calculating stormwater runoff for the site. The software takes area, curve number, time of concentration, and rainfall information and uses the TR-55 method to estimate runoff. Pre-development and post-development models were generated for these calculations. The table below shows the calculated runoff for each model. Also, see hydrographs in appendix.

Site Runoff	
Pre-Development	12.43 cfs
Post-Development	14.25 cfs

Area

The area used in calculating stormwater runoff for the site was the same in both pre-development and post-development models. It is the area of offsite runoff and the on-site area that will be developed. All developed area will be collected by the storm drain system. The area used for these models is 15.5 acres. The two models were broken up into smaller subbasins. The areas for each of these subbasins is shown in the table below.

Subbasin Area, acres		
Model	Subbasin	Area
Pre-Development	BAS-EX_A	12.33
	BAS-EX_B	3.20
Post-Development	BAS-A	2.18
	BAS-B	0.45
	BAS-C	1.34
	BAS-D	4.56
	BAS-E	0.63
	BAS-F	1.49
	BAS-G	1.80
	BAS-H	3.06

Curve Number

Curve number is a variable that relates soil conditions to stormwater runoff. The curve number is a function of land use and hydrologic soil group. A web soil survey was done on USDA.com (see

appendix). This survey helps to determine hydrologic soil group. The table below shows the curve numbers that were used for the two models.

Curve Numbers			
Model	Curve Number	Land Use	Hydrologic Soil Group
Pre-Development	85	Natural Western Desert	C
	63	Natural Western Desert	A
Post-Development	85	Natural Western Desert	C
	98	Paved Areas	A

Time of Concentration

The time of concentration (Tc) is defined as the time required for runoff to travel from the hydraulically most distant point of the sub-basin to where the runoff leaves the sub-basin (concentration point or spill point). Runoff moves through the sub-basin as sheet flow, shallow concentrated flow, open channel flow, or some combination of these. The type of runoff that occurs is a function of the sub-basin conveyance system and is best determined by field inspection. The time of concentration is determined by summing together all of the individual runoff travel times within the sub-basin. The table below shows the time of concentration used for each subbasin.

Time of Concentration, min		
Model	Subbasin	Tc
Pre-Development	BAS-EX_A	7.69
	BAS-EX_B	20.51
Post-Development	BAS-A	7.81
	BAS-B	7.54
	BAS-C	7.34
	BAS-D	8.71
	BAS-E	7.64
	BAS-F	7.34
	BAS-G	7.52
	BAS-H	47.96

Rainfall

The 100-year 3-hour storm (Farmer Fletcher distribution) storm was used to analyze the site. Information for this storm event was taken from the *City of St George Drainage Manual*. Total rainfall for this storm is 1.64 inches.

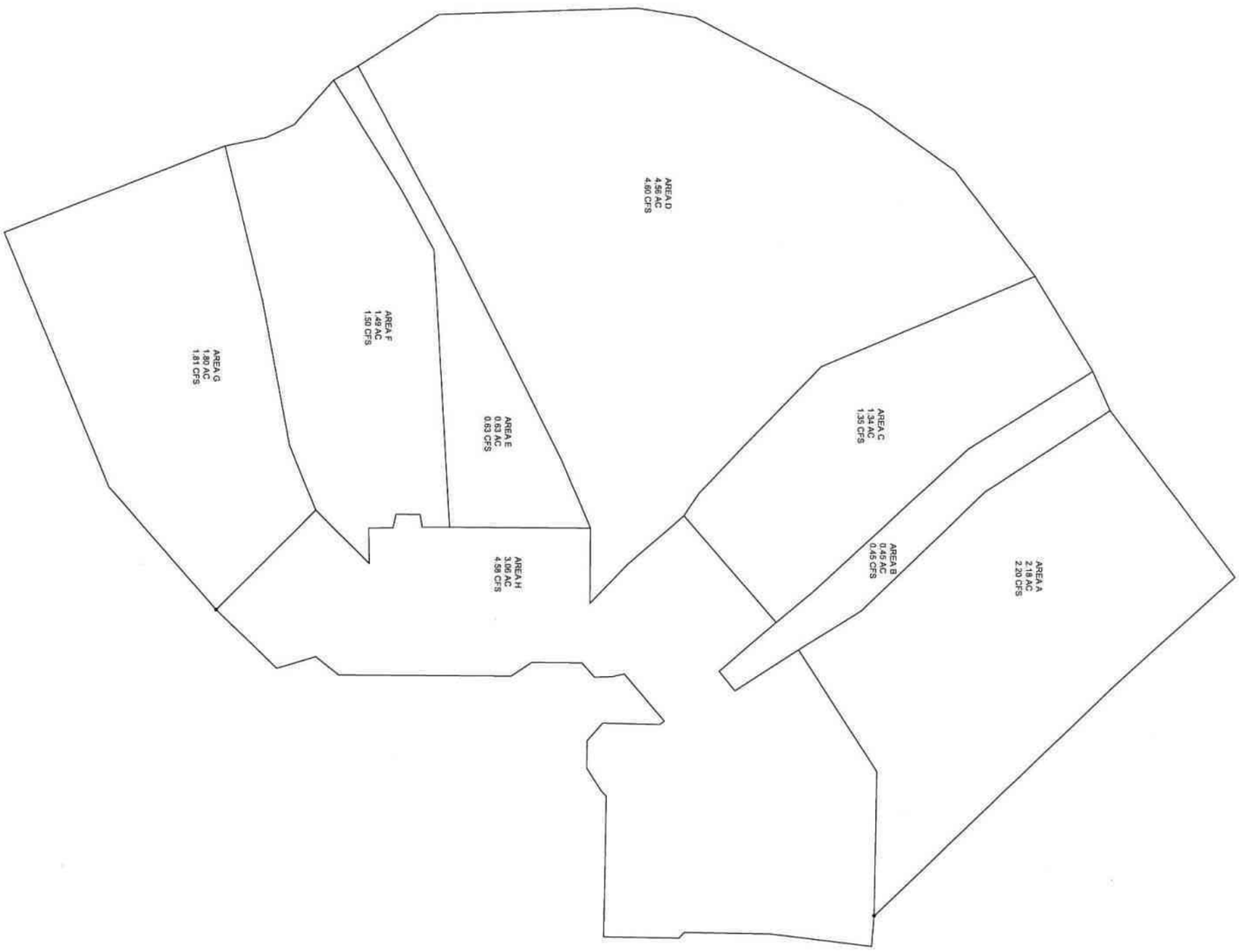
Detention

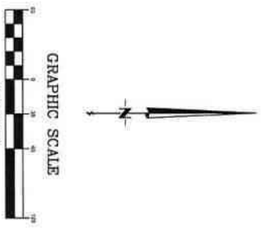
As the site develops, stormwater runoff will increase. A detention system will be used to reduce the peak runoff to pre-development levels. The allowable discharge for the post-development model is the peak runoff for the pre-development model. The allowable discharge was input into the post-development model and Storm and Sanitary Analysis returned the required detention volume (see appendix). This volume is 3733 cubic feet. This detention volume will take place in an underground system.

Conclusion

This preliminary drainage study for The Cove has addressed calculations for site runoff and stormwater detention storage. This study has shown that drainage requirements for the site are feasible. The final drainage study will provide more details for the stormwater system (inlet capture rates, pipe sizing, orifice size, detention system details, drainage swales, etc).

Appendix





DRAINAGE FIGURE

THE COVE
ST GEORGE, UTAH

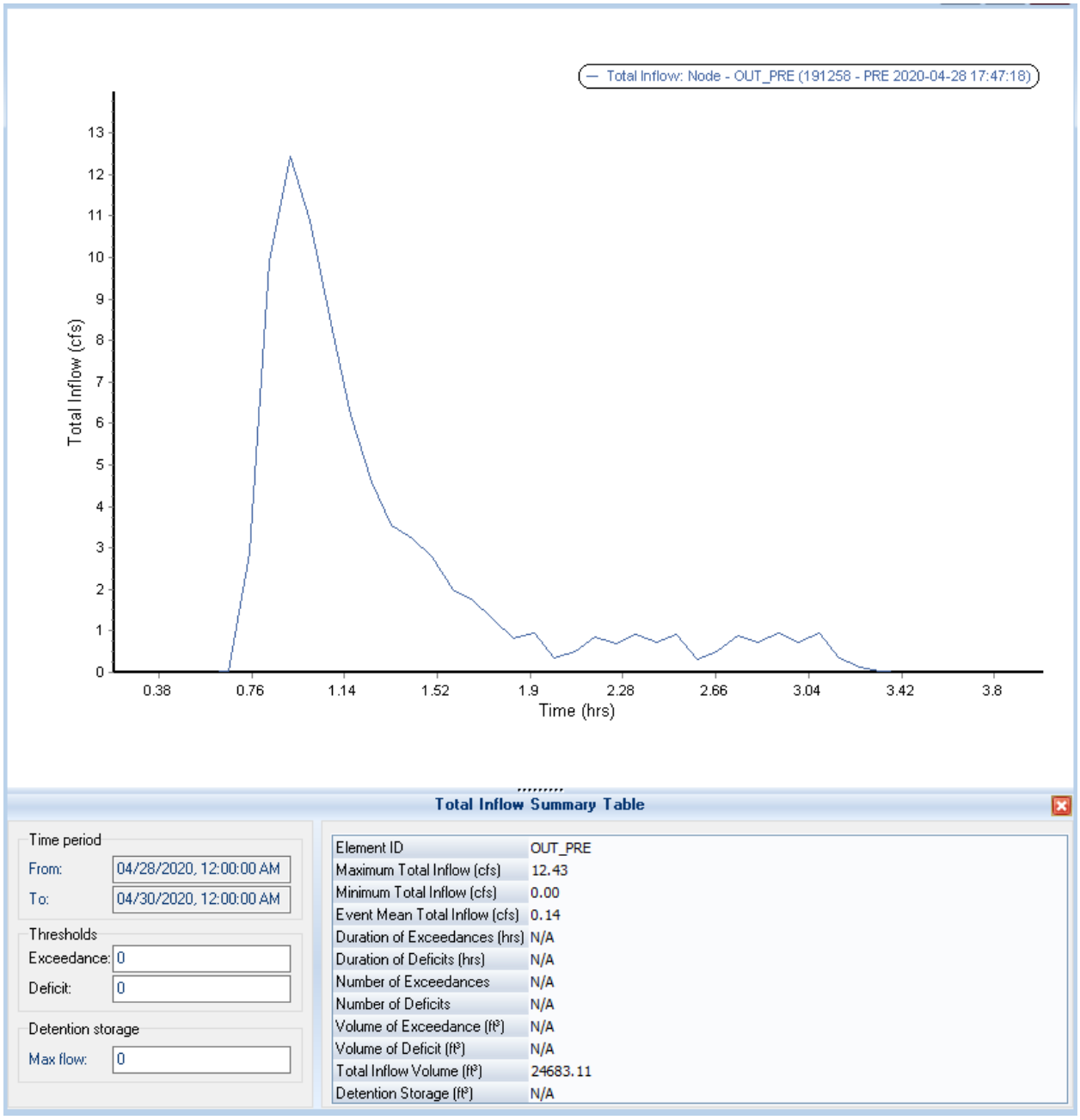
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Pre-Development Runoff Hydrograph



Total Inflow Summary Table

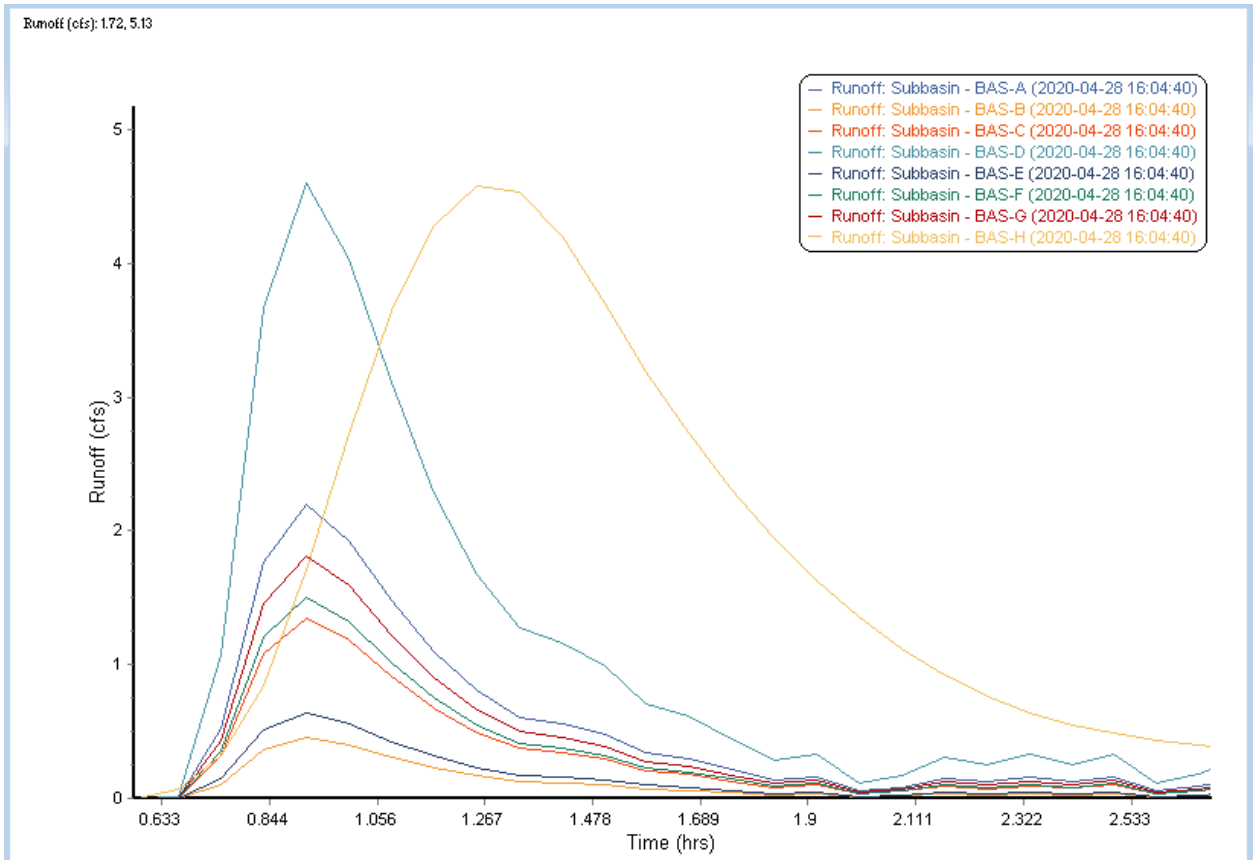
Time period
From: 04/28/2020, 12:00:00 AM
To: 04/30/2020, 12:00:00 AM

Thresholds
Exceedance: 0
Deficit: 0

Detention storage
Max flow: 0

Element ID	OUT_PRE
Maximum Total Inflow (cfs)	12.43
Minimum Total Inflow (cfs)	0.00
Event Mean Total Inflow (cfs)	0.14
Duration of Exceedances (hrs)	N/A
Duration of Deficits (hrs)	N/A
Number of Exceedances	N/A
Number of Deficits	N/A
Volume of Exceedance (ft³)	N/A
Volume of Deficit (ft³)	N/A
Total Inflow Volume (ft³)	24683.11
Detention Storage (ft³)	N/A

Post-Development Runoff Hydrographs



Runoff Summary Table

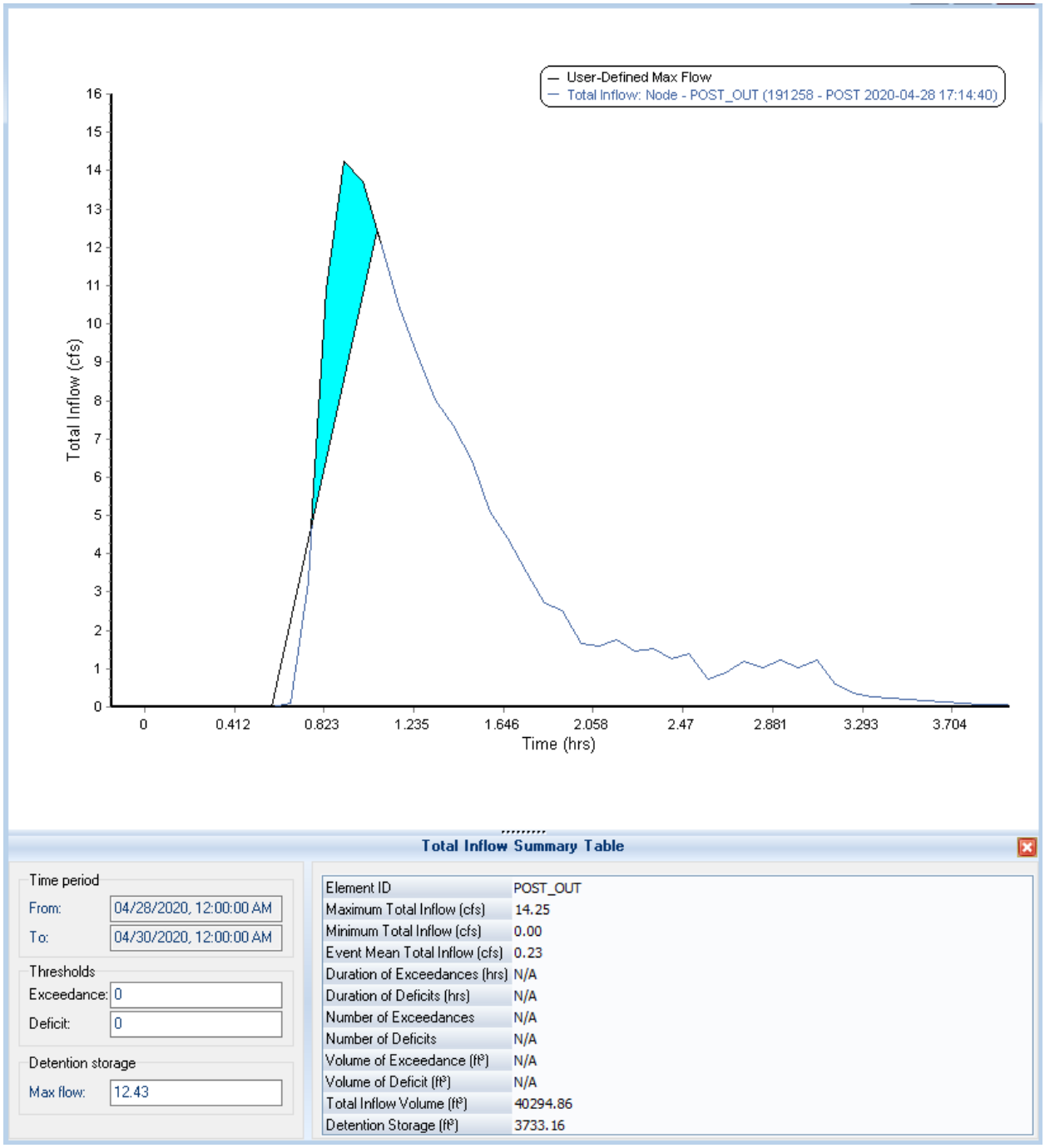
Time period
From: 04/28/2020, 12:00:00 AM
To: 04/30/2020, 12:00:00 AM

Thresholds
Exceedance: 0
Deficit: 0

Detention storage
Max flow: 0

Element ID	BAS-A	BAS-B	BAS-C	BAS-D	BAS-E	BAS-F	BAS-G	BAS-H
Maximum Runoff (cfs)	2.20	0.45	1.35	4.60	0.63	1.50	1.81	4.58
Minimum Runoff (cfs)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Event Mean Runoff (cfs)	0.03	0.01	0.02	0.05	0.01	0.02	0.02	0.09
Duration of Exceedances (hrs)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Duration of Deficits (hrs)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Number of Exceedances	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Number of Deficits	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Volume of Exceedance (ft³)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Volume of Deficit (ft³)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Runoff (ft³)	4306.73	883.46	2640.18	8985.5	1237.7	2942.61	3548.38	15750.3
Detention Storage (ft³)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Required Detention



Geotechnical Report

AGEC
Applied GeoTech

GEOTECHNICAL INVESTIGATION
& HILLSIDE EVALUATION

THE COVE

ST. GEORGE, UTAH

PREPARED FOR:

HOLDAWAY CONSTRUCTION
38 E. 590 N.
HURRICANE, UTAH 84737

ATTN:

BRENT HOLDAWAY

PROJECT NO. 2192092 **JULY 1, 2020**

1420 South 270 East • St. George, Utah 84790 • (435) 673-6850 • FAX (435) 673-1044

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SUMMARY

1. This report is a preliminary geotechnical study and also a part of the hillside submittal for St. George City Hillside Ordinance. A final report with details for design and construction will be provided up completion of the laboratory testing and evaluation of the proposed construction.

2. The site was evaluated by drilling 8 borings and observing the excavation of 4 test pits at the approximate locations shown on Figure 2 and 2a. The subsurface profile observed within the borings and test pits consisted of varied thicknesses of sand and gravel and clay overlying various types of bedrock. The bedrock varies from siltstone to shale to claystone.

   The bedrock is mapped as Dinosaur Canyon member of the Moenave Formation. Portions of the bedrock appear to be expansive. Laboratory testing is currently in progress to identify the layers and magnitude of the expansive characteristics.

3. Groundwater was encountered at various depths from 14 to 50 feet below the surface. Fluctuations in groundwater may occur over time. An evaluation of such fluctuations was beyond the scope of this report. Springs or seepages were not observed on the site. The affect of the groundwater will be evaluated and recommendations provided in the final report.

4. The topography of the site consists of a moderately steep to more gentle hillside sloping down to the east and south. The site is a cove or bowl type shape. The site is proposed to be graded by small cuts on the west and north and filling to the east and south. There will be significant cuts for the lower parking levels and building levels.

5. Based on the proposed grading, we anticipate that the majority of the cuts will be in the sands and gravels and will expose the various bedrock layers. We anticipate that the cuts for buildings will be shored temporarily and retained permanently. The upper cut on the parking area will be retained using stacked rock slopes.

6. AGEC has previously provided a Geologic hazard Assessment dated January 6, 2020. This report is attached. The geologic hazard of potentially expansive bedrock layers has not been addressed in the previous report. This hazard is discussed in this report.

7. The proposed structures may be supported on conventional spread footings bearing on a properly prepared subgrade. As an alternative, micropiles or deep foundations may be utilized. Following completion of the laboratory testing and final details of construction, detailed foundation recommendations will be provided.

8. The on-site sand and gravel soils, free of organics and debris, are suitable for use as structural fill, site grading fill, and utility trench backfill. There are occasional surface cobbles and boulders along with limited subsurface materials that are oversized for use as fill materials. The oversized material will require processing to remove the larger particles such that the maximum particle size is 6 inches and at least 50 percent of the material

passes the No. 4 sieve. Larger materials may be used on slopes for erosion protection or placed in deeper fills, provided they are properly nested. The on-site claystone bedrock is not suitable for use as structural fill, but may be used as fill in non-structural areas or as trench backfill, wall backfill, or at least 4 feet below pavement areas.

9. Positive drainage of the surface soils within the development is critical and should be maintained throughout the development. We recommend the piping of surface drainage and in no case should be ponding of water be allowed adjacent to or up-gradient of structures.

SCOPE

This report presents the results of a preliminary geotechnical investigation and hillside evaluation for the proposed Cove Development to be located in St. George, Utah, as shown in Figure 1. This report presents the subsurface conditions encountered, laboratory test results, and recommendations for the project. AGEC has previously completed a Geologic-hazard Assessment for the project dated January 6, 2020.

A field exploration of 8 borings and 4 test pits were conducted to obtain information on the subsurface conditions and to obtain samples for laboratory testing. Information obtained from the field and laboratory was used to define conditions at the site and to develop recommendations for the proposed development. AGEC has also utilized the proposed grading plans and conceptual plans to develop our recommendations. Additional details will be provided in a final report following completion of the laboratory testing.

This report has been prepared to summarize the data obtained during the study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. The report is intended to meet the requirements for evaluation for St. George City Hillside developments. The findings, conclusions and recommendations for design and construction are included in this report.

SITE CONDITIONS

The subject site consists of the parcel shown on Figure 1. The property is located west of the proposed 250 West at approximately 900 South and encompasses the hillside area or “bowl” type area as shown on the attached Figures 1, 2 and 2a. The property is moderately steep with a flatter area at the base of the hillside. Portions of the property have been previously graded with pad areas along the north and western portions of the planned construction area. The property is sparsely covered with vegetation consisting of small brush and grasses.

FIELD STUDY

On June 4-10, 2020, an engineer from AGEC visited the site for a subsurface investigation. Eight borings were drilled using a truck mounted rig using hollow stem augers. Portions of the bedrock were cored using mud rotary or air to removed cuttings from a 2.5 inch HQ core barrel for continuous sampling. The 4 test pits were excavated with a track excavator. The locations are shown on Figure 2 and 2a.

SUBSURFACE SOIL CONDITIONS

The subsurface profile observed within the borings and test pits consisted of varied thicknesses of sand and gravel and clay overlying various types of bedrock. The bedrock varies from siltstone to shale to claystone.

The bedrock is mapped as Dinosaur Canyon member of the Moenave Formation. Portions of the bedrock appear to be expansive. Laboratory testing is currently in progress to identify the layers and magnitude of the expansive characteristics.

The preliminary boring and test pit logs are shown on Figures 3 to 6 with the legend and notes on Figure 7. These logs will be updated following the classification data provided from laboratory testing in a final report.

GEOLOGY

The geologic conditions at the site were evaluated based on a review of geologic literature, and a site geologic reconnaissance.

A. **Geomorphology of the Area**

The site is located along the east slope of the West Black Ridge or edar Bench Lava Flow in St. George, Utah as shown on Figure 1. The site is also located on the north side of the Virgin River Anticline. This area is part of the St. George Basin which is bound on the north by the Pine Valley Mountains, on the east by the Hurricane Cliffs, on the west by the Beaver Dam Mountains, and on the south by the Mount Trumball area.

Bedrock in the St. George basin mainly consists of Upper Permian and Lower Jurassic sandstone, shale, siltstone, limestone, gypsum, and conglomerate. These beds are folded to the southeast into the northeast trending Virgin anticline. Several north-trending faults are present within the St. George Basin, the most prominent of which is the Washington Fault (Christensen and Deen, 1983).

The St. George Basin is characterized by basalt capped buttes and cuestas that were once stream channels along which lava flowed. Erosion of the surrounding softer sedimentary rocks over time has resulted in an inverted topography of old stream channel becoming resistant basalt ridges such as the Middleton Black Ridge and the West Black Ridge (Christenson and Deen, 1983).

The geologic structure within the basin is dominated by the Virgin anticline which trends northwest to southeast and is located south of the site. The Virgin anticline is a broad, generally symmetrical fold with maximum flank dips of 25 to 30 degrees to the northwest and southeast (Christenson and Deen, 1983).

The geologic conditions at the site were evaluated based on a review of geologic literature, boring and test pit exploration and a reconnaissance of the site.

B. Stratigraphy of the Area

The stratigraphy of the area consists of Upper Triassic to Lower Jurassic- aged bedrock of the Moenave Formation. There is alluvium (Holocene to lower Pleistocene aged) deposits over the Chinle that cover the majority of the site. The top of the ridge is capped by the Lava Ridge lava flow, which consists of Basalt of the lower Pleistocene aged deposit.

GEOLOGIC HAZARDS

Based on review of geologic literature and site reconnaissance, the following information is provided concerning geologic hazards.

A. Liquefaction

Relatively shallow bedrock was encountered across the site. Thus, based upon subsurface conditions encountered our experience in the area, the subsurface soils below the developed areas are considered to be a non-liquefiable during a severe seismic event to the depths investigated.

B. Expansive Soil/Bedrock

The presence of potentially expansive layers of bedrock is identified by the geologic mapping hazard by Lund and others, 2008. The expansive bedrock is mapped as the Dinosaur Canyon member of the Moenave Formation. Our laboratory testing is currently in progress. Our experience in the area also indicate that claystone bedrock on the project site is moderately expansive.

An evaluation and analysis along with detailed recommendations to address this concern for expansive layers will be provided in a final report.

D. Landslides

See attached document.

E. Rock Fall

See attached document.

F. Faults

Based on previous work by Christenson and Deen (1983), Willis and Higgins (1995) Lund and others (2008), the inferred location of the St. George Fault is located further east near River Road.

PROPOSED CONSTRUCTION

The Cove Development will consist of developing the property with two 2 apartment/townhome type buildings. The buildings will be multiple levels with underground parking. The buildings are to be constructed with reinforced concrete on the garage level and wood framing on the above grade levels. We anticipate wall loads on the order of 8 to 10 kips per lineal foot and column loads up to 300 kips.

There will be access to the site from 900 South and 250 West which will be further improved as a part of the site development. There is an existing sewer up the 900 South roadway alignment. The anticipated traffic for the different areas consists of a Traffic Index of 7 for the Public Roads and a 5 for the parking and access areas.

The proposed grading consists of significant temporary cuts for construction. The cuts will be retained or shored during construction. The hill side cuts above the parking area are proposed to be retained by rockery faced slopes. The fills will be located in walkout areas and in the lower area on the west side of the project.

The proposed construction, or building loads are estimated and should be verified to refine our recommendations in the final report.

RECOMMENDATIONS

Based on our experience in the area, the subsurface conditions encountered, our engineering analysis, and the proposed construction, the following recommendations are provided. A final report will be provided that defines the expansive bedrock characteristics following completion of the lab testing. The final report will include overexcavation depths for buildings, foundation alternatives such as micropiles and shoring recommendations.

A. Site Grading

Based on the subsurface conditions and proposed grading provided by Bush & Gudgell Engineering, the following is provided:

1. Subgrade Preparation

General: Prior to placing structural fill, site grading fill or concrete, the site should be grubbed to remove vegetation and soil containing roots and organics.

Expansive Bedrock Removal - Buildings and Structures: We recommend that a separation be provided between the expansive claystone and the building pad grades. The thickness of removal will be defined and provided in a final report as the laboratory testing is completed. The claystone should be removed below structures, entry areas and canopies, extending at least 5 feet beyond the perimeter of the structure. The limits of removal should be determined by survey and documented following removal.

Expansive Bedrock Removal - Roadways and Flatwork*:* We recommend providing at least a separation of 4 feet below the proposed subgrade elevation and the surface of the expansive mudstone. The material should be removed a distance of at least 2 feet beyond the edge of roadway/flatwork improvements .

2. Excavation/Slopes

Based on the proposed grading, we anticipate that the majority of the cuts will be in bedrock. The cuts are significant and will require shoring or permanent retaining. Details will be provided in a final report.

The upper cuts will be in the sands and gravels with portions of the parking cuts extending into the bedrock. In order to maintain stable slopes, they should be retained or slopes should be graded no steeper than 2:1 Horizontal to Vertical (H:V). Fill slopes should be graded no steeper than 2:1 (H:V).

To control erosion and weathering, the bedrock cut slopes should be protected by erosion protection. This would be particularly critical where softer bedrock is exposed. Benches may also be cut into the slopes to assist in controlling drainage and erosion. Benches should be at least 5 feet in width and should be constructed at intervals in accordance with the 2018 IBC. In lieu of facing bedrock cuts, they could be flattened to a 3:1 (H:V) slope.

Fill slopes should be constructed by overbuilding the slope and then cutting back the slope face to the desired grade to provide a properly compacted slope face. Fill placed on existing slopes steeper than 3:1 (H:V) should be keyed into the existing slope using a benching procedure. Benches should be of sufficient width to allow for operation of compaction equipment.

Utility trenches excavated in the on-site soils should be excavated in accordance with OSHA requirements using a OSHA Soil Class C (1½:1 H:V) for overburden soils and Soil Class A (½:1 H:V) for trenches excavated into the bedrock. Steeper trenches may require the use of shoring or a trench box to provide as safe work environment. Safe trench excavation is the responsibility of the contractor.

3. Materials

Import materials should be non-expansive, non-gypsiferous, granular soil. Listed below are the materials recommended for imported fill.

Area	Fill Type	Recommendations
Foundations/slabs	Site grading/ structural fill	**-200** <35%, **LL** <30% Maximum size: 4 inches Solubility < 1%
Roadways	Base course	CBR>50%, **200** <12% Maximum size: ¾ inch
Underslab	Base course	**-200** <12% Maximum size: 1 inch

-200 = Percent Passing the No. 200 Sieve
LL = Liquid Limit

The on-site silt, sand and gravel soils and fill soils, free of organics and debris, are suitable for use as structural fill, site grading fill, and utility trench backfill. The on-site claystone is not suitable for use as structural fill or site grading fill, but may be used as fill in non structural areas, trench backfill, wall backfill, or at least 4 feet below pavement areas. An AGEC engineer should observed the bedrock removal to determine suitability for its intended use.

4. Compaction

Compaction of fill materials placed at the site should equal or exceed the following percentages when compared to the maximum dry density as determined by ASTM D-698 or ASTM D-1557:

Area	Percent Compaction ASTM D-698*	Percent Compaction ASTM D-1557**
Subgrade	90	90
Footings/foundations	NA	95
Slabs/Pad Fill (over excavation)	100	95
Utility trench backfill (Structural Areas)	100	95
Wall Backfill (Structural Areas)	100	95

* Fine-grained or processed mudstone/clay.

** Granular site grading/structural fill

Fill should be placed in lifts which do not exceed the capability of the equipment used. Generally 6 to 8 inch lifts are adequate for heavy rubber tire equipment. Lift thicknesses should be reduced to 4 inches for hand compaction equipment. Fill placed at the site should be properly moisture conditioned prior to placement and should be tested to verify proper compaction.

Fill materials should be properly moisture conditioned prior to placement. Fine-grained should be moisture conditioned to 0 to 4 percentage points over the optimum moisture content as determined by ASTM D-698. Granular soil should be

moisture conditioned to within 2 percentage points of the optimum moisture content as determined by ASTM D-1557.

5. Drainage

The following drainage recommendations should be implemented:

- Positive site drainage should be maintained during the course of construction. In no case should water be allowed to pond adjacent to buildings/foundations.

- After construction has been completed, positive drainage of surface water away from the structures should be maintained throughout the life of the structures. We recommend a minimum slope of 6 inches in the first 10 feet from the perimeter of the structures. Hard or impermeable surfaces may be used to direct water away from buildings.

- Roof gutters should also be utilized with downspouts which extend out away and down slope from buildings. Preferably, downspouts should discharge off-site.

- Landscaping that requires water (grass) should be limited to reduce the potential for wetting of foundation support soils and to reduce the potential future accumulation of perched water on top of the bedrock.
- We also recommend that desert landscaping, which requires little to no water, be used adjacent to concrete or masonry walls which will be backfilled to reduce salt migration of soluble salts and the subsequent salt weathering on cement containing elements. The below grade portions of walls/fences which are backfilled with soil should be protected with an impermeable membrane and a subsurface drain. A gravel covered, perforated PVC pipe should also be placed at the base of the wall to carry water to a discharge point. This is intended to reduce the potential for salt weathering and sulfate attack on concrete/masonry.

6. Subsurface Drainage Protection

A perimeter subsurface drain should be provided around the basement of each structure.

The drain system should consist of 1 foot of gravel adjacent the perimeter foundation supporting the building. A 4 inch perforated PVC pipe should be placed in the bottom of the gravel zone sloped at a 1% grade (minimum) to drain by gravity. Prior to backfilling, Mirafi 140N filter fabric should be placed over the gravel.

B. Foundation Recommendations

Based on the subsurface conditions, the proposed grading provided by Bush & Gudgell Engineering and that the proper separation from expansive soils has been provided, the following foundation recommendations are provided for support of slab on grade foundations. If the expansive soils are not removed to provide the proper separation, the use of micropiles or a deep foundation system should be used. Recommendations for deep foundation systems are not included in this report. If requested, those recommendations can be provided.

1. Foundations

   The proposed structures may be supported on conventional spread footings with slab-on-grade floors supported on a properly prepared subgrade as indicated in the Subgrade Preparation section of this report.

2. Bearing Material

   Footings should bear on properly compacted structural fill underlain by a properly prepared subgrade as recommended in the Subgrade Preparation section of this report.

3. Bearing Pressure

   Spread footings bearing on properly compacted structural fill may be designed for a net allowable bearing pressure of 2,500 pounds per square foot (psf). Spot footings supporting columns or footings with a width of greater than 3 feet may be

designed for a net allowable bearing pressure of 3,000 psf. If larger footings are anticipated, the bearing pressures may be increased with further evaluation.

4. Temporary Loading Conditions

The bearing pressure indicated above may be increased by one-half for temporary wind and seismic loads.

5. Footing Width and Embedment

Spread footings should have a minimum width of 18 inches and exterior or unheated footings should be embedded at least 12 inches below the lowest adjacent grade.

6. Settlement/Heave

Based on the subsoil conditions encountered and the anticipated building loads, we estimate a total settlement/heave for the foundation designed as indicated above to be up to approximately 1 inch. Differential settlement is estimated to be approximately ½ inch.

C. Concrete Slab-on-Grade

1. Slab Support

Concrete slabs may be supported on a properly compacted subgrade as recommended in the Subgrade Preparation section of this report. Fill placed in slab areas should be tested to verify compaction meets the recommendations provided within this report.

2. Underslab Base Course

A 4-inch layer of properly compacted base course should be placed below slabs to provide a firm and consistent subgrade and promote even curing of the concrete.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

Lateral resistance for spread footings is controlled by sliding resistance developed between the footing and the subgrade soil. An ultimate friction value of 0.45 may be used in design for ultimate lateral resistance of footings bearing on properly compacted structural fill.

2. Retaining Structures

The following equivalent fluid weights are given for design of subgrade walls and retaining structures. The active condition is where the wall moves away from the soil. The passive condition is where the wall moves into the soil and the at-rest condition is where the wall does not move. We recommend the basement walls be designed in an at-rest condition.

The values listed below assume a horizontal surface adjacent the top and bottom of the wall.

Description	Active	At-Rest	Passive
Granular Backfill (Sand or Gravel)	35 pcf	55 pcf	350 pcf
Granular Backfill - Earth Pressure Coefficient	0.28	0.44	-
On-site Clay Soil/Processed claystone	50 pcf	65pcf	190 pcf
On-site Clay Soil/Processed claystone - Earth Pressure Coefficient	0.45	0.59	-

The above values account for the lateral earth pressures due to the soil and level backfill conditions and do not account for hydrostatic pressures or surcharge loads.

Lateral loading should be increased to account for surcharge loading using the appropriate earth pressure coefficient and a rectangular distribution if structures are placed above the wall and are within a horizontal distance equal to the height of the

wall. If the ground surface slopes up away from the wall, the equivalent fluid weights should also be increased.

Care should be taken to prevent percolation of surface water into the backfill material adjacent to the retaining walls. The risk of hydrostatic buildup can be reduced by placing a subdrain behind the walls consisting of free-draining gravel wrapped in a filter fabric.

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weights should be modified as follows according to the Mononobe-Okabe method assuming a level backfill condition:

Lateral Earth Pressure Condition	Seismic Modification (2% PE in 50 yrs)
	Granular Backfill
Active	7 pcf increase
At-rest	no increase
Passive	18 pcf decrease

The resultant of the seismic increase should be placed up ⅓ from the base of the wall.

4. Safety Factors

The given values assume mobilization of the soil to achieve the assumed soil strength. Conventional safety factors used for structural analysis for such items as overturning and sliding resistance should be used in design.

E. Seismicity

Listed below is a summary of the site parameters as required by the 2018 International Building Code and ASCE 7, Chapter 20:

Description	Seismic Event - 2% PE in 50 Yrs
	Value
2018 IBC Site Class	C
PGA	0.22g
S_s (0.2 second period)	0.505g
S_1 (1 second period)	0.164g
F_{PGA}	1.2
F_a	1.298
F_v	1.5

The values provided above were generated using the ASCE 7-16 Siesmic Hazard tool.

Based on the observed subsurface conditions, a ground motion hazard analysis (GMHA) as per ASCE 7-16 is not required by the 2018 International Building Code. A 10-percent decrease in design seismic load might be achieved if shear wave velocities are measured on site. If this is requested, we propose to perform a Refraction Microtremor (ReMi) survey to measure subsurface shear wave velocity.

F. Soil Corrosion

Our experience has shown that portions of the on-site soil/bedrock and many imported soils may contain sulfates in sufficient concentration to be corrosive to concrete. Therefore, we recommend concrete elements that will be exposed to the on-site soils be designed in accordance with provisions provided in the American Concrete Institute Manual of Concrete Practice (ACI) 318-14. Tables 19.3.1.1 and 19.3.2.1 of ACI 318-14 should be referenced for design of concrete elements utilizing a Sulfate Exposure Class of S2.

Consideration should also be given to cathodic protection of buried metal pipes. We recommend utilizing PVC pipes where local building codes allow.

G. Pavement

Based on the subsoil conditions encountered and the laboratory test results, the following recommendations are given:

1. Analysis

   Asphaltic Concrete: The flexible pavement analysis is based on UDOT and AASHTO design methods and a 20 year design life. The following parameters were considered for our analysis:

   - Base course that meets specifications which would correspond to a Structural Coefficient (a_2) of at least 0.12. Asphalt that provides a Structural Coefficient (a_1) of at least 0.40.

   - Drainage Coefficient = 1.0.
   - The subgrade support soils consists generally of silty sand to gravel. Based on the on-site soils, a M_R value of 15,000 psi was used for the subgrade based upon an estimated California Bearing Ratio (CBR) value of 10 percent and the relationship between CBR and Resilient Modulus (M_R).
   - Serviceability Index: P_o=4.2, P_t=2.5.
   - Reliability of 90 percent.
   - Standard Deviation (S_o) = 0.45.

2. Subgrade Support

   We anticipate the subgrade materials will consist of compacted on-site silty sand to gravel. Our design assumes a properly compacted subgrade. Prior to placing base course or pavement area grading fill, the subgrade should be prepared as recommended in the Subgrade Preparation section of this report.

3. Pavement Thickness

Based on the anticipated traffic, a 20 year design life, PCC and AASHTO design methods, the following pavement sections are recommended.

	Flexible Pavement	
Area	Asphaltic concrete (inches)	Base Course (inches)
300 West, 900 South	3	8
Acces/Entrance Road	2.5	8
Parking areas	2.5	6

4. Pavement Materials

The pavement materials should meet AASHTO and City of St. George Specifications for gradation and quality. The pavement thicknesses indicated above assume that the base course is high quality material with a CBR of at least 60 percent. Asphalt material should have a Marshall stability of at least 1,800 pounds.

5. Drainage

The collection and diversion of drainage away from the pavement surface is extremely important to the satisfactory performance of the pavement section. Proper drainage should be provided. We further recommend a yearly maintenance program including crack sealing and a surface treatment such as a “slurry seal” to extend the pavement life and reduce water infiltration into the subsurface soils.

H. Construction Testing and Observations

We recommend testing fill, concrete, and asphalt materials at a frequency which meets or exceeds St. George City minimum testing frequency requirements for city improvements.

We also recommend the following:

1. Verify the subgrade is properly prepared/compacted in accordance with the recommendations provided in the Subgrade Preparation section of this report.

2. Verify that foundation subgrade is properly compacted prior to placement of concrete.

3. Conduct compaction testing on fill placed below foundations, in building pads, and paved areas. We recommend testing each foot of fill placed.

4. Conduct construction materials testing of soils, concrete and asphalt materials and special inspections as required for the proposed construction by St. George City and the structural engineer.

5. Conduct special inspections on the proposed building as required by the 2018 International Building Code and the structural engineer.

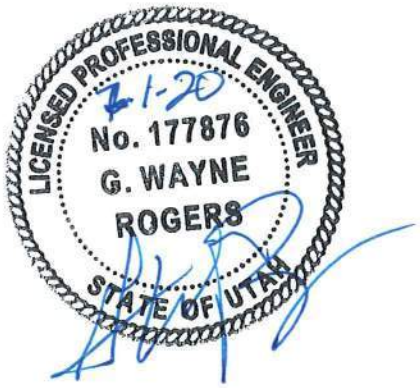
I. Geotechnical Recommendation Review

The client should familiarize themselves with the information contained in this report. If specific questions arise or if the client does not fully understand the conclusions/recommendations provided, AGEC should be contacted to provide clarification.

LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices in the area for the use of the client for design purposes. The conclusions and recommendations included within the report are based on the information obtained from the subsurface investigation, laboratory test results and our experience in the area. Variations in the subsurface conditions may not become evident until excavation is conducted. If the subsurface conditions or groundwater level are found to be significantly different from those described above, we should be notified to reevaluate our recommendations.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.



G. Wayne Rogers, P.E.

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REFERENCES:

Christenson, G.E. and Deen, R.D., 1983, Engineering Geology of the St. George area Washington County, Utah: Utah Geological and Mineral Survey Special Studies 58, 32 p., scale 1:24,000.

Lund, W.R., Knudsen, T.R., Vice, G.S., and Shaw, L.M., 2008, Geologic hazards and adverse construction conditions, St. George-Hurricane Metropolitan Area, Washington County, Utah, Utah Geological Survey Special Study 127, 14 plates, scale 1:24,000.

Hayden, Janice, M and Willis, Grant C. UGS Map 251DM. 2011, Geologic Map of the St. George Quadrangle, Washington County, Utah, Utah Geological Survey.



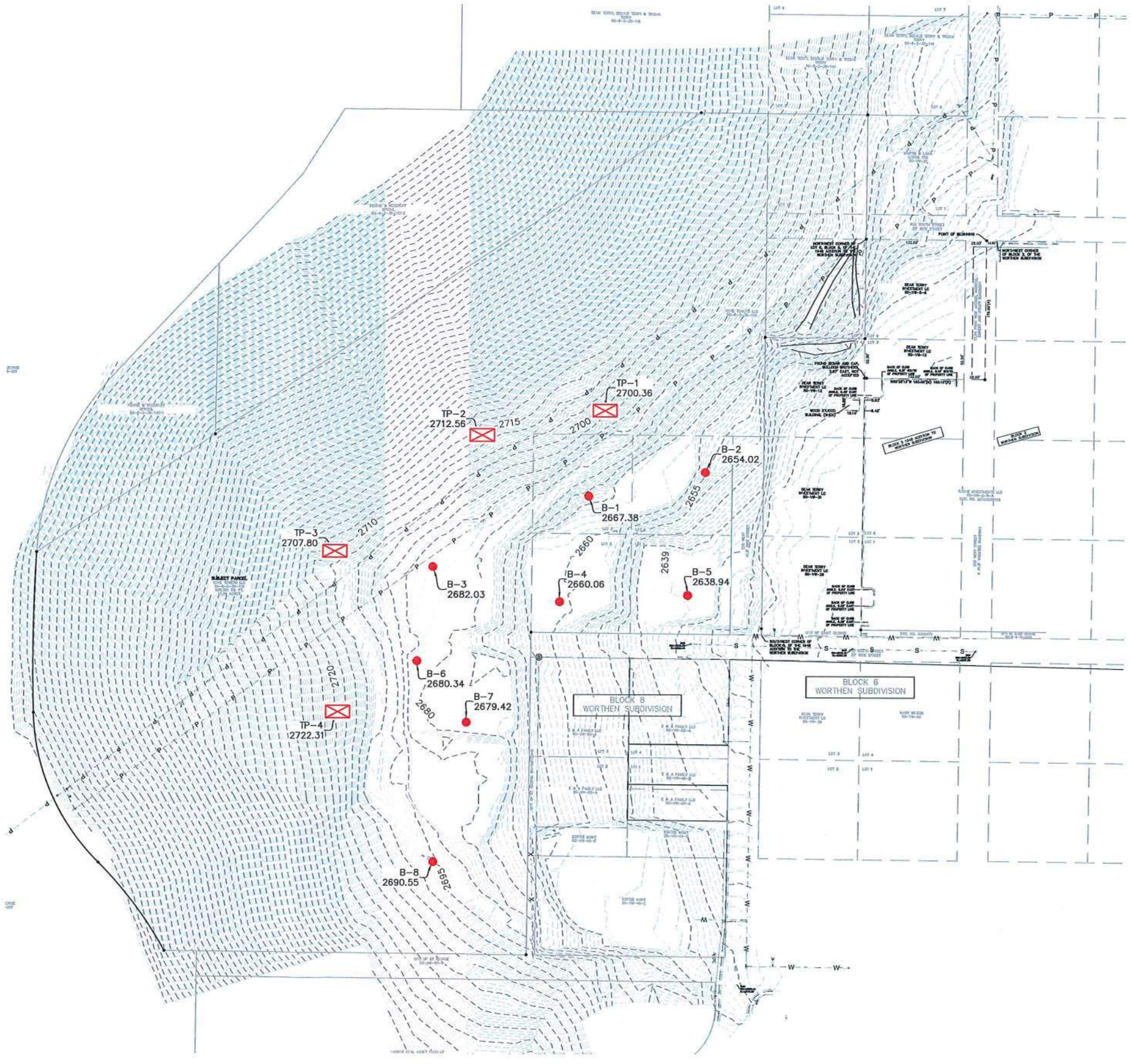
THE COVE
ST. GEORGE, UTAH

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Not to Scale

2192092	AGEC	Vicinity Map	Figure 1

THE COVE
ST. GEORGE, UTAH



- Approximate boring location
- Approximate test pit location

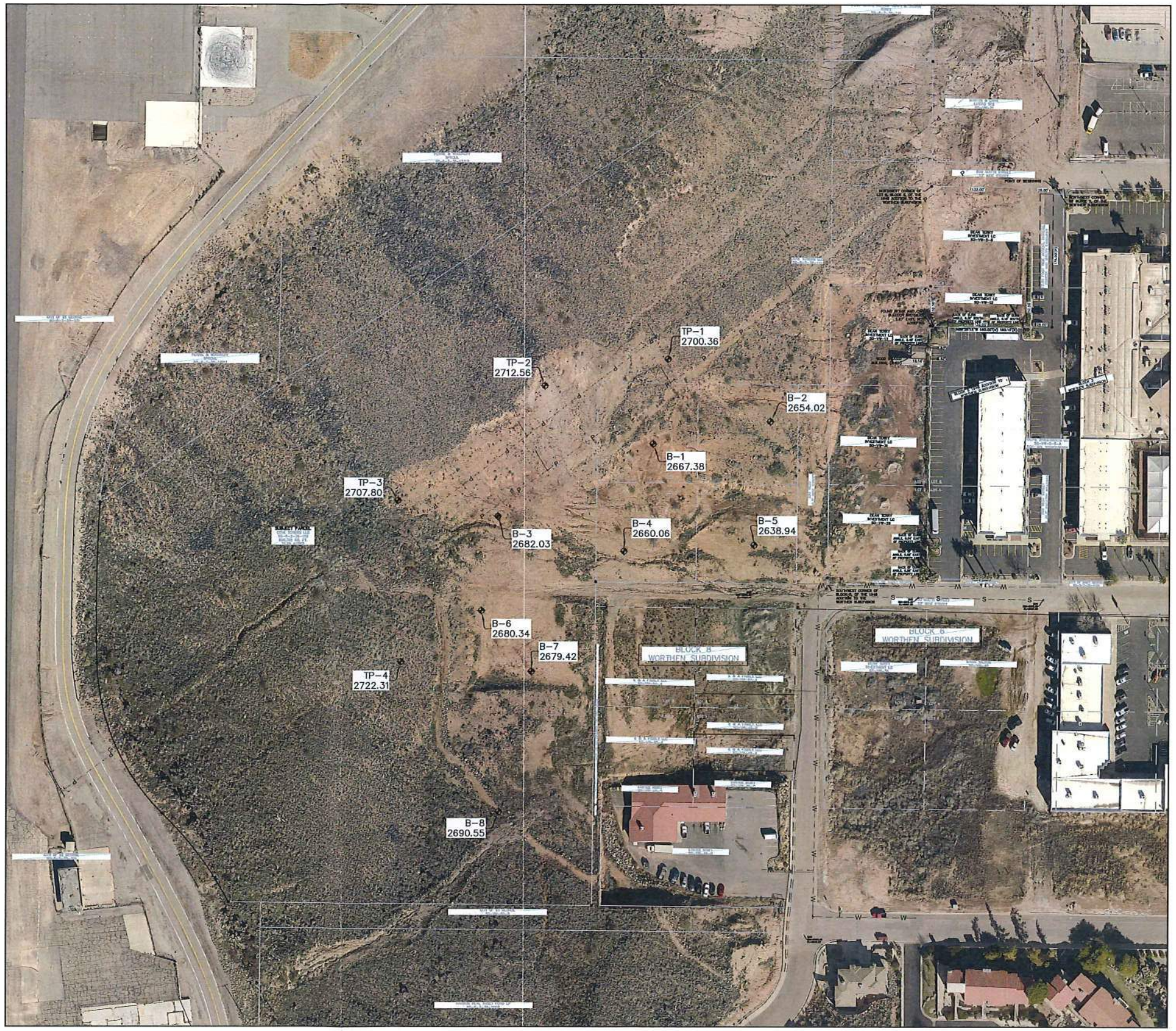
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0 150 300 feet

Approximate Scale

2192092	AGEC	Site Plan	Figure 2

THE COVE
ST. GEORGE, UTAH

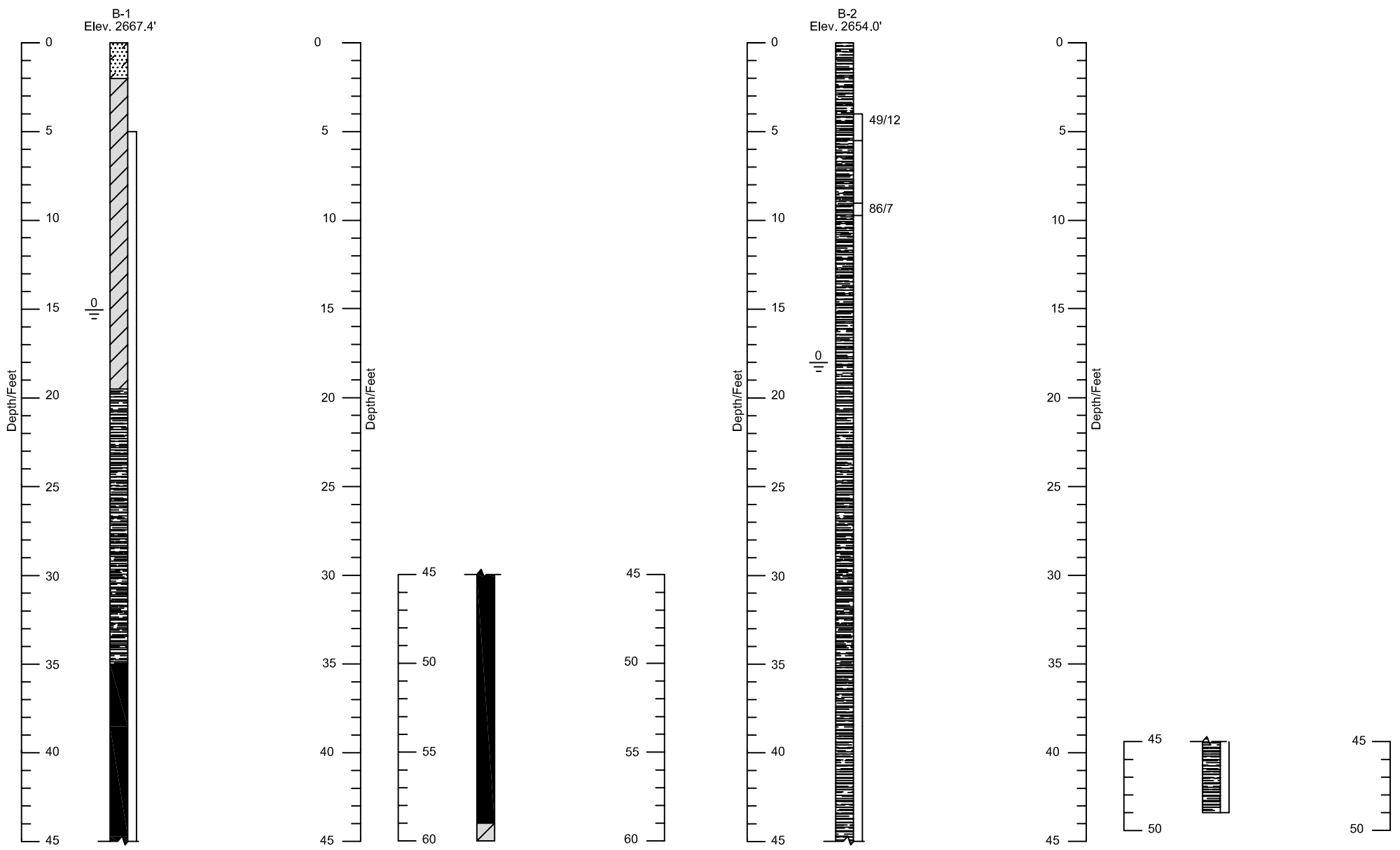


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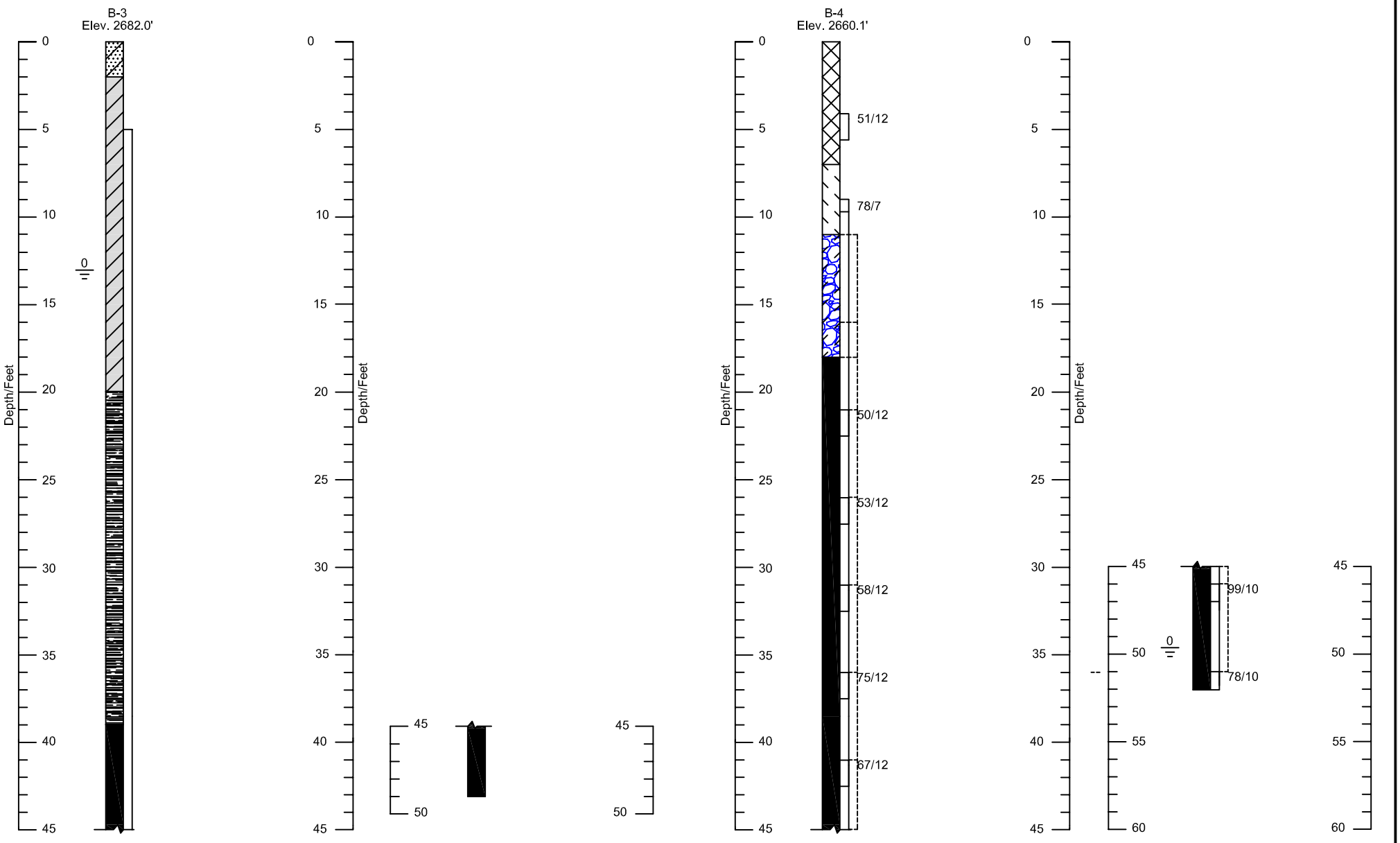
0 200 400 feet

Approximate Scale

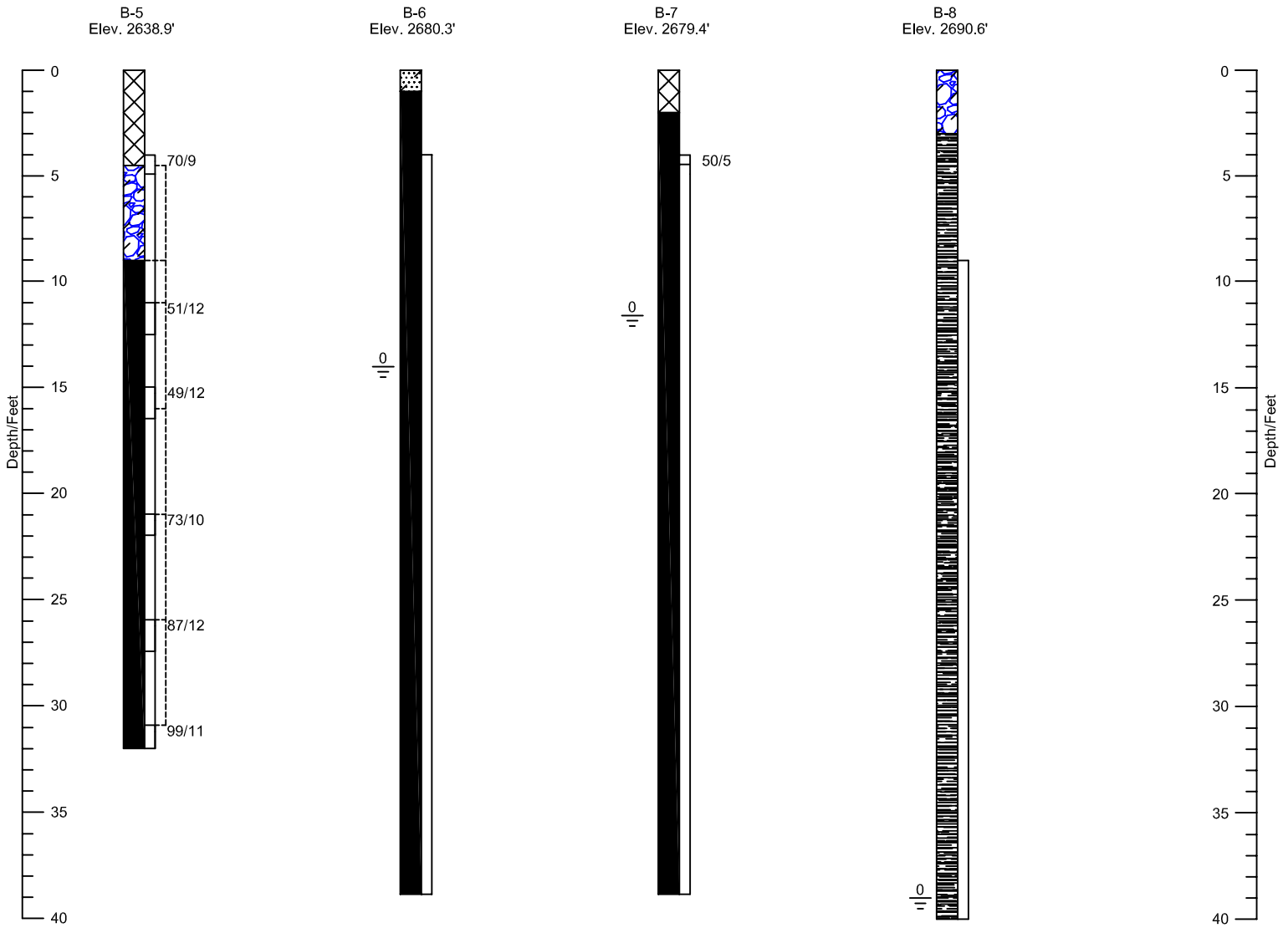
2192092	AGEC	Site Plan	Figure 2a



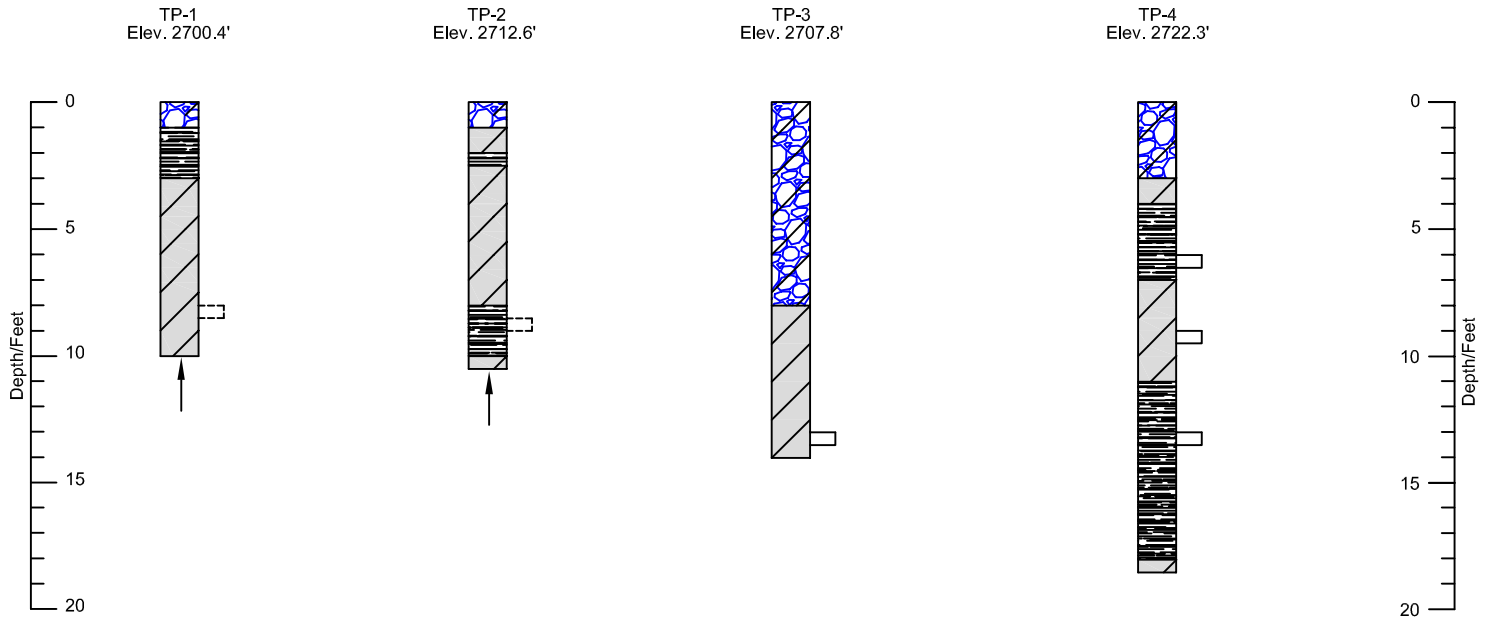
2192092 | AGEC | Logs of Exploratory Borings | Figure 3



2192092 | AGEC | Logs of Exploratory Borings | Figure 4



2192092	AGEC	Logs of Exploratory Borings	Figure 5



2192092	AGEC	Logs of Exploratory Borings	Figure 6

LEGEND:



Fill; Silty to Clayey Sand with Gravel, poorly compacted, slightly moist, and reddish brown in color.



Fat Clay (CH); medium stiff, moist, and reddish brown in color.



Clayey Sand (SC); medium dense, slightly moist, and reddish brown in color.



Silty Sand (SM); medium dense, moist, and reddish brown in color.



Clayey Gravel (GC); dense, moist, basalt cobbles and boulders, and black to red in color.



Silty Gravel with Sand (GM); dense, moist, basalt cobbles and boulders, and black to red in color.



Shale Bedrock; moderately hard, slightly moist, low to medium plastic, layered, gypsum, and red in color.



Claystone Bedrock; soft to moderately hard, moist, medium to high plastic, gypsum streaks, and red with white in color.



Siltstone Bedrock; moderately hard, slightly moist, non to low plastic, sandstone lenses/layers, and red-brown in color.



California drive sample taken. The symbol 10/12 indicates that 10 blows from a 140 pound hammer falling 30 inches were required to drive the sampler 12 inches.



Indicates core sample taken.



Indicates relatively undisturbed block sample taken.



Indicates disturbed sample taken.



Indicates the depth to free water and the number days after excavation the measurement was taken.

Indicates practical trackhoe refusal on boulders, sandstone bedrock, or limestone bedrock.

NOTES:

1. The borings were drilled on June 4, 5, 8, 9, and 10 with a truck mounted drill rig equipped with 8-inch hollow-stem augers. The test pits were excavated on June 9 and 10, 2020 with a trackhoe. Portions of the bedrock were cored using a 2½ inch diameter HQ bit using either air or mud rotary.
2. The locations and elevations of the borings and test pits were measured by survey by Bush and Gudgell, Inc.
3. The boring and test pit locations and elevations should be considered accurate only to the degree implied by the method used.
4. The lines between the materials shown on the logs represent the approximate boundaries between material types and the transitions may be gradual.
5. Water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water level may occur with time.



B-1 @ 5-15 ft.



B-1 @ 15-24 ft



B-1 @ 24-32 ft.



B-1 @ 32-41 ft.



B-1 @ 41-50 ft.



B-1 @ 50-58 ft.



B-1 @ 58-60 ft.



B-2 @ 9-23 ft.



B-2 @ 23-32 ft.



B-2 @ 32-42 ft.



B-2 @ 42-44 ft.



B-3 @ 4-19 ft.



B-3 @ 19-29 ft.



B-3 @ 29-39 ft.



B-3 @ 39-49 ft.



B-6 @ 4-14 ft.



B-6 @ 14–26 ft.



B-6 @ 26-34 ft.



B-6 @ 34-39 ft.



B-7 @ 4-17 ft.



B-7 @ 17-26 ft.



B-7 @ 26-36 ft.



B-7 @ 36-39 ft.



B-8 @ 9-22 ft.



B-8 @ 22-29 ft.



B-8 @ 29-34 ft.



B-8 @ 34-39 ft.

AGEC
Applied GeoTech

January 6, 2020

Holdaway Construction
38 East 590 North
Hurricane, Utah 84737

Attention: Brent Holdaway
EMAIL: bholdaway@live.com

Subject: Geologic-hazard Assessment
Proposed Cove Development
300 West 900 South
St George, Utah
Project No. 2192092

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. (AGEC) was requested to evaluate geologic hazards for the proposed Cove development to be constructed at approximately 300 West 900 South in St George, Utah.

PROPOSED CONSTRUCTION

We understand a mixed-use development consisting of retail, restaurant and residential facilities is planned for the east portion of the property. The west side of the developed area will be cut into the slope of the hillside.

GEOLOGY

The geology of the site is mapped by Hayden and Willis (2011) to consist of talus and landslide deposits on the hillside and bedrock near the base of the slope. The relatively flat east side of the property is mapped as mixed eolian and alluvial deposits. The bedrock is the Springdale Sandstone Member of the Kayenta Formation overlying the Whitmore Point Member of the Moenave Formation overlying the Dinosaur Canyon Member of the Moenave Formation. The bedrock dips gently down in a north/east direction.

Low-sun-angle aerial photographs from 1981, color aerial photographs from 2000, black and white aerial photographs from 1960 and lidar data from 2017 were reviewed to evaluate geologic hazards in the area. The resolution of the photographs along is not sufficient to allow evaluation of rockfall. In addition, the area planned for development had been disturbed

by the time of the photographs. Landslide deposits can be identified on the aerial photographs south of the site. The landslide mapped on the northwest slope above the proposed development area is not apparent from the aerial photographs or lidar. The area mapped as landslide is terraced suggesting there may be creep or shallow-depth movement of the ground in this area. The affected soil does not appear to extend more than about 2 or 3 feet deep.

ROCKFALL EVALUATION

There are outcrops of basalt above the property with some areas of rock that could potentially become dislodged, particularly during a major earthquake, and result in rockfall hazard for the proposed development. The rocks are generally less than 5 feet in size. The approximate extent of the rockfall hazard is presented on Figure 2. This is based on field observation and experience with similar sites in the area. The extent of the potential rockfall hazard cannot be well defined due to land disturbance and likely removal of rocks in the runout zone.

The area planned for buildings could be protected from rockfall hazards by constructing a barrier along the uphill side of the development or removal of the source rocks.

The rockfall-protection berm, assumed to be constructed just up slope of the west and northwest cut slopes for the development, should have a height of at least 8 feet, a top width of at least 6 feet and an upslope face of ½ horizontal to 1 vertical or steeper. It is important to have a steep upslope face for the berm so rocks are not directed over the berm. The berm should be reinforced using geogrid to maintain a steep upslope face. The reinforcement spacing and slope construction will depend on the type of fill used and reinforcement selected. Internal design of the berm reinforcement could be provided upon request.

LANDSLIDE EVALUATION

The landslide on the northwest side of the property appears to be less than 2 or 3 feet deep and is not expected to be a hazard for the proposed development if slopes are adequately reinforced. This should be evaluated in the geotechnical study for the site.

OTHER GEOLOGIC HAZARDS

Other geologic hazards considered for this study are debris flow and fault rupture. Based on geologic mapping for the area, our site reconnaissance, and review of aerial photographs and lidar data, these are not considered hazards at the site.

LIMITATIONS

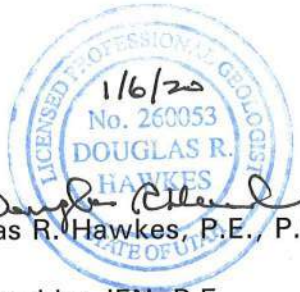
This letter has been prepared in accordance with generally geologic engineering practices in the area for the use of the client. The conclusions and recommendations included in the letter are based on conditions observed during our field study, topographic information provided and

our experience with similar type projects. If conditions are significantly different from those described in this letter, we should be notified to reevaluate the recommendations given.

If you have questions or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

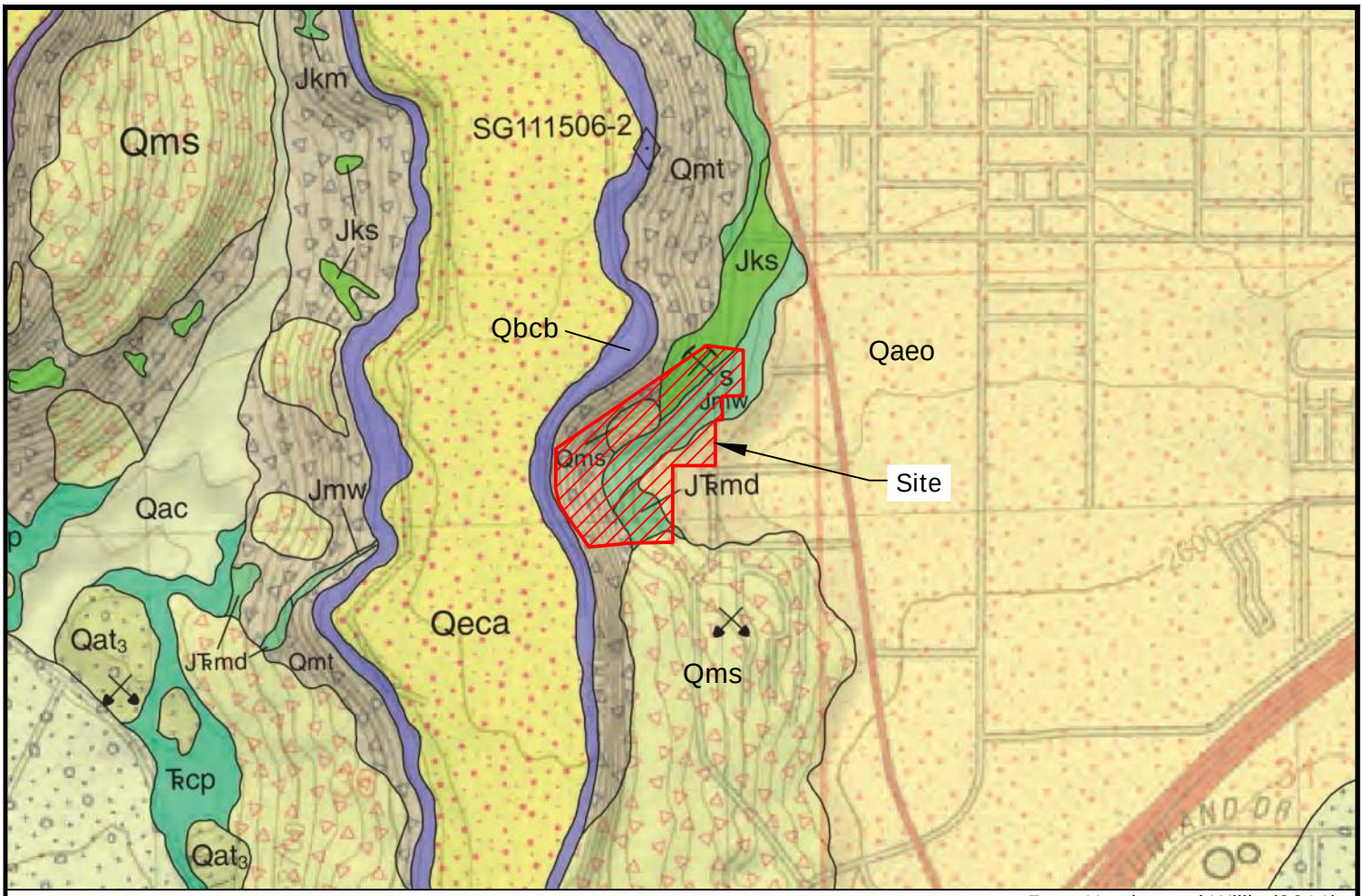


Douglas R. Hawkes, P.E., P.G.

Reviewed by JEN, P.E.
DRH/rs
Enclosures

Reference:

Hayden, J.M. and Willis, G.C., 2011; Geologic map of the St George 7.5' quadrangle, Washington County, Utah, Utah Geological Survey Map 251DM.



From Hayden and Willis (2011)

EXPLANATION OF SYMBOLS AND GEOLOGIC UNITS IN AREA OF PROPOSED DEVELOPMENT

Qmt - Talus deposits (Holocene to upper Pleistocene)

Qms - Landslide deposits (Holocene to middle Pleistocene).

Qeca - Eolian and alluvial deposits with thick calcic soil on lava flows (Holocene to lower Pleistocene).

Qaeo - Mixed alluvial and eolian deposits (Holocene to middle Pleistocene).

Qbcb - Cedar Bench lava flow (lower Pleistocene)

Jks - Springdale Sandstone Member of the Kayenta Formation (Lower Jurasic)

Jmw - Whitmore Point Member of the Moenave Formation (Lower Jurassic)

JTrmd - Dinosaur Canyon Member of the Moenave Formation (Lower Jurassic to Upper Triassic).

——— — — Geologic contact between units, dashed where approximate.

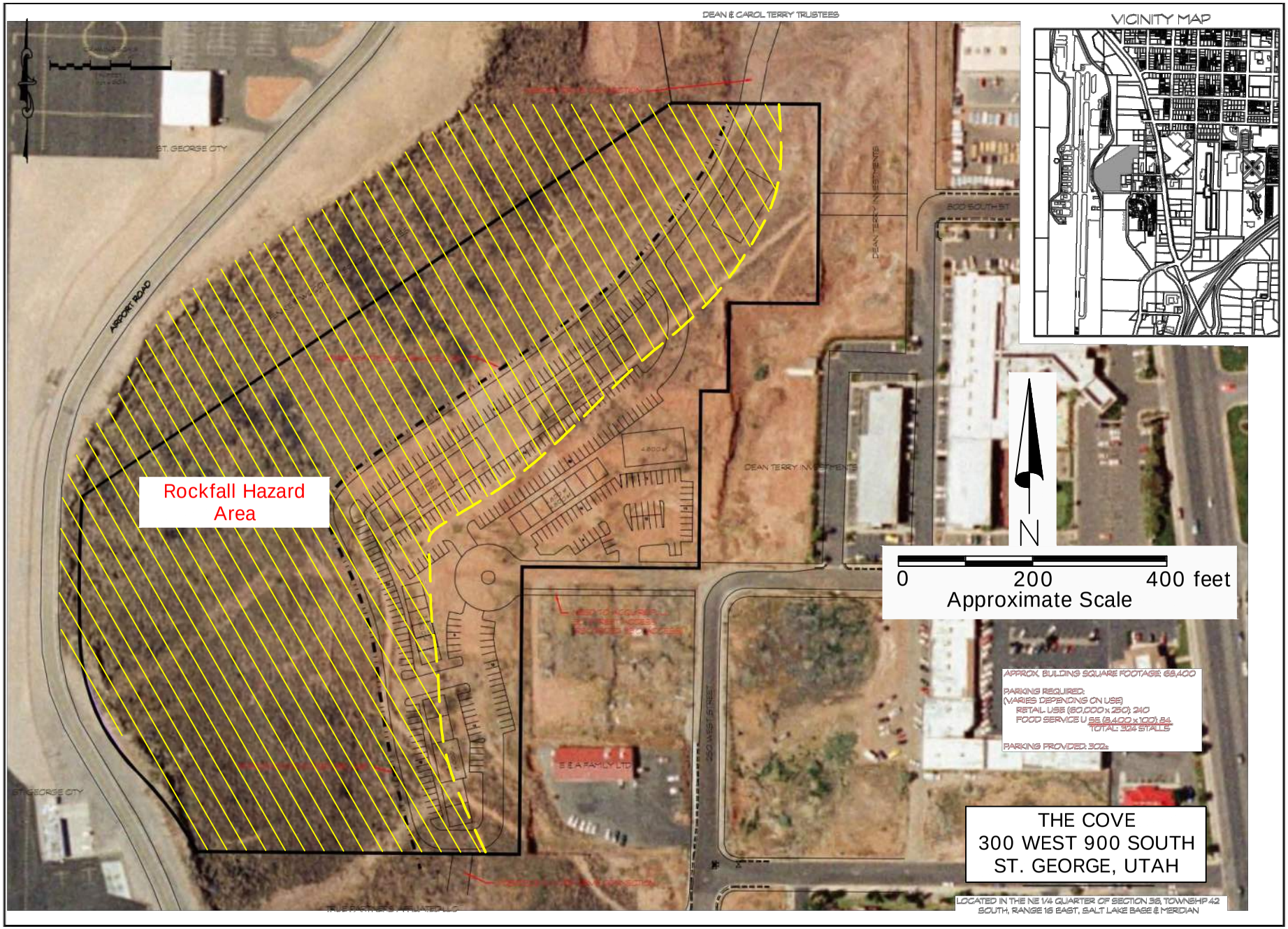
Normal fault, bar and ball on down thrown side, dashed where approximate, dotted where concealed.

N

0 1000 2000 feet

Approximate Scale

THE COVE
300 WEST 900 SOUTH
ST. GEORGE, UTAH



2192092	AGEC	Rockfall Hazard Area	Figure 2

Geologic Hazards Assessment

AGEC
Applied GeoTech

January 6, 2020

Holdaway Construction
38 East 590 North
Hurricane, Utah 84737

Attention: Brent Holdaway
EMAIL: bholdaway@live.com

Subject: Geologic-hazard Assessment
Proposed Cove Development
300 West 900 South
St George, Utah
Project No. 2192092

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. (AGEC) was requested to evaluate geologic hazards for the proposed Cove development to be constructed at approximately 300 West 900 South in St George, Utah.

PROPOSED CONSTRUCTION

We understand a mixed-use development consisting of retail, restaurant and residential facilities is planned for the east portion of the property. The west side of the developed area will be cut into the slope of the hillside.

GEOLOGY

The geology of the site is mapped by Hayden and Willis (2011) to consist of talus and landslide deposits on the hillside and bedrock near the base of the slope. The relatively flat east side of the property is mapped as mixed eolian and alluvial deposits. The bedrock is the Springdale Sandstone Member of the Kayenta Formation overlying the Whitmore Point Member of the Moenave Formation overlying the Dinosaur Canyon Member of the Moenave Formation. The bedrock dips gently down in a north/east direction.

Low-sun-angle aerial photographs from 1981, color aerial photographs from 2000, black and white aerial photographs from 1960 and lidar data from 2017 were reviewed to evaluate geologic hazards in the area. The resolution of the photographs along is not sufficient to allow evaluation of rockfall. In addition, the area planned for development had been disturbed

by the time of the photographs. Landslide deposits can be identified on the aerial photographs south of the site. The landslide mapped on the northwest slope above the proposed development area is not apparent from the aerial photographs or lidar. The area mapped as landslide is terraced suggesting there may be creep or shallow-depth movement of the ground in this area. The affected soil does not appear to extend more than about 2 or 3 feet deep.

ROCKFALL EVALUATION

There are outcrops of basalt above the property with some areas of rock that could potentially become dislodged, particularly during a major earthquake, and result in rockfall hazard for the proposed development. The rocks are generally less than 5 feet in size. The approximate extent of the rockfall hazard is presented on Figure 2. This is based on field observation and experience with similar sites in the area. The extent of the potential rockfall hazard cannot be well defined due to land disturbance and likely removal of rocks in the runout zone.

The area planned for buildings could be protected from rockfall hazards by constructing a barrier along the uphill side of the development or removal of the source rocks.

The rockfall-protection berm, assumed to be constructed just up slope of the west and northwest cut slopes for the development, should have a height of at least 8 feet, a top width of at least 6 feet and an upslope face of ½ horizontal to 1 vertical or steeper. It is important to have a steep upslope face for the berm so rocks are not directed over the berm. The berm should be reinforced using geogrid to maintain a steep upslope face. The reinforcement spacing and slope construction will depend on the type of fill used and reinforcement selected. Internal design of the berm reinforcement could be provided upon request.

LANDSLIDE EVALUATION

The landslide on the northwest side of the property appears to be less than 2 or 3 feet deep and is not expected to be a hazard for the proposed development if slopes are adequately reinforced. This should be evaluated in the geotechnical study for the site.

OTHER GEOLOGIC HAZARDS

Other geologic hazards considered for this study are debris flow and fault rupture. Based on geologic mapping for the area, our site reconnaissance, and review of aerial photographs and lidar data, these are not considered hazards at the site.

LIMITATIONS

This letter has been prepared in accordance with generally geologic engineering practices in the area for the use of the client. The conclusions and recommendations included in the letter are based on conditions observed during our field study, topographic information provided and

our experience with similar type projects. If conditions are significantly different from those described in this letter, we should be notified to reevaluate the recommendations given.

If you have questions or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

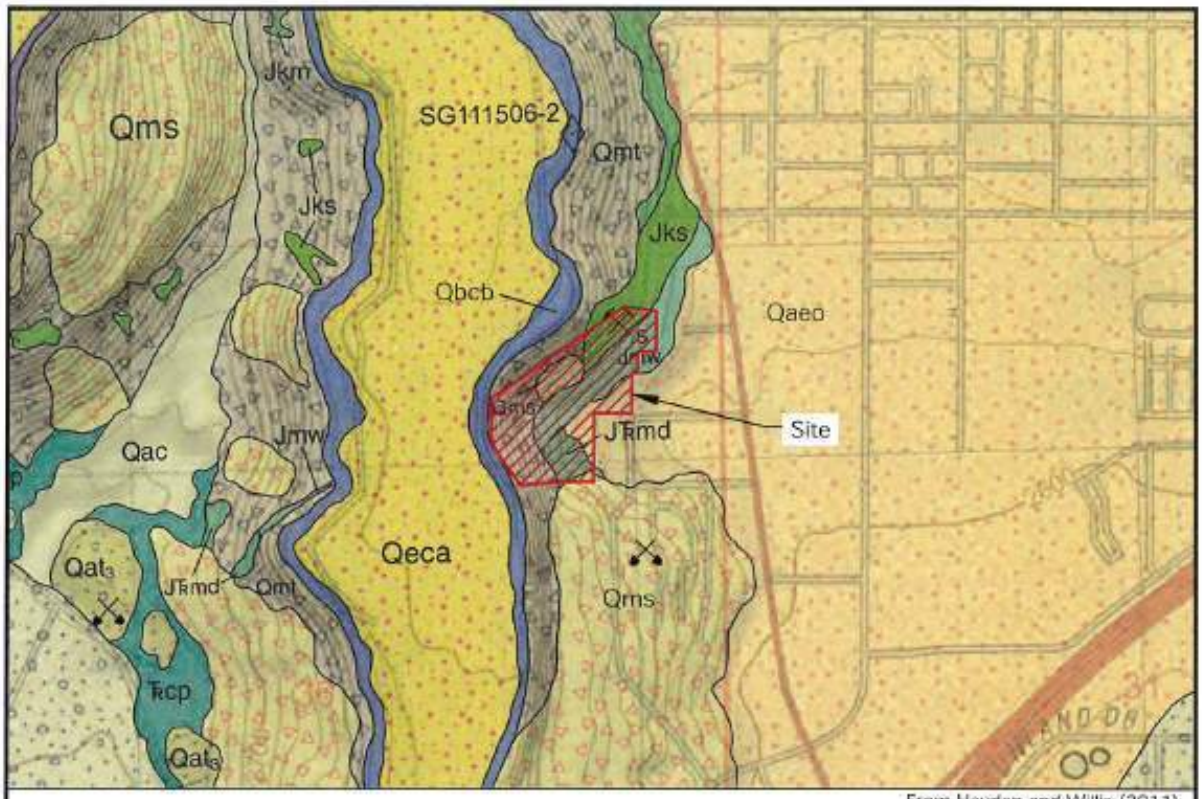


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2192092	AGEC	Geologic Map	Figure 1



2192092	AGEC	Rockfall Hazard Area	Figure 2