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, February 23, 2022** commencing on-site at approximately 8:30 a.m.

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

1. Consider a request for a hillside development permit at the Divario development. The applicant is proposing to construct in the area shown on the slope map labeled 20-29% and 30-39%. This is specifically in the PA-4 area which is situated in the far south west corner of the Divario development. The property is currently zoned Single-Family Residential, minimum lot size 10,000 square feet (R-1-10). The applicant is 730 St George, LLC. Case No. 2022-HS-003. This item was continued from the January 26, 2022 meeting. (*See 'Meeting Place' exhibit below*). **Meeting time approx. 8:30 am**

2. Consider a request for a hillside development permit at the Divario development. The applicant is proposing to construct in the area shown on the slope map labeled 20-29% and open space. This is specifically in the PA-18 area which is situated in the northern portion of the Divario development. The property is currently zoned Single-Family Residential, minimum lot size 10,000 square feet (R-1-10). The applicant is 730 St George, LLC. Case No. 2022-HS-004. (*See 'Meeting Place' exhibit below*). **Meeting time approx. 9:00 am**

3. Consider a request for a hillside development permit at the South Rim at Foremaster Ridge Phase 4 development. The applicant is proposing to allow structures in the 30' ridgeline setback in anticipation of the construction of a residential home on lot 85. The property is generally located at 1709 Ridgeline Circle and is currently zoned Single Family Residential, minimum lot size 10,000 sf (R-1-10). The applicant is Robert and Rhonda Marshall. Case No. 2022-HS-007. **Meeting time approx. 10:00 am**

4. Consider a request for a hillside development permit at the South Rim at Foremaster Ridge Phase 4 development. The applicant is proposing to allow structures in the 30' ridgeline setback in anticipation of the construction of a residential home on lot 86. The property is generally located at 1721 Ridgeline Circle and is currently zoned Single Family Residential, minimum lot size 10,000 sf (R-1-10). The applicant is Joshua Ballantyne. Case No. 2022-HS-006. **Meeting time approx. 10:00 am**

5. Consider a request to determine the ridgeline at Foremaster Ridge Lot 120 subdivision. The applicant is proposing to build a residential home on this parcel and would like to know where the ridgeline falls on this property. The applicant would also like to receive a reduction in the front setbacks from 25' to 20'. The property is generally located at 445 S. Five Sisters Drive and is currently zoned Single Family Residential, minimum lot size

10,000 sf (R-1-10). The applicant is John Wilson. Case No. 2022-HS-008. **Meeting time approx. 10:30 am**

6. Consider approval of the meeting minutes from January 26, 2022.

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 Locations

## Item #1 Intersection of Gap Canyon Pkwy & Canyon View Dr.




## Item #2 Intersection of Gap Canyon Pkwy and Divario Canyon Dr.



# Item #3 & #4 1709 and 1721 E. Ridgeline Circle




# Item #5 Foremaster Ridge Lot 120 (Approx 445 S. Five Sister's Dr)



St.George
Community Development

# ITEM 1

## Hillside Permit

HILLSIDE REVIEW BOARD AGENDA REPORT: **01/26/2022**
HILLSIDE REVIEW BOARD AGENDA REPORT: **02/23/2022**

HILLSIDE DEVELOPMENT PERMIT
**Divario (Formerly "The Lakes") PA-4**
Case No. 2022-HS-003

**Update:** On January 26, 2022, the Hillside Review Board (HRB) met on site to review the request for a Hillside permit for Divario PA-4. While on site, the HRB identified a wash that they felt was important to preserve. The applicant agreed and the application was tabled to the next meeting to give the applicant the chance to revise the plans. He has done so, and the revised plans have been attached to this report as Exhibit 'B'.

**Request:** This is a request for a Hillside Development Permit to allow the applicant to construct in the area shown on the slope map labeled 20-29% and 30-39%. This is specifically in the PA-4 area which is situated in the far south west corner of the Divario development.

**Hillside History:**

**1) 2005 -** Case No. 2005-HS-013 "The Lakes" (7/21/2005 - agenda item #2) – An overall conceptual hillside development permit review for 730 acres. Rosenberg Associates.

**2) 2008** - Case No. 2008-HS-006 "PA-17" The Lakes (7/16/2008) – 12.30 acres. Rosenberg Associates.

**3) 2008** - Case No. 2008-HS-012 (10/30/2008) Determine which PA areas have sensitive slopes and will require future hillside meetings for subdivisions; being PA-3, PA-4, PA-12, PA-13, PA-14, PA-15, PA-16, and PA-17 will require HS review (*Note: PA's # 1, 2, 4, 5, 6, 7, 8, 9 (if less than 10 ft.), 10, 11, & 18 will not require hillside review*).

**4) 2016** - Case No. 2016-HS-001 (1/20/2016) – Approx. 45.73 acres. The Hillside Review Board met and reviewed PA-14 and PA-16 and at that time approved the exclusion of washes and rock outcroppings in these 2 areas. However, following that review meeting, Rosenberg Associates met with City staff to revisit two additional rock outcroppings that were not looked at as closely by the board. One of these was located in PA-14, labeled as Item #1. Following the meeting with City staff it was determined to re-design the lot layout and grading around the feature and preserve it as a subdivision amenity in order to avoid scheduling another hillside review board meeting. The project design proceeded with that feature preserved.

**5) 2021** – Case No. 2021-001 (01/27/2021) – Approx. 19.78 acres. The Hillside Review Board reviewed a request for PA-9 to allow cuts and fills in excess of 10 feet in height. This was a requirement from the original hillside review in 2008. This was ultimately approved by the City Council.

**Exhibits Provided:**

1) Exhibit A - Overall Slope Analysis – Sheet 1
"Exhibit 1" in the packet shows the overall slope analysis for the entire PA (Planning Areas). *Note: There is a chart "Hillside Review" on the sheet that shows which PA areas will require a hillside review and which will not.*

2) Exhibit B – Preliminary Plat
"Exhibit B" depicts the proposed grading and layout for PA-4 at Divario. Additionally, Grading and Cross Sections pages are attached.

3) Exhibit C - Drainage Report
August 2016 – Drainage report produce by Rosenberg Associates.

4) Exhibit D – Executive Geotechnical Report
July 2005 – This was produced during the initial review of the Lakes development in 2005. Produced by Rosenberg Associates.

**Background:**

Open Space - The total proposed undisturbed open space and improved open space area for "The Lakes" will be approximately 202 acres (*which is about 28 % of the total project area*).

Manmade Slopes - Manmade slopes were identified and excluded (see blue area in "Exhibit A")

Exclusions - The hillside board allowed exclusions for small washes and rock outcroppings (see pink area in "Exhibit A")

Future Hillside Review - In 2008 the Hillside Board didn't visit all the small washes and outcroppings but left them for future consideration as plans would be submitted (with subdivisions). It was determined that some would require further review by the Hillside Board. PA-4 was one of those areas that require further review.

**Owner:** 730 St George, LLC

**Engineer:** Rosenberg Associates

**Location:** PA-4 is generally located south-west of Gap Canyon Parkway approximately 1,200 feet.

**Acreage:** 35.64 Acres

**Zoning:** R-1-8

**Powers & Duties:** Section 10-13A-8.B.1 of the "Hillside Review Board Powers and Duties" states that the hillside board can make recommendations to "adopt, modify or reject a proposal" to the Planning Commission (PC).

**Permit required:** Section 10-13A-7 requires that all major development (i.e., cut greater than 4', etc.) on slopes above 20% requires a 'hillside development permit' granted by the City Council upon recommendation from the Hillside Review Board and the Planning Commission.

**Applicable Ordinance(s):**

*(Selected portions)*

10-13A-1: Density and Disturbance Standards

A. The hillside development overlay zone (HDOZ) limits development densities and provides specific development incentives to transfer underlying zone densities from hillsides (sending areas), to less steep slopes or more safe development areas (receiving areas), within a development.

| Percent Natural Slope | Dwelling Units (DU) / Acre |
|---|---|
| 0-19 | See underlying zone |
| 20-29 | 2 DU/acre, provided the units are clustered on 30 percent (30%) or less of the land area within this slope category. 70 percent of this slope category shall remain undisturbed. The 70 percent area is based upon the overall area/development rather than per lot. Also see subsections A1, A2, and A3 of this section. |
| 30-39 | 1 DU/10 acres, provided no more than 5 percent (5%) of the site is disturbed, and 95 percent of the site remains undisturbed. If the cumulative area is at least 1 acre but less than 10 acres, the cumulative area shall be allowed 1 DU. |
| 40 | Development is not permitted (0%), **except** as provided for in subsection A4 of this section. |

Section 10-13A-1: Density and Disturbance Standards

F. The applicant may:

1. Transfer all development density from steeper slope categories (sending areas), to areas within the development with natural slopes of twenty percent (20%) or less (receiving areas); and
2. Develop additional bonus density, calculated from each slope category, as follows:
    a. Natural slopes twenty percent (20%) or less transferred on a one-to-one (1:1) unit basis; plus

b. One (1) additional density unit for each density unit transferred from natural slopes of twenty-one percent (21%) to thirty percent (30%); plus

c. Two (2) additional density units for each density unit transferred from natural slopes of thirty-one percent (31%) to forty percent (40%).

3. Unit calculation for the receiving area shall be based on the requirements of the sending area zone.

G. Density transfers to the receiving area may occur without a zone change within the receiving area even though the resulting density or configuration may exceed the density limits of the receiving area zone. Other than density, the receiving area's zoning requirements apply to development in the receiving area. For instance, lot sizes may vary, but single-family zoning districts only allow single-family detached dwellings.

H. If the applicant proposes to develop within the twenty-one percent (21%) to forty percent (40%) slope area, the applicant cannot employ partial density transfers from the sending area and must propose a design, site development plans, and a grading plan that blends and harmonizes all aspects of the proposed development into the natural topography, and that minimizes road cuts and fills.

I. Non-disturb areas within a residential lot as shown on the slope analysis map shall not be used to calculate minimum lot size.

J. Disturbance standards do not apply to the city for limited city facilities: trails, parks, and utilities.

**HSRB Motion Options:** The Hillside Review Board can recommend several different options to the Planning Commission and the City Council:

1. Denial
2. Approval as presented
3. Approval with specific conditions and comments added as required.

**Example Motion:** The hillside board recommends _____ of the request for a Hillside Development Permit to allow development of PA-4 as requested and outlined the staff report and has the following comments:

1. _____

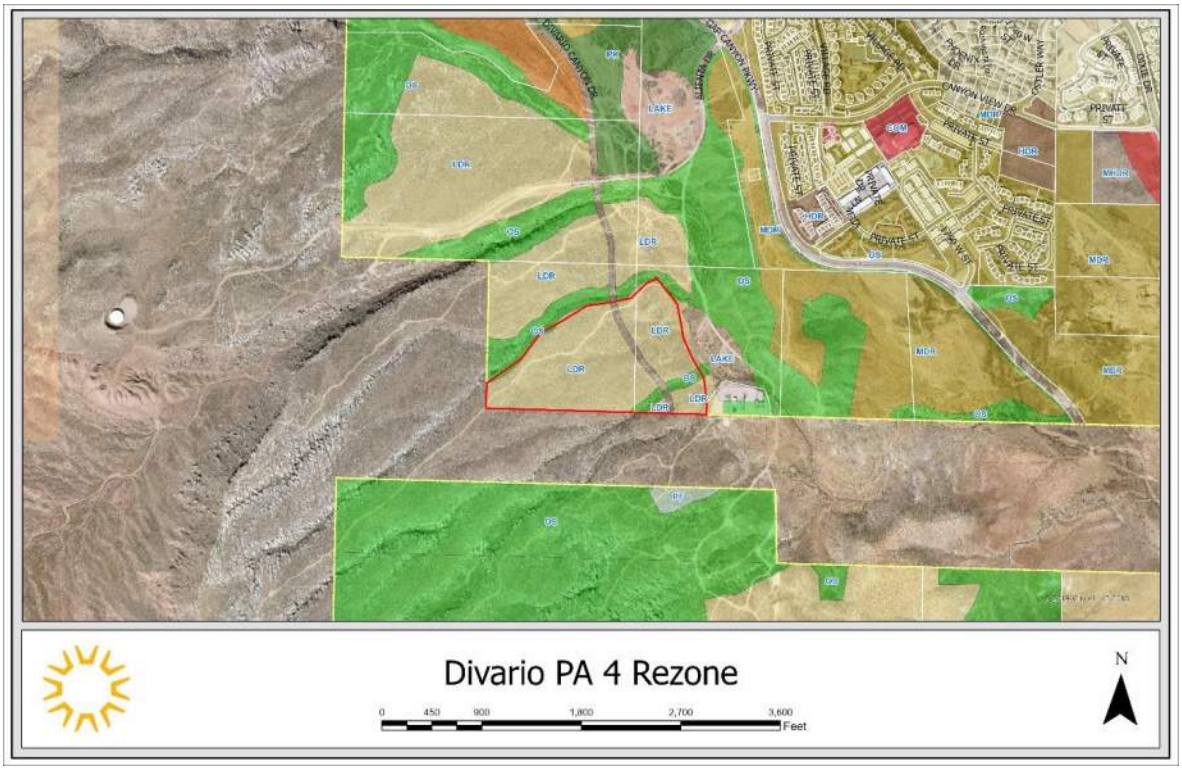
2. _____

3. _____

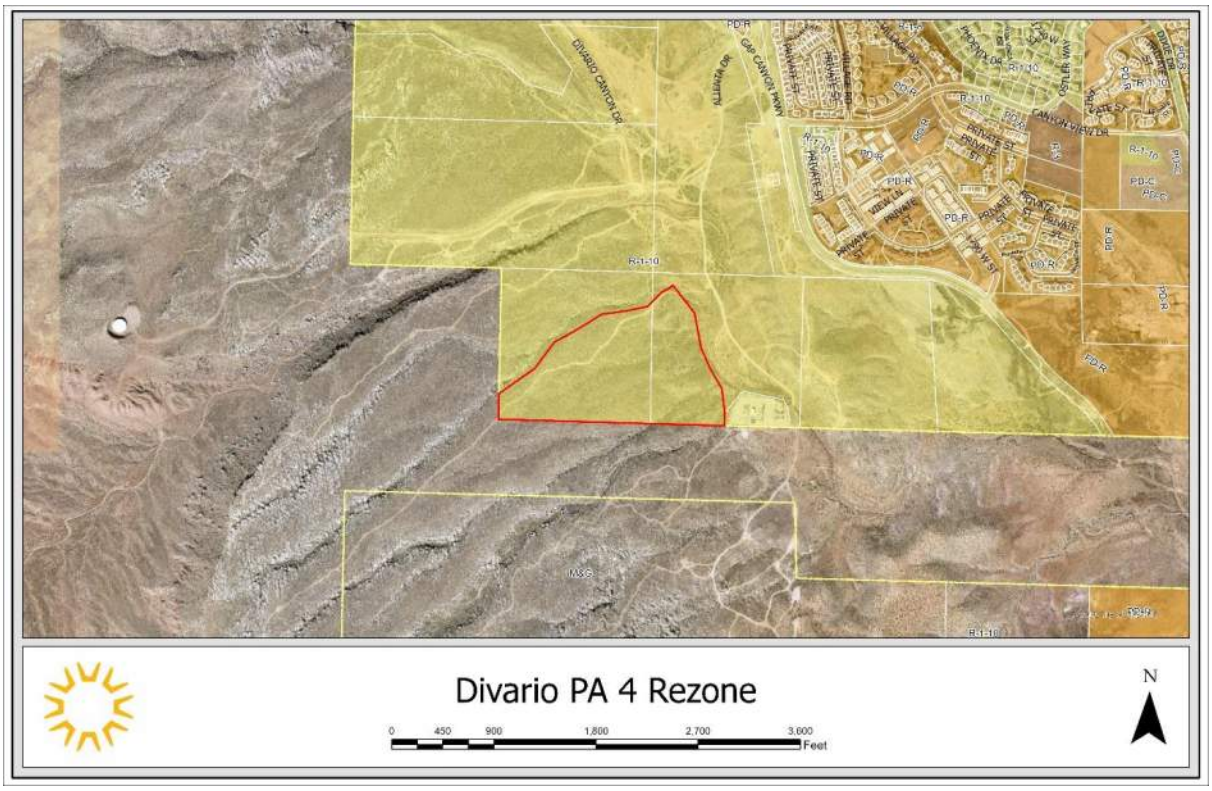
# Vicinity Map




# General Plan = LDR

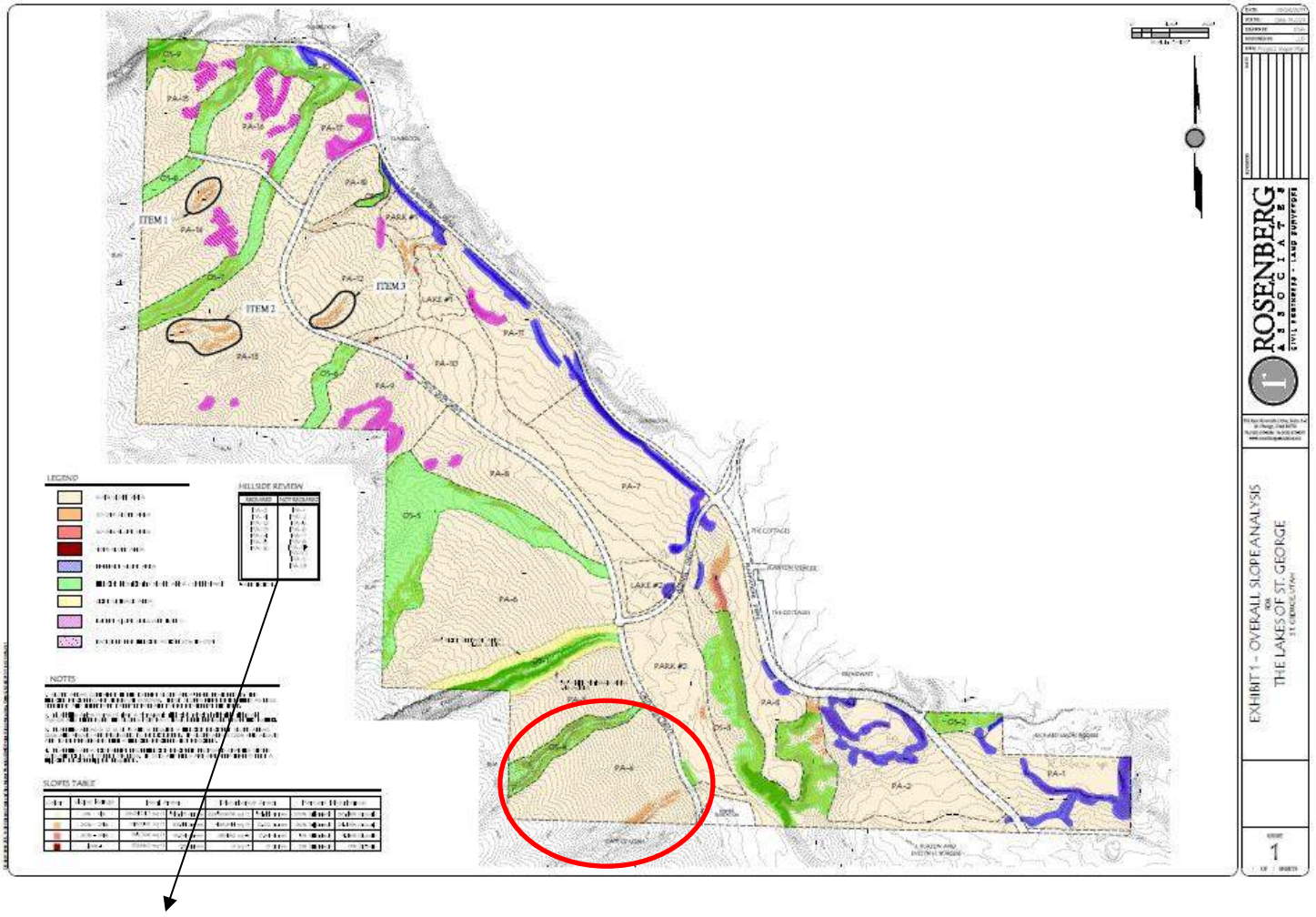


# Zoning = R-1-8 (Not reflected on the map)



# Exhibit A

Slope Map




## HILLSIDE REVIEW

| REQUIRED | NOT REQUIRED |
|---|---|
| PA-3 | PA-1 |
| PA-4 | PA-2 |
| PA-12 | PA-5 |
| PA-13 | PA-6 |
| PA-14 | PA-7 |
| PA-15 | PA-8 |
| PA-16 | PA-9* |
| | PA-10 |
| | PA-11 |
| | PA-18 |

* SEE NOTE 4.

## NOTES

1. SLOPE AREAS CONTAINED IN THE 'EXEMPT SLOPE AREA' WERE REVIEWED BY THE HILLSIDE REVIEW BOARD (HSRB) ON 10/30/08. THESE SLOPES WERE DETERMINED AS LESS SENSITIVE AND THEREFORE EXEMPT FROM ANY FUTURE REVIEW BY THE HSRB.

2. PLANNING AREA 17 (PA-17) HAD A SEPARATE HILLSIDE REVIEW MEETING HELD ON 7-16-08 AND THEREFORE THE SLOPES FOR PA-17 HAVE BEEN REMOVED FROM THIS EXHIBIT.

3. PLANNING AREAS 3, 12, 13, 14, 15 AND 16 REQUIRE A HILLSIDE REVIEW IF SLOPE AREAS (20% AND ABOVE) ARE PROPOSED TO BE DISTURBED. IF SLOPE AREAS (20% AND ABOVE) ARE TO BE PRESERVED, THEN A HILLSIDE REVIEW IS NOT REQUIRED.

4. PLANNING AREA 9 IS EXEMPT FROM HILLSIDE REVIEW IF PROPOSED GRADING SHOWS CUTS AND FILLS AT 10 FEET OR LESS. IF CUTS AND FILLS ARE GREATER THAN 10 FEET A HILLSIDE REVIEW WILL BE REQUIRED.

# Exhibit B

Preliminary Plat

125 LOTS

LOT 1 11884 S.F. 0.27 AC.
LOT 2 10522 S.F. 0.24 AC.
LOT 3 17986 S.F. 0.41 AC.
LOT 4 12024 S.F. 0.28 AC.
LOT 5 12590 S.F. 0.29 AC.
LOT 6 8077 S.F. 0.19 AC.
LOT 7 8027 S.F. 0.18 AC.
LOT 8 10229 S.F. 0.23 AC.
LOT 9 11180 S.F. 0.26 AC.
LOT 10 8009 S.F. 0.18 AC.
LOT 11 7551 S.F. 0.17 AC.
LOT 12 7553 S.F. 0.17 AC.
LOT 13 8018 S.F. 0.18 AC.
LOT 14 8014 S.F. 0.18 AC.
LOT 15 8802 S.F. 0.20 AC.
LOT 16 12421 S.F. 0.29 AC.
LOT 17 12306 S.F. 0.28 AC.
LOT 18 9287 S.F. 0.21 AC.
LOT 19 8421 S.F. 0.19 AC.
LOT 20 8398 S.F. 0.19 AC.
LOT 21 8366 S.F. 0.19 AC.
LOT 22 8683 S.F. 0.20 AC.
LOT 23 9983 S.F. 0.23 AC.
LOT 24 8754 S.F. 0.20 AC.
LOT 25 8000 S.F. 0.18 AC.
LOT 26 7995 S.F. 0.18 AC.
LOT 27 8018 S.F. 0.18 AC.
LOT 28 8039 S.F. 0.18 AC.
LOT 29 10002 S.F. 0.23 AC.
LOT 30 8004 S.F. 0.18 AC.
LOT 31 8000 S.F. 0.18 AC.
LOT 32 8777 S.F. 0.20 AC.
LOT 33 8000 S.F. 0.18 AC.
LOT 34 8000 S.F. 0.18 AC.
LOT 35 8019 S.F. 0.18 AC.
LOT 36 12996 S.F. 0.30 AC.
LOT 37 17021 S.F. 0.39 AC.
LOT 38 12223 S.F. 0.28 AC.
LOT 39 11351 S.F. 0.26 AC.
LOT 40 9437 S.F. 0.22 AC.
LOT 41 17307 S.F. 0.40 AC.
LOT 42 13657 S.F. 0.31 AC.
LOT 43 10122 S.F. 0.23 AC.
LOT 44 8531 S.F. 0.20 AC.
LOT 45 8000 S.F. 0.18 AC.
LOT 46 8000 S.F. 0.18 AC.
LOT 47 8000 S.F. 0.18 AC.
LOT 48 8000 S.F. 0.18 AC.
LOT 49 8000 S.F. 0.18 AC.
LOT 50 8000 S.F. 0.18 AC.
LOT 51 8000 S.F. 0.18 AC.
LOT 52 8095 S.F. 0.19 AC.
LOT 53 10878 S.F. 0.25 AC.
LOT 54 8006 S.F. 0.18 AC.
LOT 55 8000 S.F. 0.18 AC.
LOT 56 8024 S.F. 0.18 AC.
LOT 57 8031 S.F. 0.18 AC.
LOT 58 8740 S.F. 0.20 AC.
LOT 59 10719 S.F. 0.25 AC.
LOT 60 8055 S.F. 0.18 AC.
LOT 61 8028 S.F. 0.18 AC.
LOT 62 8000 S.F. 0.18 AC.
LOT 63 9142 S.F. 0.21 AC.
LOT 64 8006 S.F. 0.18 AC.
LOT 65 8000 S.F. 0.18 AC.
LOT 66 8438 S.F. 0.19 AC.
LOT 67 8935 S.F. 0.21 AC.
LOT 68 9886 S.F. 0.23 AC.
LOT 69 10650 S.F. 0.24 AC.
LOT 70 11096 S.F. 0.25 AC.
LOT 71 8399 S.F. 0.19 AC.
LOT 72 8539 S.F. 0.20 AC.
LOT 73 8184 S.F. 0.19 AC.
LOT 74 8000 S.F. 0.18 AC.
LOT 75 8339 S.F. 0.19 AC.
LOT 76 8032 S.F. 0.18 AC.
LOT 77 8190 S.F. 0.19 AC.
LOT 78 8078 S.F. 0.19 AC.
LOT 79 8112 S.F. 0.19 AC.
LOT 80 8154 S.F. 0.19 AC.
LOT 81 8099 S.F. 0.19 AC.
LOT 82 8212 S.F. 0.19 AC.
LOT 83 8345 S.F. 0.19 AC.
LOT 84 10539 S.F. 0.24 AC.
LOT 85 9512 S.F. 0.22 AC.
LOT 86 8103 S.F. 0.19 AC.
LOT 87 8769 S.F. 0.20 AC.
LOT 88 8000 S.F. 0.18 AC.
LOT 89 8147 S.F. 0.19 AC.
LOT 90 8073 S.F. 0.19 AC.
LOT 91 8516 S.F. 0.20 AC.
LOT 92 8073 S.F. 0.19 AC.
LOT 93 8025 S.F. 0.18 AC.
LOT 94 8345 S.F. 0.19 AC.
LOT 95 7914 S.F. 0.18 AC.
LOT 96 8875 S.F. 0.20 AC.
LOT 97 8201 S.F. 0.19 AC.
LOT 98 9501 S.F. 0.22 AC.
LOT 99 9412 S.F. 0.22 AC.
LOT 100 8275 S.F. 0.19 AC.
LOT 101 8210 S.F. 0.19 AC.
LOT 102 8196 S.F. 0.19 AC.
LOT 103 8503 S.F. 0.20 AC.
LOT 104 7773 S.F. 0.18 AC.
LOT 105 8137 S.F. 0.19 AC.
LOT 106 8023 S.F. 0.18 AC.
LOT 107 8583 S.F. 0.20 AC.
LOT 108 8024 S.F. 0.18 AC.
LOT 109 10659 S.F. 0.24 AC.
LOT 110 8974 S.F. 0.21 AC.
LOT 111 8285 S.F. 0.19 AC.
LOT 112 8463 S.F. 0.19 AC.
LOT 113 8326 S.F. 0.19 AC.
LOT 114 8315 S.F. 0.19 AC.
LOT 115 8462 S.F. 0.19 AC.
LOT 116 8769 S.F. 0.20 AC.
LOT 117 8423 S.F. 0.19 AC.
LOT 118 9233 S.F. 0.21 AC.
LOT 119 12168 S.F. 0.28 AC.
LOT 120 8255 S.F. 0.19 AC.
LOT 121 8717 S.F. 0.20 AC.
LOT 122 8610 S.F. 0.20 AC.
LOT 123 9088 S.F. 0.21 AC.
LOT 124 8472 S.F. 0.19 AC.
LOT 125 9944 S.F. 0.23 AC.

50.00' WASH

# Exhibit C

Drainage Report

# TECHNICAL DRAINAGE CONTROL REPORT

**Project Land Use Planning, Offsite Road Construction, and Mass Grading**
**The Lakes Master Plan Community**
**St. George, Utah**

Prepared For:

**730 St. George, LLC**
1636 Indian Wells Drive
Boulder City, Nevada 89005

**Rosenberg Associates**
352 East Riverside Drive, Suite A-2
St. George, Utah 84790




August 30, 2016

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ROSENBERG ASSOCIATES
CIVIL ENGINEERS LAND SURVEYORS

# TABLE OF CONTENTS


1.0 PROJECT LOCATION ..... 1

2.0 PROPERTY DESCRIPTION ..... 2

3.0 EXISTING OFF-SITE DRAINAGE DESCRIPTION ..... 2

3.1 Upstream Drainage ..... 2
3.2 Downstream Drainage ..... 3

4.0 EXISTING ON-SITE DRAINAGE DESCRIPTION ..... 3

5.0 MASTER PLANNED DRAINAGE CONSIDERATIONS ..... 3

5.1 Master Plan Hydrologic Model ..... 3
5.2 Master Plan Drainage Infrastructure ..... 3

6.0 FEMA AND OTHER REGULATORY REQUIREMENTS ..... 4

6.1 FEMA 100-Year Floodplain Delineation ..... 4
6.2 Erosion Hazard Zone ..... 4

7.0 OTHER DRAINAGE STUDIES IMPACTING THE SITE ..... 5

8.0 PROPOSED DRAINAGE FACILITIES ..... 5

8.1 Mass Grading ..... 5
8.2 Detail Grading ..... 6
8.3 Offsite Roadways ..... 6
8.4 Open Channels ..... 6
8.5 Regional Detention Facilities ..... 7

9.0 PROPOSED DRAINAGE FACILITIES DRAINAGE COMPLIANCE ..... 7

10.0 DESIGN RUNOFF COMPUTATIONS ..... 8

10.1 Hydrologic Calculations ..... 8
10.2 Comparison of Peak Flow Values ..... 9

11.0 PROPOSED DRAINAGE FACILITIES DESIGN COMPUTATIONS ..... 9

11.1 Culvert and Channel Capacity Design ..... 9
11.2 Street Capacity Design ..... 10
11.3 Storage Facilities Design ..... 10

12.0 REQUIRED EASEMENTS AND RIGHT-OF-WAY ..... 11

13.0 FEMA FLOODWAY AND FLOODPLAIN CALCULATIONS ..... 11

14.0 CONCLUSIONS AND STATEMENT OF COMPLIANCE ..... 11

15.0 APPENDIX ..... 12

*Figure 1 – Land Use Plan for The Lakes at St. George*
*Figure 2 – Watershed Map for The Lakes at St. George*
*Figure 3 – FEMA Regulatory 100-Year Floodplain*
*Figure 4 – Proposed Culvert Crossings*
*Figure 5 – Custom Soil Resource Report for Washington County Area*

Watershed Hydrology Model Input Spreadsheets
Watershed Hydrology Model Hydraulic Routing Spreadsheets
Watershed Hydrology Model Curve Number Spreadsheets
Watershed Hydrology Model Lag Time Spreadsheets
HEC-HMS Model and Output Tables
Culvert Calculation Worksheets

# 1.0 PROJECT LOCATION

The following Drainage Control Plan and Report is submitted in support of The Lakes at St. George Master Plan Community, a proposed project, located along Plantations Drive in western St. George, Utah, spanning the distance between the Sunbrook Community at the end of Sunbrook Drive to the north, and near the Tonaquint Business Park to the South. The site is located within Sections 27, 28, 34 and 35 in Township 42 South, Range 16 West, Salt Lake Base and Meridian.

This report has been prepared to evaluate regional storm flows at key locations within the project area in order to perform mass grading operations, and to construct the following proposed off-site roadways to access the proposed development/planning areas:

- Plantations Drive
- Lago Vista Drive
- Alienta Drive
- Sentieri Vista Drive

This report has been prepared in accordance with the requirements and procedures outlined in the *Washington County Flood Control Authority Storm Drainage Systems Design and Management Manual*[1]. Conclusions and recommendations are made herein regarding drainage improvements required, floodplain impacts, and general conformance to city ordinances. Separate drainage studies will be prepared for each specific planning area to address localized drainage concerns and compliance with the city's drainage requirements.

The following supplemental figures have been prepared and included in the Appendix for reference and illustration information:

- *Figure 1 – Land Use Plan for The Lakes at St. George*, illustrating project location, project planning areas, and proposed planning area land uses and densities.
- *Figure 2 – Watershed Map for The Lakes at St. George*, illustrating the major watershed boundaries impacting the site.
- *Figure 3 – FEMA Regulatory 100-Year Floodplain Exhibit Map*, illustrating the drainage channels subject to the regulatory requirements of the Federal Emergency Management Agency (FEMA).
- *Figure 4 –Culvert Crossings*, showing the approximate location, minimum pipe diameter, and minimum slope requirements of culvert crossings and storm drain pipelines for the offsite roads including Plantations Drive, Lago Vista Drive, Alienta Drive, and Sentieri Vista Drive.
- *Figure 5 – Custom Soil Resource Report for Washington County Area*, showing soils and soil properties on the subject property.

[1] Bowen, Collins and Associates, Washington County Flood Control Authority Storm Drainage Design and Management Manual, Draft v0.3.

# 2.0 PROPERTY DESCRIPTION

The proposed Lakes at St. George is a 731-acre master plan community that is planned to be comprised of single-family residences, multi-family residences, parks and open spaces, commercial areas, public buildings such as churches, and associated streets of various right-of-way widths. *Figure 1 – Land Use Plan*, shows an overall view of the property. The proposed project is divided into 16 individual planning areas noted as PA-1, PA-2, etc. A legend on Figure 1 lists the master planned land uses and densities proposed for each planning area as follows:

- Low Density Residential: up to 4 units per acre, includes PA-4, PA-5, PA-6, PA-14, PA-15, and PA-16 covering approximately 174 acres.
- Medium Density Residential: up to 9 units per acre, includes PA-2, PA-3, PA-7, PA-9, PA-10, PA-11, PA-12, and PA-13 covering approximately 236 acres.
- High Density Residential: up to 15 units per acre, includes PA-1, PA-17, and PA-18 covering approximately 48 acres.
- Commercial/Mixed Use: includes PA-8 covering approximately 27 acres.

The remainder of the property will remain as undisturbed or improved open spaces to consist of parks, trails and other recreational facilities. These open spaces provide a natural break between each planning area, and most of them are located to accommodate the existing naturally flowing drainage patterns. The focal point of the open spaces will be two 5-acre lakes that will be used for detention, and to provide storage facilities for the City of St. George re-use water network.

# 3.0 EXISTING OFF-SITE DRAINAGE DESCRIPTION

## 3.1 UPSTREAM DRAINAGE

Storm water impacting the project from upstream sources generally originates on undeveloped desert land and drain in a sheet flow manner towards ephemeral washes that carry the concentrated water to the project property from the west and south.

The watershed impacting the proposed Lakes at St. George is illustrated in *Figure 2 – Watershed Map*. As seen in the exhibit, the total watershed area has been divided into a number of subareas to better pinpoint runoff amounts at specific locations within the project. Most off-site storm water enters the project from property belonging to the Bureau of Land Management (BLM). A small amount of off-site storm water enters the project along Plantations Drive from property belonging to the Sunbrook master plan community.

### 3.2 DOWNSTREAM DRAINAGE

In both the existing and proposed developed condition, storm water will exit the property in either the Box Canyon Wash, draining the northern portion of the property consisting of subarea Groups X, Y, A and B; or the Gap Wash, draining the rest of the property to the south and east. Flows leaving the project in the Box Canyon Wash travel through the Sunbrook Golf Course a distance of approximately 6,000 feet before discharging to the Santa Clara River just upstream of the Dixie Drive crossing at Mathis Park. Flows leaving the project in the Gap Wash travel eastward toward the Tonaquint Business Park, covering a total distance of approximately 4,800 feet before discharging to the Santa Clara River just north of the City of St. George Tonaquint Cemetery.

## 4.0 EXISTING ON-SITE DRAINAGE DESCRIPTION

In the undeveloped condition, the study area drains by sheet flow and washes to the Box Canyon Wash and the Gap Wash as shown in Figure 2. In the developed condition, storm water runoff will drain to the same major washes preserved in the designated open space corridors, as in the undeveloped condition.

## 5.0 MASTER PLANNED DRAINAGE CONSIDERATIONS

### 5.1 MASTER PLAN HYDROLOGIC MODEL

The Lakes property has been included in the hydrologic model prepared for the city's drainage master plan summarized in the *City of St. George Storm Drain Master Plan Update*[2]. Referencing Figure 2, Subareas A1, A2, A3, B1, B2, B3, B4, X1, X2, Y1, and Y2 in this report are part of the Box Canyon Wash BC100 master plan subarea. Subareas C1, C2, C3, C4, C5, D1, D2 in this report are part of the Gap Wash G20 master plan subarea. Subareas E1, E2, E3, E4, F1, F2, G1, G2, and H1 are part of the Gap Wash watershed G40 master plan subarea.

### 5.2 MASTER PLAN DRAINAGE INFRASTRUCTURE

Existing master planned drainage infrastructure impacting The Lakes project is limited to one 36-inch diameter pipe, labeled Pipe G50-2 in the city master plan and noted to carry a design flow of 65 cubic feet per second (cfs). This pipe conveys drainage from the Las Palmas and Worldmark Resort properties along 1790 West Street, discharging into the project property along the Plantations Drive right-of-way.

Proposed master planned drainage infrastructure impacting The Lakes project includes two proposed pipes linking to Pipe G50-2:

[2] Bowen, Collins and Associates and John H. Humphrey, City of St. George Storm Drain Master Plan Update, July, 2009.

- Pipe G50-1, a proposed 30-inch diameter pipe noted to carry a design flow of 65 cfs, to convey storm water along the Plantations Drive right-of-way along the Worldmark Resort frontage, and connecting to existing Pipe G50-2 at the intersection of 1790 West Street.
- Pipe G50-3, a proposed 42-inch diameter pipe noted to carry a design flow of 196 cfs, to combine flows from G50-1 and G50-2 and convey storm water south and eastward along the future Plantations Drive right-of-way.

The above existing and proposed pipelines were factored into this report analysis with some modifications to suit the drainage patterns and open space corridors proposed in The Lakes land use plan.

# 6.0 FEMA AND OTHER REGULATORY REQUIREMENTS

## 6.1 FEMA 100-YEAR FLOODPLAIN DELINEATION

Two drainage washes are located within the 100-year floodplain that are subject to the regulatory requirements of the Federal Emergency Management Agency (FEMA) including the Box Canyon Wash and the Gap Wash, as noted on the current FEMA Flood Insurance Rate Maps[3]. The 100-year floodplain boundaries for these two washes are shown in *Figure 3 – FEMA Regulatory 100-Year Floodplain Exhibit Map*.

Box Canyon Wash clips the north side of the property and receives drainage from Subareas A1, A2, A3, B1, B2, B3, Y1, Y2, X1, and X2. The remaining Subareas drain to the Gap Wash. Figure 3 illustrates the location of regulatory Zone A for both the Box Canyon and Gap washes, which is defined as the 100-year floodplain Special Flood Hazard Area with no base flood elevations established. All areas noted as Zone A are located within the designated open spaces for The Lakes master plan community. Areas proposed for development are all located within Zone X, which is defined to be outside the 0.2% annual floodplain.

## 6.2 EROSION HAZARD ZONE

The subject property is not located within an "Erosion Hazard Zone" as defined by the City of St. George.

[3] Federal Emergency Management Agency (FEMA) National Flood Insurance Program, Flood Insurance Rate Map, Washington County, Utah Map Numbers 49053C1007G and 49053C1009G, Effective Date April 2, 2009.

# 7.0 OTHER DRAINAGE STUDIES IMPACTING THE SITE

The following studies were referenced in preparing this report:

- The Lakes at St. George Hydrology Report, prepared by Rosenberg Associates, dated May 15, 2008. This report is a general overview of major drainage patterns encompassing the entire Lakes planned development property boundary. This report updates the earlier report to current city analysis and drainage design standards.
- Four Dams at The Lakes Preliminary Drainage Evaluation, prepared by Rosenberg Associates, dated September 14, 2005. This report is a hydrologic analysis of the proposed "lakes" to be constructed in the master plan community open space.
- Box Canyon Wash Hydraulic Modeling, performed by Rosenberg Associates in 2008. This work resulted in the delineation of the 100-year floodplain along the Box Canyon Wash.

# 8.0 PROPOSED DRAINAGE FACILITIES

Drainage facilities proposed for The Lakes master plan community will convey water through the planning areas and connecting roads by a combination of grading, street improvements, and storm drain infrastructure. Specific routing, sizing, and placement of storm drain infrastructure will be proposed during the detailed design stage of each planning area; however, this report has been prepared to evaluate regional storm flows at key locations within the project area in order to perform mass grading operations, and to construct the following proposed off-site roadways to access the proposed development/planning areas:

- Plantations Drive: Extending from the north property boundary and heading in a southeasterly direction approximately 12,400 feet to the southeastern property boundary.
- Lago Vista Drive: Extending from the point of intersection with Plantations Drive on the northwest side of the parcel, and extending in a southeasterly direction approximately 8,900 feet to the southwestern property boundary.
- Alienta Drive: Extending from Lago Vista Drive northward approximately 2,400 feet where it ties to the existing Alienta Drive.
- Sentieri Vista Drive: Extending from Lago Vista Drive in the northwest area of the project and heading in a westward direction approximately 1,300 feet through planning areas PA-14, Pa-16, and terminating in PA-15.

## 8.1 MASS GRADING

It is the desire of the project developers to conduct mass grading operations on portions of the master plan project. The purpose of this is to be able to move earth materials between the planning areas. Planning areas with an abundance of quality material that can be used for general fill, structural fill, and/or utility trench bedding will be mined and the excess material moved to planning areas where additional fill material is needed.

Limited grading design will be performed for various phases of mass grading. Plans will be submitted to the City of St. George engineering department and processed for a grading permit before any grading operations begin. Mass grading design will focus on maintaining the existing drainage patterns by picking up storm water offsite flows, routing storm water through the mass graded planning area to be discharged back into the open space areas as close as practicable to the historic point of discharge.

## 8.2 DETAIL GRADING

Detailed grading plans will be submitted with the project development plans for each planning area to include individual lot and/or building pad grading, interior road plan and profile drawings, and underground storm drain plan and profile where needed.

A detailed drainage study will be prepared for the proposed development and submitted with the project construction plans for each individual planning area.

## 8.3 OFFSITE ROADWAYS

Construction of the offsite roadways including Plantations Drive, Lago Vista Drive, Alienta Drive, and Sentieri Vista Drive, as noted above, will occur in phases as needed to service the development of the planning areas. The peak storm water runoff values in this drainage study were used to evaluate roadway cross section conveyance capacity, to size in-line underground storm water pipelines, and to locate and size offsite roadway culvert crossings. The approximate location, minimum pipe diameter sizing, and minimum slope requirements of culvert crossings and storm drain pipelines are illustrated in *Figure 4 – Proposed Offsite Road Culvert Crossing and Storm Drain Facilities*. Detailed construction plans for all offsite roadway drainage improvements will be submitted with the applicable planning area construction plans.

## 8.4 OPEN CHANNELS

Construction of open channels are proposed to convey storm water through the disturbed open space areas. The proposed routing location, size, minimum design slope and capacity of these channels will be addressed with the detailed drainage design of the adjacent planning areas or design of open space area. The channels are generally located as follows:

- Between Lake 1 and Lake 2 adjacent to Lago Vista Drive
- Routing the Gap Wash through Park 2 adjacent to Lago Vista Drive, between Lake 2 and the power substation.
- Routing the Gap Wash through planning areas PA-1 and PA-2 inside the boundaries of the delineated floodplain.

Additional temporary man-made open channels may need to be constructed to route storm water through mass-graded planning areas, then directed back into the natural drainages located in the adjacent open space areas. The peak flow values of this report will be used to

size these temporary channels, which will be called out as needed on the individual mass grading construction plans. Once the planning area goes into final design, these channels will be replaced with improved streets, storm drains, or culverts.

### 8.5 REGIONAL DETENTION

It is the desire of the project developers to detain increased storm water caused by development. Rather than design numerous smaller detention facilities for each planning area, storm water will be routed into regional facilities adjacent to the two 5-acre lake amenities, as discussed below. Storm water won't be routed directly in the lake amenities, but into a containment area next to the lake to help maintain the quality of the city's re-use water that will be stored in the lake facilities. Master Plan Model results indicate that detention may be minimal or not required. Finalization of detention needs will be addressed with detailed drainage design of each planning area.

- Lake 1 Detention Basin: Increased storm water runoff generated in Subareas B2 and B3 will be routed directly into a detention basin adjacent to Lake 1, then discharged into the Box Canyon Wash. Additional capacity and outlet control facilities will be installed in this detention basin to also detain the total combined increase from Subareas A2, A3, X2, and Y2. This will allow the increase from these subareas to discharge directly to Box Canyon Wash while limiting the total peak flow discharging from the property to the peak "pre-developed" design condition.
- Lake 2 Detention Basin: Increased storm water runoff generated in Subareas C2, C3 and D2 will be routed directly into a detention basin adjacent to Lake 2, then discharged into the Gap Wash. Additional capacity and outlet control facilities will be installed in this detention basin to also detain the total combined increase from Subareas E2, E3, E4, F2 and G2. This will allow the increase from these subareas to discharge directly to the Gap Wash while limiting the total peak flow discharging from the property to the peak "pre-developed" design condition.

## 9.0 PROPOSED DRAINAGE FACILITIES COMPLIANCE

The hydrologic and hydraulic analysis utilized for design of The Lakes master plan community storm water drainage facilities were performed in accordance with the requirements of the Washington County Flood Control Authority (WCFCA) *Storm drainage Systems Design and Management Manual*. Specific compliance measures were as follows:

- Hydrologic Analysis: The hydraulic analyses performed for The Lakes off-site and on-site watershed was performed in accordance with Section 4 of the drainage manual utilizing the US Army Corps of Engineers HEC-HMS Version 4.1[4] modeling software. The hydrologic

[4] U.S. Army Corps of Engineers, Hydraulic Engineering Circular Hydrologic Modeling System (HEC-HMS) software, Version 3.5.

analysis is discussed in greater detail in Section 10 of this report, with detailed information included in the appendix.

- Street Design: Street drainage design was performed in accordance with Section 3 of the drainage manual assuming that Sentieri Vista Drive is a minor collector, Lago Vista Drive and Alienta Drive are major collectors, and Plantations Drive is a major arterial in accordance with Table 3-1.
- Storm Drain Design: Storm drain design for Sentieri Vista Drive, Lago Vista Drive, Alienta Drive, and Plantations Drive was performed in accordance with Section 3 of the drainage manual assuming an open-channel flow condition.
- Culvert Design: Culverts for the offsite road system were designed in accordance with Section 3 of the drainage manual to fully convey the 100-year design storm event in an open channel flow condition.
- Open Channel Design: Open channels conveying storm water from detention areas to the Box Canyon Wash and Gap Wash, and conveying flows adjacent to Lago Vista Drive, will be designed with future phases. Open channels will be designed to match the natural channel flow characteristics of the existing channels.
- Storage Facilities Design: The two regional detention facilities have been sited and will designed with future phases as needed.

# 10.0 DESIGN RUNOFF COMPUTATIONS

## 10.1 HYDROLOGIC CALCULATIONS

The US Army Corps of Engineers HEC-HMS Version 4.1 was used to perform the hydrologic analysis for this study. The Farmer-Fletcher distribution is used for the 3-hour storm events and the SCS Type II distribution is used for the 24-hour storm events. The SCS Composite Curve Number method was utilized to determine the runoff curve number since all areas within the watershed evaluated are currently undeveloped.

Tables summarizing model input for the following values have been included in the appendix:

- Watershed areas, longest length, and average slope for the pre-developed and proposed post-developed condition.
- SCS composite curve number values for the pre-developed and proposed post-developed condition.
- Hydrologic model junction and routing characteristics.
- Calculated times of concentration and lag time.

### 10.2 COMPARISON OF PEAK FLOW VALUES

Modeling for The Lakes master plan development considered both the existing pre-developed condition and the assumed post-developed condition, in order to size storm drainage facilities and to compare impacts to storm water peak flow values caused by proposed development. HEC-HMS model peak storm values for all subareas, junctions, and routing conditions for the pre-developed and proposed post-developed condition are included in the appendix.

Post-developed conditions were assumed to match the proposed uses and densities described in Section 2 of this report and illustrated in *Figure 1 – Land Use Plan*. Since exact layout for each of the 16 individual planning areas is not known at this point, detailed drainage study update reports will be submitted with the development of each planning area.

## 11.0 PROPOSED DRAINAGE FACILITIES DESIGN COMPUTATIONS

Computations for the hydraulic design of The Lakes master plan community storm water drainage facilities were performed in accordance with the requirements of the Washington County Flood Control Authority *Storm Drainage Systems Design and Management Manual*. Output tables for calculations are included in the appendix.

### 11.1 CULVERT AND CHANNEL CAPACITY DESIGN

Culvert and channel capacities utilized Manning's equation for open channel flow:[5]

$$Q = \frac{1.49\,(A)^{5/3}(S)^{1/2}}{n(P)^{2/3}}$$

Where
- Q = Hydraulic Capacity, in cubic feet per second (cfs)
- A = Cross Sectional Flow Area, in square feet
- S = Average Slope, in feet per foot
- n = Manning's Roughness Coefficient
- P = Wetted Perimeter, in feet

[5] Flammer, Jeppson, and Keedy, Fundamental Principles and Applications of Fluid Mechanics, Utah State University, 1986, p. 289.

Table 11-1 lists the Manning's roughness coefficients used in the model evaluation:

**TABLE 11-1: MANNING'S ROUGHNESS COEFFICIENTS**

| Surface Description | Manning's n Value |
|---|---|
| High Density Polyethylene Pipe (HDPE) | 0.010 |
| Concrete Pipe (RCP) | 0.013 |
| Open Channels | 0.078 |
| Asphalt Pavement | 0.015 |

The following parameters were assumed for each evaluation:

- All culvert capacities were evaluated as flowing full in the open channel flow condition, assuming no surcharge.
- The slope of each culvert was assumed to be the average slope of the drainage basin or routing, unless additional information was known to justify a different value.
- If existing drainage or future road drainage infrastructure was determined to be inadequate to accommodate the modeled design storm, the culvert or open channel was sized to accommodate the full modeled design storm value.

## 11.2 STREET CAPACITY DESIGN

Street capacities were modeled using Manning's equation for open channel flow based on the master planned street cross-section, assuming full street improvements were constructed. Minimum slopes for all street sections were assumed to be at 0.5%.

## 11.3 STORAGE FACILITIES DESIGN

The two regional detention facilities are proposed, as discussed in Section 8.5. The master plan calculations summarized in this report do not include a proposed size for these two facilities, since overall post-development values do not exceed the pre-development values. If localized post-developed drainage values are determined to exceed pre-developed values during detailed drainage design of the planning areas, the storage facilities will be designed utilizing HEC-HMS output files, sizing for the 10-year 24-hour design storm, and sizing for the worst-case condition (whichever yielded the greatest volume) of the 100-year 3-hour design storm or the 100-year 24-hour design storm. Since not all subareas will be able to be routed directly through one of the detention basins, it is assumed that the regional facilities may need to be oversized to compensate for the total increased flow where storm water exits the property in the Box Canyon Wash for Lake 1, or in the Gap Wash for Lake 2, as discussed in Section 8.5 of this report.

## 12.0 REQUIRED EASEMENTS AND RIGHTS-OF-WAY

No additional easements or rights-of-way are being proposed for storm water drainage with the master plan, mass grading, or construction of offsite roadways. Major drainage channels within the proposed project are to remain in the open space areas shown in Figure 1, the master land use plan. Specific drainage easements, if needed within the individual planning areas, will be noted with the submittal of the planning area detailed drainage study report and project construction plans.

## 13.0 FEMA FLOODWAY AND FLOODPLAIN CALCULATIONS

No additional hydrologic or hydraulic calculations were performed for the purposes of modifying the existing floodplain as delineated on the FEMA flood insurance rate maps. It is the intention of the project developer to leave all designated floodplain areas for the Box Canyon Wash and Gap Wash out of the residential development areas.

## 14.0 CONCLUSIONS AND STATEMENT OF COMPLIANCE

This report for the drainage design of The Lakes Master Plan was prepared under my direct supervision in accordance with the provisions of Washington County Flood Control Authority (WCFCA) Storm Drainage Systems Design and Management Manual, and was designed to comply with the provisions thereof. I understand that the City of St. George and WCFCA do not and will not assume liability for drainage facilities design.

# APPENDIX

*Figure 1 – Land Use Plan for The Lakes at St. George*
*Figure 2 – Watershed Map for The Lakes at St. George*
*Figure 3 – FEMA Regulatory 100-Year Floodplain*
*Figure 4 – Proposed Culvert Crossing Calculations*
*Figure 5 – Custom Soil Resource Report for Washington County Area*

Watershed Hydrology Model Input Spreadsheets
Watershed Hydrology Model Hydraulic Routing Spreadsheets
Watershed Hydrology Model Curve Number Spreadsheets
Watershed Hydrology Model Lag Time Spreadsheets
HEC-HMS Model and Output Tables
Culvert Calculation Worksheets

## AREA TOTALS

| | | |
|---|---|---|
| | = 173.80 ACRES | 23.8% |
| | = 236.12 ACRES | 32.3% |
| | = 48.43 ACRES | 6.6% |
| | = 27.04 ACRES | 3.7% |
| | = 202.84 ACRES | 27.8% |
| | = 42.48 ACRES | 5.8% |
| TOTAL | = 730.71 ACRES | 100% |

## NOTE

THE BOUNDARIES DESIGNATED FOR LAKES AND PARKS ARE SUBJECT TO CHANGE AT THE DEVELOPERS DISCRETION.

## LEGEND

- LOW DENSITY RESIDENTIAL (UP TO 4 UNITS PER ACRES)
- MEDIUM DENSITY RESIDENTIAL (UP TO 9 UNITS PER ACRE)
- HIGH DENSITY RESIDENTIAL (UP TO 15 UNITS PER ACRE)
- COMMERCIAL/MIXED USE
- OPEN SPACE / PARKS / LAKES (SEE NOTE BELOW)
- ROADWAYS / CITY PROPERTY
- MAJOR ARTERIALS
- MINOR ARTERIALS
- REGIONAL TRAILS (PAVED)
- LOCAL TRAILS (PAVED)
- RECREATION TRAILS (DIRT)
- FUTURE ROADWAYS
- PROPERTY LINE
- WASHES
- TRAILHEAD SITE

## PLANNING AREAS

| AREA | ZONE | ACRES | DENSITY |
|---|---|---|---|
| P.A.-1 | HDR | 28.09 | UP TO 15 UNITS/ACRE |
| P.A.-2 | MDR | 35.96 | UP TO 9 UNITS/ACRE |
| P.A.-3 | MDR | 24.10 | UP TO 9 UNITS/ACRE |
| P.A.-4 | LDR | 33.52 | UP TO 4 UNITS/ACRE |
| P.A.-5 | LDR | 19.37 | UP TO 4 UNITS/ACRE |
| P.A.-6 | LDR | 59.74 | UP TO 4 UNITS/ACRE |
| P.A.-7 | MDR | 35.93 | UP TO 9 UNITS/ACRE |
| P.A.-8 | MIXED USE | 27.04 | UP TO 10 UNITS/ACRE |
| P.A.-9 | MDR | 13.30 | UP TO 9 UNITS/ACRE |
| P.A.-10 | MDR | 11.33 | UP TO 9 UNITS/ACRE |
| P.A.-11 | MDR | 27.17 | UP TO 9 UNITS/ACRE |
| P.A.-12 | MDR | 26.88 | UP TO 9 UNITS/ACRE |
| P.A.-13 | MDR | 61.45 | UP TO 9 UNITS/ACRE |
| P.A.-14 | LDR | 28.44 | UP TO 4 UNITS/ACRE |
| P.A.-15 | LDR | 16.35 | UP TO 4 UNITS/ACRE |
| P.A.-16 | LDR | 16.38 | UP TO 4 UNITS/ACRE |
| P.A.-17 | HDR | 12.31 | UP TO 15 UNITS/ACRE |
| P.A.-18 | HDR | 8.03 | UP TO 15 UNITS/ACRE |

BLM
SANTA CLARA CITY

FUTURE CONNECTION TO WESTERN CORRIDOR

SUNBROOK DR.

BOX CANYON WASH

OPEN SPACE
4.29 ACRES

P.A.-15
16.35 ACRES

P.A.-16
16.38 ACRES

P.A.-17
12.31 ACRES

P.A.-18
8.03 ACRES

OPEN SPACE
2.44 ACRES

P.A.-14
28.44 ACRES

SUNBROOK

BLM
(NON-INCORPORATED)

PARK #1
4.29 ACRES

PLANTATIONS DR.

P.A.-12
26.88 ACRES

LAKE #1
5.00 ACRES

OPEN SPACE
8.84 ACRES

P.A.-13
61.45 ACRES

OPEN SPACE
3.92 ACRES

P.A.-9
13.30 ACRES

P.A.-10
11.33 ACRES

P.A.-11
27.17 ACRES

P.A.-8
27.04 ACRES

PARK #3
2.75 ACRES

P.A.-7
35.93 ACRES

OPEN SPACE
0.33 ACRES

SUNBROOK DR.

LUCE DEL SOL DR.

ALIENTA DR.

HIGHLANDS

ALIENTA DR.

OPEN SPACE
1.92 ACRES

PROPOSED FIRE STATION

COTTAGES NORTH

SALES CENTER

CANYON VIEW DR.

(FUTURE)

OPEN SPACE
29.01 ACRES

P.A.-6
59.74 ACRES

LAKE #2
5.07 ACRES

P.A.-3
24.10 ACRES

COTTAGES SOUTH

OPEN SPACE
1.79 ACRES

EXISTING SUBSTATION (TO BE REMOVED)

EXISTING BLM TRAILHEAD

OPEN SPACE
12.41 ACRES

PARK #2
25.00 ACRES

OPEN SPACE
40.44 ACRES

LAS PALMAS

TRENDWEST

P.A.-5
19.37 ACRES

OPEN SPACE
6.82 ACRES

P.A.-4
33.52 ACRES

SUBSTATION
3.24 ACRES

OPEN SPACE
3.43 ACRES

RICHARD JASON ROGERS

P.A.-2
35.96 ACRES

PLANTATIONS DR.

DIXIE DR.

P.A.-1
28.09 ACRES

TRAILHEAD

J. BURTON & EVELYN H. BURGESS

(FUTURE)

HWY. 18 TO VEYO.
PINE VALLEY
DUKE DOWNS RD.
SUNSET BLVD.
VIEW DR.
VALLEY
GREEN VALLEY
DUKE DR.
ST. GEORGE BLVD.
DOWNTOWN
BLUFF ST.
INTERSTATE I-15 TO SALT LAKE CITY
DIXIE
VIRGIN RIVER
BLOOMINGTON
BLOOMINGTON HILLS
INTERSTATE I-15 TO LAS VEGAS, NEV.

The Lakes at St. George

NORTH

LOCATION MAP
ST. GEORGE, UTAH

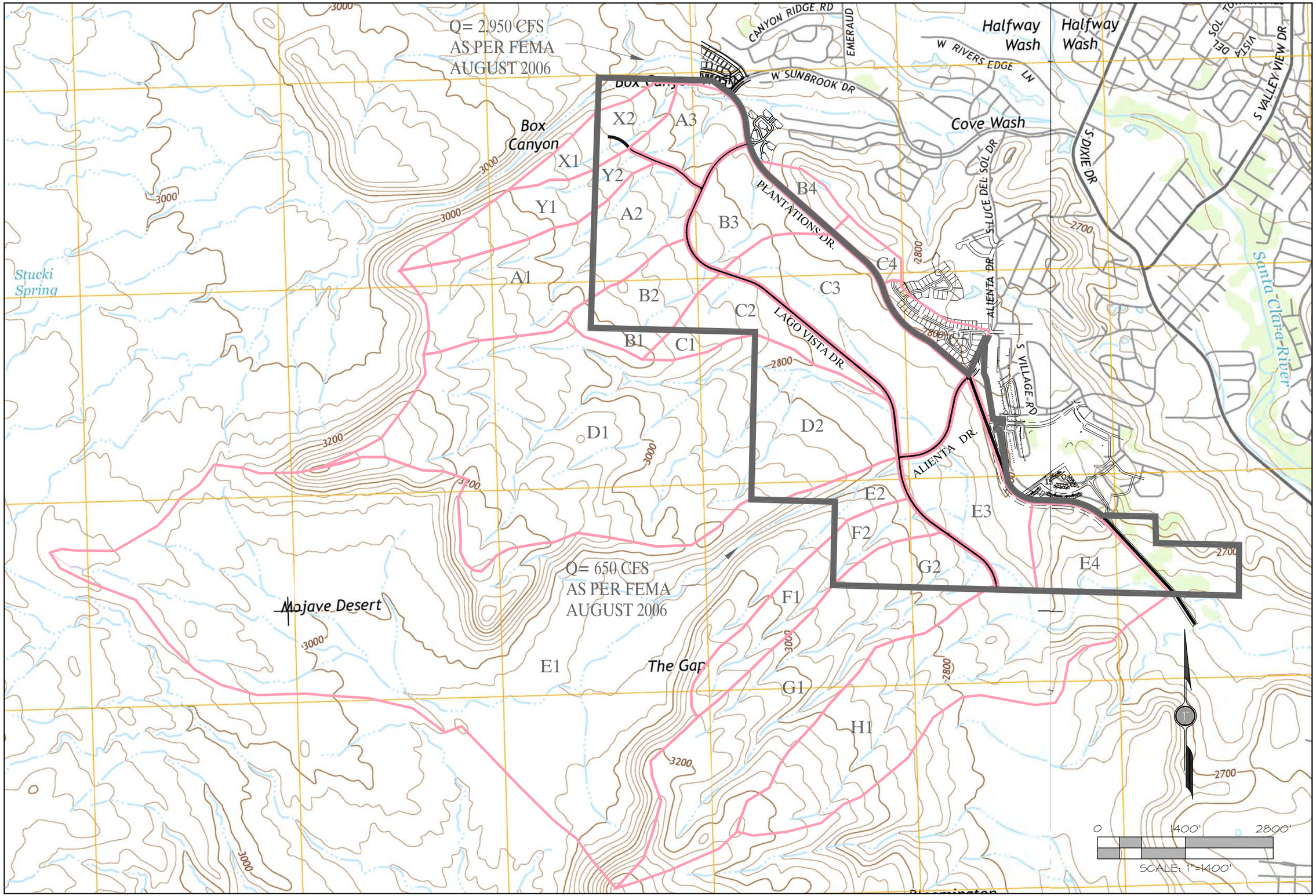
DATE: 8/31/2016
JOB NO.: 1286-14-014
DESIGNED BY: JLW
CHECKED BY: RMA
DWG: Land Use Plan

REVISIONS
DATE

ROSENBERG ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS
352 East Riverside Drive, Suite A-2
St. George, Utah 84790
Ph (435) 673-8586 Fx (435) 673-8397
www.racivil.com

# Land Use Plan
FOR
# The Lakes at St. George
St. George, Utah

SHEET
Fig. 1
1 OF 1 SHEETS




DATE: 4-14-08
JOB NO.: 1286-PDA
DRAWN BY: JRH
DESIGNED BY:
DWG: WATERSHED MAP

REVISIONS
DATE

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# FIGURE 2 WATERSHED MAP
FOR
# THE LAKES AT ST. GEORGE
ST. GEORGE, UTAH

SHEET
Fig. 2
1 OF 1 SHEETS

## NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Floodway Data table shown on this FIRM.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) Zone 12N. **Horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov/.

**Base map** information shown on this FIRM was provided in digital format by the U.S. Farm Service National Agriculture Imagery Program (NAIP), dated summer 2004, and by the U.S. Geological Survey Digital Orthophoto Quadrangles, dated 1993 and later, produced at a scale of 1:24000. The data was obtained from the State Geographic Information Dataset (SGID) maintained by the Automated Geographic Reference Center (AGRC).

Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

**Corporate limits** shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip/.

NFIP — NATIONAL FLOOD INSURANCE PROGRAM

**PANEL 1007G**

# FIRM
FLOOD INSURANCE RATE MAP

**WASHINGTON COUNTY, UTAH**
**AND INCORPORATED AREAS**

**PANEL 1007 OF 1225**
(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| SANTA CLARA, CITY OF | 490179 | 1007 | G |
| ST. GEORGE, CITY OF | 490177 | 1007 | G |
| WASHINGTON COUNTY | 490224 | 1007 | G |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
49053C1007G
EFFECTIVE DATE
APRIL 2, 2009

Federal Emergency Management Agency

NFIP — NATIONAL FLOOD INSURANCE PROGRAM

**PANEL 1009G**

# FIRM
FLOOD INSURANCE RATE MAP

**WASHINGTON COUNTY, UTAH**
**AND INCORPORATED AREAS**

**PANEL 1009 OF 1225**
(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| ST. GEORGE, CITY OF | 490177 | 1009 | G |
| WASHINGTON COUNTY | 490224 | 1009 | G |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
49053C1009G
EFFECTIVE DATE
APRIL 2, 2009

Federal Emergency Management Agency

NFIP — NATIONAL FLOOD INSURANCE PROGRAM

**PANEL 1028G**

# FIRM
FLOOD INSURANCE RATE MAP

**WASHINGTON COUNTY, UTAH**
**AND INCORPORATED AREAS**

**PANEL 1028 OF 1225**
(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

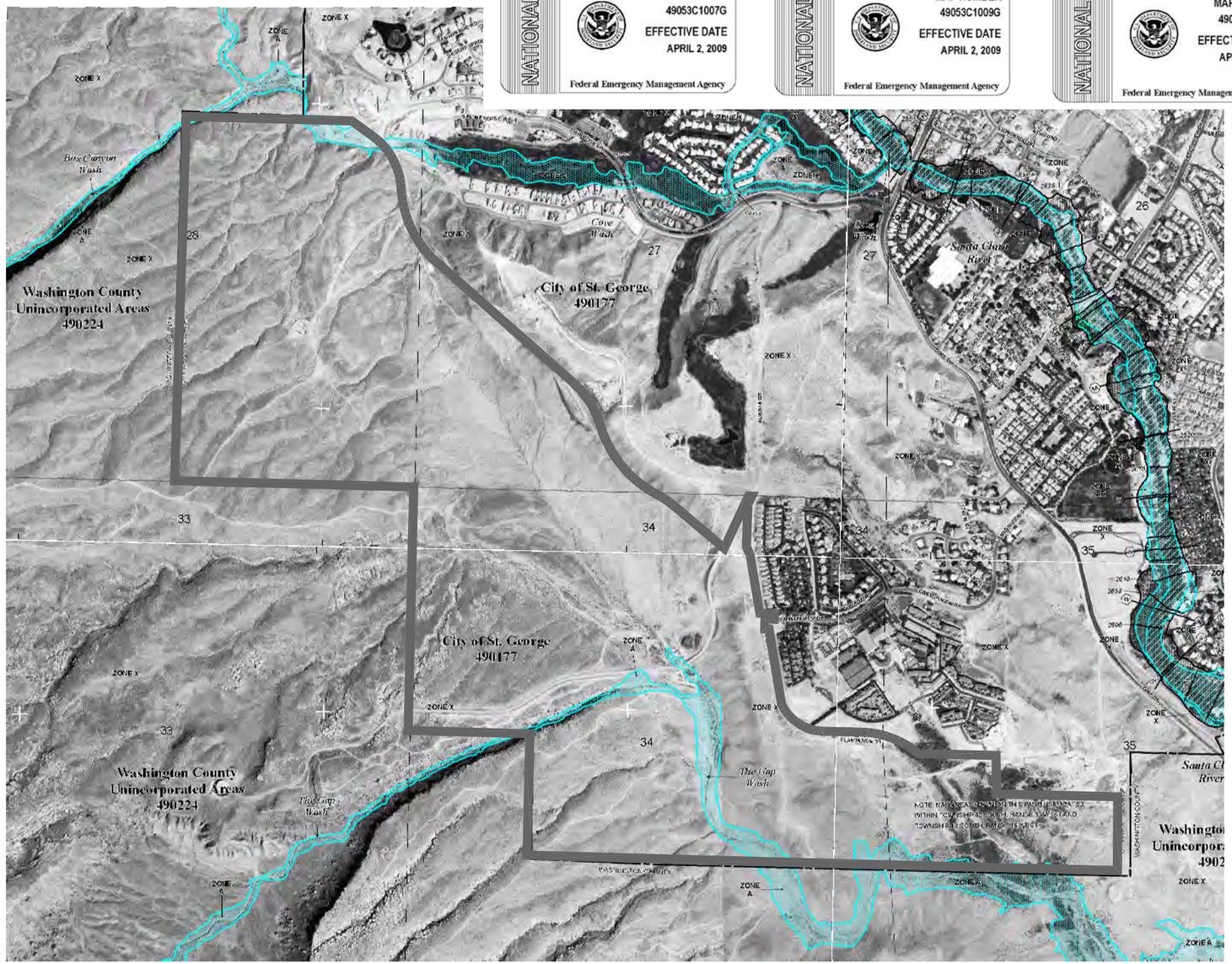
CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
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| ST. GEORGE, CITY OF | 490177 | 1028 | G |
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Federal Emergency Management Agency




## LEGEND

**SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- **ZONE A** No Base Flood Elevations determined.
- **ZONE AE** Base Flood Elevations determined.
- **ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- **ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- **ZONE AR** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- **ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- **ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- **ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

**FLOODWAY AREAS IN ZONE AE**

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

**OTHER FLOOD AREAS**

- **ZONE X** Area of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

**OTHER AREAS**

- **ZONE X** Areas determined to be outside the 0.2% annual chance floodplain.
- **ZONE D** Areas in which flood hazards are undetermined, but possible.

**COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**

**OTHERWISE PROTECTED AREAS (OPAS)**

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL. 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

- (A)—(A) Cross section line
- (23)—(23) Transect line
- 87°07'45", 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 4376 000 m E — 1000-meter Universal Transverse Mercator grid values, zone 12
- 600000 FT — 5000-foot grid ticks: Utah State Plane coordinate system, south zone (FIPSZONE 4302), Lambert Conformal Conic projection
- DX5510 × — Bench mark (See explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
APRIL 2, 2009

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

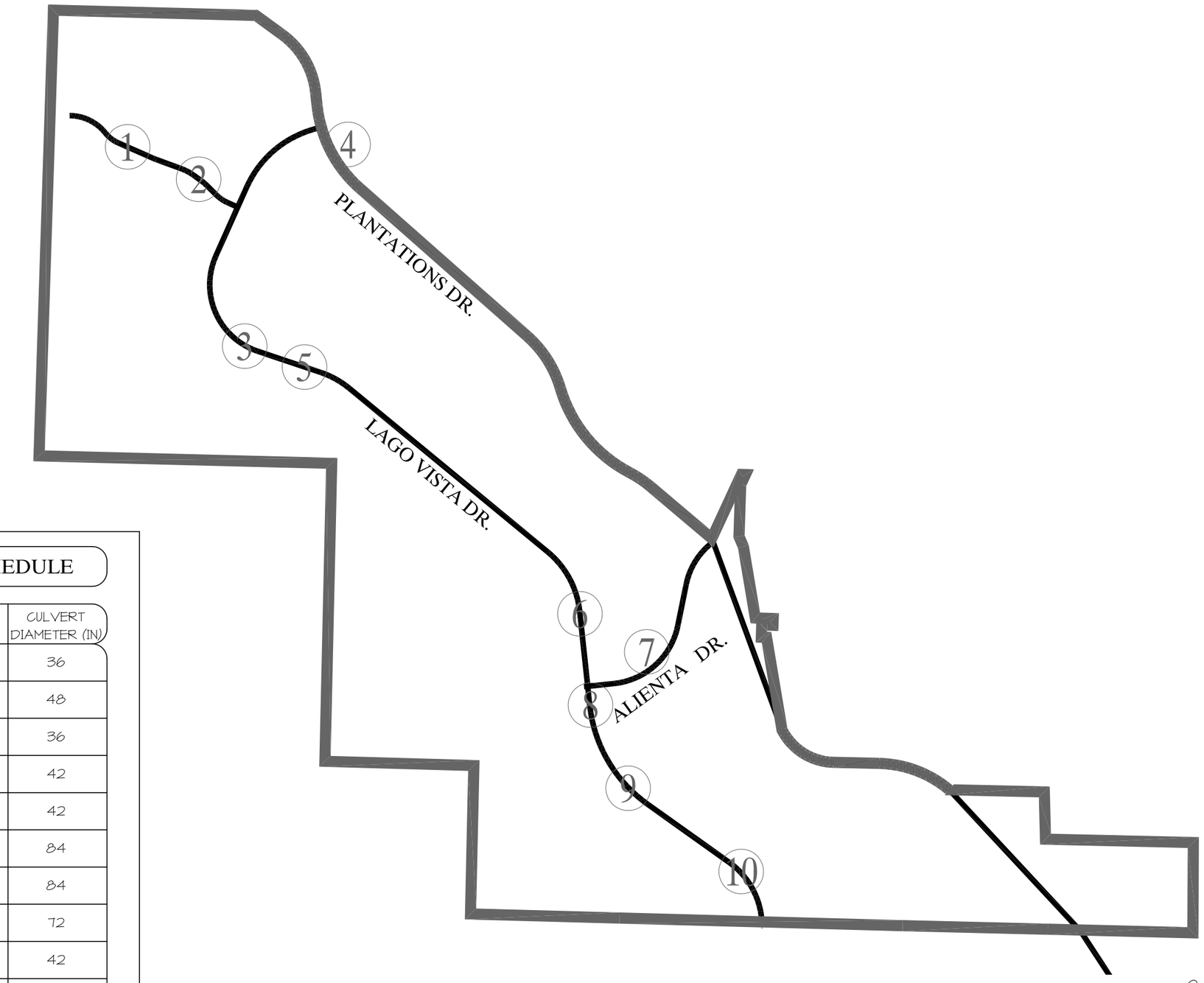
MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

DATE: 4-14-08
JOB NO.: 1286-PDA
DRAWN BY: JRH
DESIGNED BY:
DWG: WATERSHED MAP
DATE
REVISIONS


ROSENBERG ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS
352 East Riverside Drive, Suite A-2
St. George, Utah 84790
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www.rosenbergassociates.net


FIGURE 3- FEMA Regulatory 100-YR Floodplain
FOR
The Lakes at St. George
St. George, Utah

SHEET
Fig. 3
1 OF 1 SHEETS




## CULVERT SCHEDULE

| CULVERT ID | 100-YR FLOW (CFS) | CULVERT DIAMETER (IN) |
|---|---|---|
| 1 | 80.7 | 36 |
| 2 | 191.9 | 48 |
| 3 | 88.1 | 36 |
| 4 | 139.9 | 42 |
| 5 | 104.5 | 42 |
| 6 | 654.3 | 84 |
| 7 | 810.0 | 84 |
| 8 | 456.7 | 72 |
| 9 | 134.7 | 42 |
| 10 | 249.4 | 60 |

NOTE
CULVERT DIAMETER CALCULATIONS ASSUME 1.0% SLOPE.

0 1000' 2000'
SCALE: 1"=1000'

DATE: 4-14-08
JOB NO.: 1286-PDA
DRAWN BY: JLN
DESIGNED BY: RMA
DWG: WATERSHED MAP

REVISIONS DATE

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# FIGURE 4 CULVERT CROSSINGS FOR THE LAKES AT ST. GEORGE

ST. GEORGE, UTAH

SHEET
Fig. 4
1 OF 1 SHEETS

United States Department of Agriculture

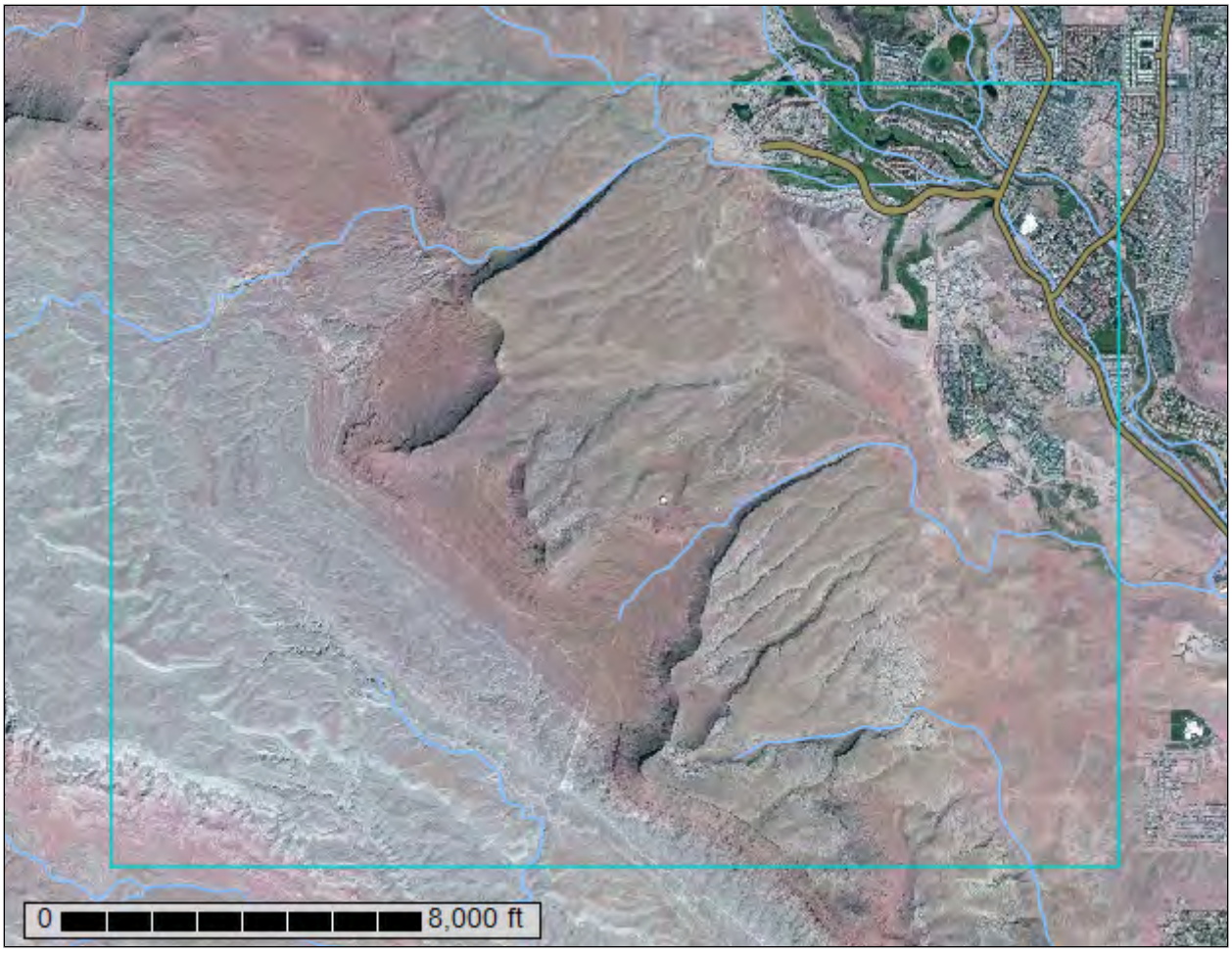
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

# Custom Soil Resource Report for Washington County Area, Utah

## The Lakes




August 19, 2016

# Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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# Contents

**Preface**.....2
**How Soil Surveys Are Made**.....5
**Soil Map**.....7
Soil Map.....8
Legend.....9
Map Unit Legend.....10
Map Unit Descriptions.....10
Washington County Area, Utah.....13
BA—Badland.....13
BB—Badland, very steep.....13
EB—Eroded land-Shalet complex, warm.....13
FA—Fluvaquents and torrifluvents, sandy.....15
GA—Gullied land.....17
GP—Gravel pits.....17
Ha—Hantz silty clay loam.....17
HG—Hobog-Rock land association.....18
IAF—Isom cobbly sandy loam, 3 to 30 percent slopes.....20
JaC—Junction fine sandy loam, 2 to 5 percent slopes.....21
LcC—Laverkin fine sandy loam, 2 to 5 percent slopes.....22
LeB—Leeds silty clay loam, 1 to 2 percent slopes.....23
NLE—Nikey sandy loam, 3 to 15 percent slopes.....24
PnC—Pintura loamy fine sand, 1 to 5 percent slopes.....26
PoD—Pintura loamy fine sand, hummocky, 1 to 10 percent slopes.....27
RE—Renbac-Rock land association.....28
RO—Rock land.....29
Tc—Tobler fine sandy loam.....30
Td—Tobler silty clay loam.....31
W—Water.....32
WBD—Winkel gravelly fine sandy loam, 1 to 8 percent slopes.....32
**Soil Information for All Uses**.....34
Soil Properties and Qualities.....34
Soil Qualities and Features.....34
Hydrologic Soil Group (The Lakes).....34
**References**.....40

# How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

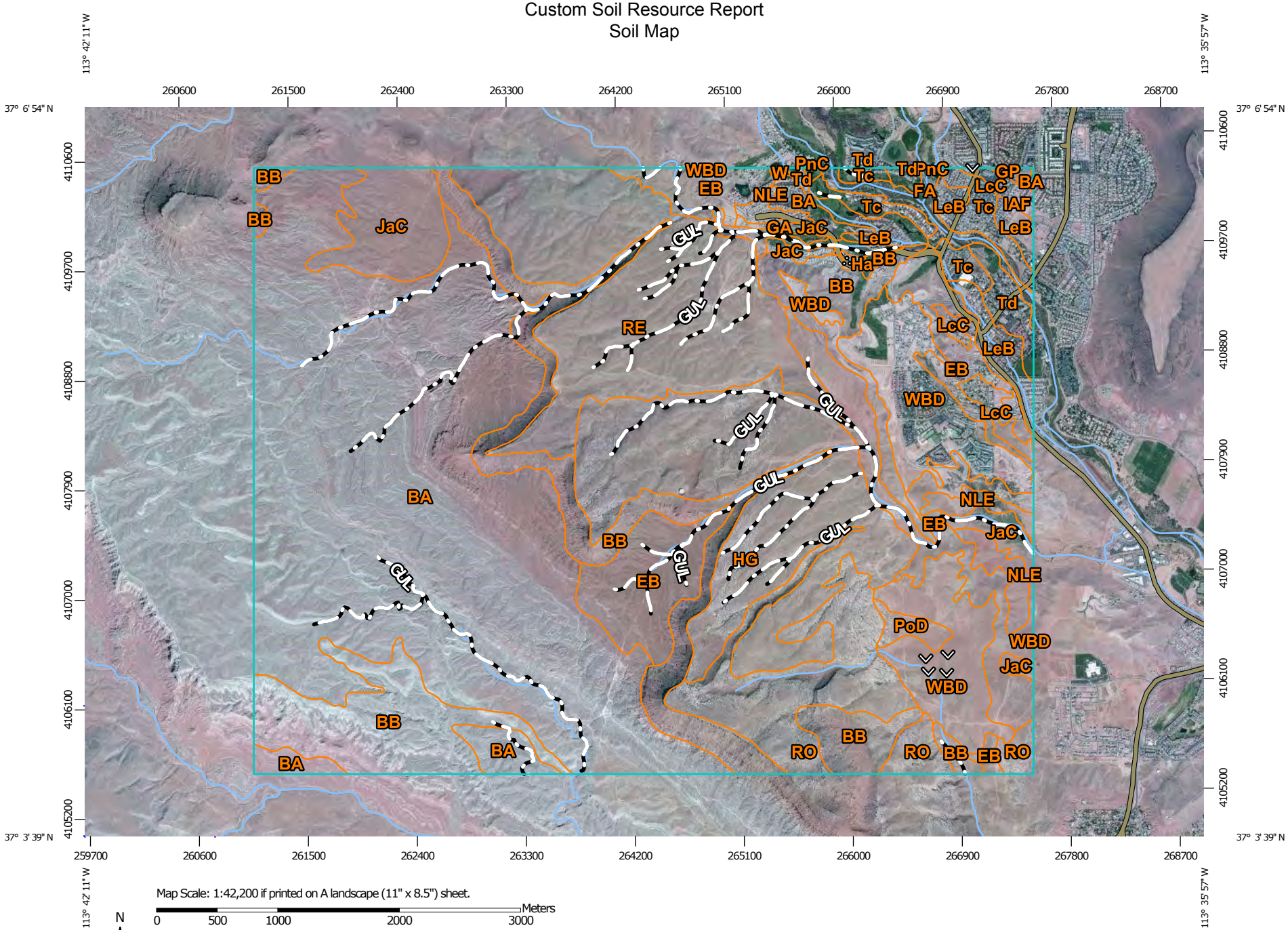
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

# Custom Soil Resource Report
## Soil Map



## MAP LEGEND

**Area of Interest (AOI)**

Area of Interest (AOI)

**Soils**

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

**Special Point Features**

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

**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.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
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 9, Sep 23, 2015

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

Date(s) aerial images were photographed: Aug 11, 2010—Nov 3, 2010

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.

# Map Unit Legend

| Washington County Area, Utah (UT641) | | | |
|---|---|---|---|
| **Map Unit Symbol** | **Map Unit Name** | **Acres in AOI** | **Percent of AOI** |
| BA | Badland | 2,583.6 | 32.5% |
| BB | Badland, very steep | 1,031.7 | 13.0% |
| EB | Eroded land-Shalet complex, warm | 727.4 | 9.1% |
| FA | Fluvaquents and torrifluvents, sandy | 63.4 | 0.8% |
| GA | Gullied land | 35.1 | 0.4% |
| GP | Gravel pits | 4.1 | 0.1% |
| Ha | Hantz silty clay loam | 9.7 | 0.1% |
| HG | Hobog-Rock land association | 870.7 | 10.9% |
| IAF | Isom cobbly sandy loam, 3 to 30 percent slopes | 15.6 | 0.2% |
| JaC | Junction fine sandy loam, 2 to 5 percent slopes | 250.5 | 3.1% |
| LcC | Laverkin fine sandy loam, 2 to 5 percent slopes | 49.5 | 0.6% |
| LeB | Leeds silty clay loam, 1 to 2 percent slopes | 142.6 | 1.8% |
| NLE | Nikey sandy loam, 3 to 15 percent slopes | 100.1 | 1.3% |
| PnC | Pintura loamy fine sand, 1 to 5 percent slopes | 3.1 | 0.0% |
| PoD | Pintura loamy fine sand, hummocky, 1 to 10 percent slopes | 30.4 | 0.4% |
| RE | Renbac-Rock land association | 893.1 | 11.2% |
| RO | Rock land | 431.7 | 5.4% |
| Tc | Tobler fine sandy loam | 129.0 | 1.6% |
| Td | Tobler silty clay loam | 71.5 | 0.9% |
| W | Water | 2.7 | 0.0% |
| WBD | Winkel gravelly fine sandy loam, 1 to 8 percent slopes | 507.9 | 6.4% |
| **Totals for Area of Interest** | | **7,953.3** | **100.0%** |

# Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

# Washington County Area, Utah

## BA—Badland

**Map Unit Composition**

*Badland:* 100 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Badland**

**Setting**

*Landform:* Escarpments, hills
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Free face, side slope
*Down-slope shape:* Convex
*Across-slope shape:* Convex

## BB—Badland, very steep

**Map Unit Composition**

*Badland:* 100 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Badland**

**Setting**

*Landform:* Escarpments, hills
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Free face, side slope
*Down-slope shape:* Convex
*Across-slope shape:* Convex

## EB—Eroded land-Shalet complex, warm

**Map Unit Setting**

*National map unit symbol:* j8ds
*Elevation:* 3,600 to 5,550 feet
*Mean annual precipitation:* 10 to 13 inches
*Mean annual air temperature:* 52 to 56 degrees F
*Frost-free period:* 165 to 170 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Eroded land:* 78 percent
*Shalet and similar soils:* 20 percent
*Minor components:* 2 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Eroded Land

#### Setting

*Landform:* Erosion remnants
*Parent material:* Residuum weathered from shale

### Description of Shalet

#### Setting

*Landform:* Swales
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Parent material:* Residuum weathered from shale

#### Typical profile

*H1 - 0 to 4 inches:* clay loam
*H2 - 4 to 12 inches:* clay loam
*H3 - 12 to 16 inches:* weathered bedrock

#### Properties and qualities

*Slope:* 2 to 20 percent
*Depth to restrictive feature:* 4 to 15 inches to paralithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* High
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately high (0.00 to 0.20 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 20 percent
*Gypsum, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* Very low (about 2.1 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* D
*Ecological site:* Desert Shallow Loam (Creosotebush) (R030XY134UT)
*Hydric soil rating:* No

### Minor Components

#### Badland

*Percent of map unit:* 2 percent

## FA—Fluvaquents and torrifluvents, sandy

### Map Unit Setting

*National map unit symbol:* j8dt
*Elevation:* 2,500 to 3,000 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 205 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Fluvaquents and similar soils:* 55 percent
*Torrifluvents and similar soils:* 35 percent
*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Fluvaquents

#### Setting

*Landform:* Swales
*Landform position (three-dimensional):* Talf
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Parent material:* Sandy alluvium derived from limestone, sandstone, and shale

#### Typical profile

*H1 - 0 to 5 inches:* fine sand
*H2 - 5 to 60 inches:* stratified fine sand to silt loam

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Poorly drained
*Runoff class:* Negligible
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (6.00 to 20.00 in/hr)
*Depth to water table:* About 6 to 24 inches
*Frequency of flooding:* Frequent
*Frequency of ponding:* Rare
*Calcium carbonate, maximum in profile:* 20 percent
*Salinity, maximum in profile:* Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 10.0
*Available water storage in profile:* Low (about 4.2 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7w
*Hydrologic Soil Group:* A/D
*Ecological site:* Loamy Bottom (Basin Big Sagebrush) (R035XY011UT)

*Hydric soil rating:* Yes

### Description of Torrifluvents

#### Setting

*Landform:* Flood plains
*Landform position (three-dimensional):* Talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium derived from limestone, sandstone, and shale

#### Typical profile

*H1 - 0 to 5 inches:* loamy fine sand
*H2 - 5 to 60 inches:* stratified loamy fine sand to silt loam

#### Properties and qualities

*Slope:* 0 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Very low
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (6.00 to 20.00 in/hr)
*Depth to water table:* About 42 to 72 inches
*Frequency of flooding:* Frequent
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 20 percent
*Salinity, maximum in profile:* Nonsaline to moderately saline (0.0 to 8.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* Low (about 4.8 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7w
*Hydrologic Soil Group:* A
*Ecological site:* Loamy Bottom (Basin Big Sagebrush) (R035XY011UT)
*Other vegetative classification:* Loamy Bottom (Basin Big Sagebrush) (035XY011UT)
*Hydric soil rating:* No

### Minor Components

#### Riverwash

*Percent of map unit:* 4 percent
*Landform:* Flood plains
*Landform position (three-dimensional):* Dip
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Hydric soil rating:* Yes

#### Tobler, fine sandy loam

*Percent of map unit:* 3 percent

#### Tobler, silty clay loam

*Percent of map unit:* 3 percent

## GA—Gullied land

**Map Unit Composition**

*Gullied land:* 100 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

## GP—Gravel pits

**Map Unit Composition**

*Gravel pit:* 100 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Gravel Pit**

**Interpretive groups**

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 8s

*Hydric soil rating:* No

## Ha—Hantz silty clay loam

**Map Unit Setting**

*National map unit symbol:* j8dy

*Elevation:* 2,700 to 3,300 feet

*Mean annual precipitation:* 8 to 11 inches

*Mean annual air temperature:* 57 to 65 degrees F

*Frost-free period:* 190 to 195 days

*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**

*Hantz and similar soils:* 85 percent

*Minor components:* 15 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Hantz**

**Setting**

*Landform:* Alluvial fans

*Down-slope shape:* Concave

*Across-slope shape:* Convex

*Parent material:* Mixed alluvium derived from limestone, sandstone, and shale

**Typical profile**

*H1 - 0 to 9 inches:* silty clay loam

*H2 - 9 to 19 inches:* silty clay
*H3 - 19 to 47 inches:* silty clay
*H4 - 47 to 70 inches:* silty clay

**Properties and qualities**

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 20 percent
*Gypsum, maximum in profile:* 5 percent
*Salinity, maximum in profile:* Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* High (about 10.8 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3s
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* C
*Hydric soil rating:* No

**Minor Components**

**Leeds**

*Percent of map unit:* 5 percent

**Tobler**

*Percent of map unit:* 5 percent

**St. george, moderately saline**

*Percent of map unit:* 5 percent

## HG—Hobog-Rock land association

**Map Unit Setting**

*National map unit symbol:* j8dx
*Elevation:* 2,600 to 3,800 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Hobog and similar soils:* 50 percent
*Rock land:* 40 percent

*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Hobog

#### Setting

*Landform:* Mesas
*Down-slope shape:* Linear
*Across-slope shape:* Convex
*Parent material:* Material weathered from sandstone

#### Typical profile

*H1 - 0 to 4 inches:* very cobbly loam
*H2 - 4 to 13 inches:* very flaggy loam
*H3 - 13 to 17 inches:* unweathered bedrock

#### Properties and qualities

*Slope:* 3 to 40 percent
*Depth to restrictive feature:* 8 to 20 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Very high
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately high (0.00 to 0.20 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 25 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* Very low (about 0.6 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* D
*Ecological site:* Desert Shallow Loam (Creosotebush) (R030XY134UT)
*Hydric soil rating:* No

### Description of Rock Land

#### Setting

*Landform:* Ridges
*Down-slope shape:* Convex
*Across-slope shape:* Convex

### Minor Components

#### Rock outcrop

*Percent of map unit:* 5 percent

#### Renbac

*Percent of map unit:* 5 percent

## IAF—Isom cobbly sandy loam, 3 to 30 percent slopes

### Map Unit Setting

*National map unit symbol:* j8f0
*Elevation:* 2,700 to 3,900 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 175 to 195 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Isom and similar soils:* 90 percent
*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Isom

#### Setting

*Landform:* Alluvial fans
*Down-slope shape:* Concave
*Across-slope shape:* Convex
*Parent material:* Cobbly alluvium derived from limestone, sandstone, and shale

#### Typical profile

*H1 - 0 to 2 inches:* very cobbly sandy loam
*H2 - 2 to 10 inches:* very cobbly sandy loam
*H3 - 10 to 22 inches:* very cobbly sandy loam
*H4 - 22 to 60 inches:* extremely cobbly sandy loam

#### Properties and qualities

*Slope:* 3 to 30 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 60 percent
*Gypsum, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* Low (about 3.3 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* A

*Ecological site:* Desert Shallow Loam (Creosotebush) (R030XY134UT)
*Hydric soil rating:* No

**Minor Components**

**Shallow soils**
*Percent of map unit:* 5 percent

**Nickey**
*Percent of map unit:* 5 percent

## JaC—Junction fine sandy loam, 2 to 5 percent slopes

**Map Unit Setting**
*National map unit symbol:* j8f4
*Elevation:* 2,700 to 3,400 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**
*Junction and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Junction**

**Setting**
*Landform:* Alluvial fans, hills
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Concave, convex
*Across-slope shape:* Convex

**Typical profile**
*H1 - 0 to 2 inches:* fine sandy loam
*H2 - 2 to 9 inches:* fine sandy loam
*H3 - 9 to 21 inches:* fine sandy loam
*H4 - 21 to 32 inches:* fine sandy loam
*H5 - 32 to 60 inches:* fine sandy loam

**Properties and qualities**
*Slope:* 1 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Very low
*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None

*Calcium carbonate, maximum in profile:* 20 percent
*Gypsum, maximum in profile:* 7 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Moderate (about 7.2 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* A
*Ecological site:* Desert Loam (Creosotebush) (R030XY110UT)
*Hydric soil rating:* No

**Minor Components**

**Tobler**

*Percent of map unit:* 5 percent

**Harrisburg**

*Percent of map unit:* 5 percent

**Junction**

*Percent of map unit:* 5 percent

## LcC—Laverkin fine sandy loam, 2 to 5 percent slopes

**Map Unit Setting**

*National map unit symbol:* j8fg
*Elevation:* 2,550 to 3,300 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**

*Laverkin and similar soils:* 90 percent
*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Laverkin**

**Setting**

*Landform:* Alluvial fans, stream terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Concave, linear
*Across-slope shape:* Convex, concave
*Parent material:* Alluvium derived from limestone, sandstone, and shale

**Typical profile**

*H1 - 0 to 3 inches:* fine sandy loam
*H2 - 3 to 16 inches:* fine sandy loam
*H3 - 16 to 30 inches:* sandy clay loam
*H4 - 30 to 42 inches:* sandy clay loam

*H5 - 42 to 60 inches:* sandy clay loam

**Properties and qualities**

*Slope:* 2 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 30 percent
*Gypsum, maximum in profile:* 5 percent
*Salinity, maximum in profile:* Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
*Available water storage in profile:* High (about 9.4 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* B
*Ecological site:* Desert Loam (Creosotebush) (R030XY110UT)
*Hydric soil rating:* No

**Minor Components**

**Tobler**

*Percent of map unit:* 5 percent

**Nikey**

*Percent of map unit:* 5 percent

## LeB—Leeds silty clay loam, 1 to 2 percent slopes

**Map Unit Setting**

*National map unit symbol:* j8fk
*Elevation:* 2,550 to 3,300 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 200 days
*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**

*Leeds and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Leeds**

**Setting**

*Landform:* Flood plains

*Landform position (three-dimensional):* Talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium derived from limestone, sandstone, and shale

**Typical profile**

*H1 - 0 to 8 inches:* silty clay loam
*H2 - 8 to 15 inches:* silty clay loam
*H3 - 15 to 23 inches:* sandy loam
*H4 - 23 to 60 inches:* silt loam

**Properties and qualities**

*Slope:* 1 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 20 percent
*Salinity, maximum in profile:* Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* High (about 10.1 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3s
*Hydrologic Soil Group:* C
*Ecological site:* Desert Loam (Creosotebush) (R030XY110UT)
*Hydric soil rating:* No

**Minor Components**

**Hantz**

*Percent of map unit:* 4 percent

**St george**

*Percent of map unit:* 4 percent

**Leeds**

*Percent of map unit:* 4 percent

**Tobler**

*Percent of map unit:* 3 percent

## NLE—Nikey sandy loam, 3 to 15 percent slopes

**Map Unit Setting**

*National map unit symbol:* j8fw
*Elevation:* 2,650 to 3,350 feet
*Mean annual precipitation:* 8 to 11 inches

*Mean annual air temperature:* 59 to 62 degrees F
*Frost-free period:* 180 to 195 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Nikey and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Nikey**

**Setting**

*Landform:* Alluvial fans
*Down-slope shape:* Concave
*Across-slope shape:* Convex
*Parent material:* Gravelly alluvium derived from limestone, sandstone, and shale

**Typical profile**

*H1 - 0 to 3 inches:* sandy loam
*H2 - 3 to 26 inches:* fine sandy loam
*H3 - 26 to 38 inches:* very gravelly loam
*H4 - 38 to 46 inches:* very gravelly loam
*H5 - 46 to 60 inches:* very gravelly loam

**Properties and qualities**

*Slope:* 3 to 15 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 30 percent
*Gypsum, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Moderate (about 6.5 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* B
*Ecological site:* Desert Loam (Creosotebush) (R030XY110UT)
*Hydric soil rating:* No

**Minor Components**

**Harrisburg**

*Percent of map unit:* 5 percent

**Isom**

*Percent of map unit:* 5 percent

**Nikey**

*Percent of map unit:* 5 percent

## PnC—Pintura loamy fine sand, 1 to 5 percent slopes

### Map Unit Setting

*National map unit symbol:* j8g9
*Elevation:* 2,600 to 3,600 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Farmland of statewide importance

### Map Unit Composition

*Pintura and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Pintura

#### Setting

*Landform:* Mountain slopes
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Parent material:* Eolian sands derived from sandstone

#### Typical profile

*H1 - 0 to 3 inches:* loamy fine sand
*H2 - 3 to 65 inches:* fine sand

#### Properties and qualities

*Slope:* 1 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Somewhat excessively drained
*Runoff class:* Very low
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (6.00 to 20.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Low (about 3.1 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* A
*Ecological site:* Desert Sand (Indian ricegrass) (R030XY120UT)
*Hydric soil rating:* No

**Minor Components**

**Toquerville**
*Percent of map unit:* 4 percent

**Harrisburg**
*Percent of map unit:* 4 percent

**Tobler**
*Percent of map unit:* 4 percent

**Ivins**
*Percent of map unit:* 3 percent

## PoD—Pintura loamy fine sand, hummocky, 1 to 10 percent slopes

**Map Unit Setting**
*National map unit symbol:* j8gb
*Elevation:* 2,600 to 3,600 feet
*Mean annual precipitation:* 7 to 8 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**
*Pintura and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Pintura**

**Setting**
*Landform:* Mountain slopes
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Parent material:* Hummocky eolian sands derived from sandstone

**Typical profile**
*H1 - 0 to 3 inches:* loamy fine sand
*H2 - 3 to 65 inches:* fine sand

**Properties and qualities**
*Slope:* 1 to 10 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Somewhat excessively drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (6.00 to 20.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None

*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Low (about 3.1 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3s
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* A
*Ecological site:* Desert Sand (Indian ricegrass) (R030XY120UT)
*Hydric soil rating:* No

**Minor Components**

**Dune land**

*Percent of map unit:* 5 percent

**Pintura**

*Percent of map unit:* 5 percent

**Toquerville**

*Percent of map unit:* 5 percent

## RE—Renbac-Rock land association

**Map Unit Setting**

*National map unit symbol:* j8gd
*Elevation:* 2,800 to 4,000 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 61 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Renbac and similar soils:* 60 percent
*Rock land:* 25 percent
*Minor components:* 5 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Renbac**

**Setting**

*Landform:* Mountain slopes
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Parent material:* Material weathered from sandstone, conglomerate, and shale

**Typical profile**

*H1 - 0 to 2 inches:* channery clay loam
*H2 - 2 to 5 inches:* very channery clay
*H3 - 5 to 9 inches:* very channery clay

*H4 - 9 to 12 inches:* very flaggy sandy loam
*H5 - 12 to 16 inches:* unweathered bedrock

**Properties and qualities**

*Slope:* 2 to 30 percent
*Depth to restrictive feature:* 8 to 17 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately high (0.00 to 0.60 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 25 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Very low (about 1.0 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* D
*Ecological site:* Semidesert Shallow Hardpan (Blackbrush) (R030XY230UT)
*Hydric soil rating:* No

**Minor Components**

**Hobog**

*Percent of map unit:* 5 percent

## RO—Rock land

**Map Unit Composition**

*Rock land:* 80 percent
*Minor components:* 20 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Rock Land**

**Setting**

*Landform:* Mountain slopes
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Convex
*Across-slope shape:* Convex

**Minor Components**

**Shallow soils**

*Percent of map unit:* 20 percent

## Tc—Tobler fine sandy loam

### Map Unit Setting

*National map unit symbol:* j8h2
*Elevation:* 2,500 to 3,500 feet
*Mean annual precipitation:* 10 to 13 inches
*Mean annual air temperature:* 48 to 57 degrees F
*Frost-free period:* 160 to 170 days
*Farmland classification:* Prime farmland if irrigated

### Map Unit Composition

*Tobler and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Tobler

#### Setting

*Landform:* Alluvial fans, hills
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Concave, convex
*Across-slope shape:* Convex
*Parent material:* Alluvium derived from sandstone and shale

#### Typical profile

*H1 - 0 to 4 inches:* fine sandy loam
*H2 - 4 to 13 inches:* fine sandy loam
*H3 - 13 to 38 inches:* fine sandy loam
*H4 - 38 to 60 inches:* fine sandy loam

#### Properties and qualities

*Slope:* 1 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Very low
*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Moderate (about 7.2 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* A
*Ecological site:* Desert Loam (Creosotebush) (R030XY110UT)
*Hydric soil rating:* No

**Minor Components**

**Harrisburg**
*Percent of map unit:* 4 percent

**Ivins**
*Percent of map unit:* 4 percent

**Pintura**
*Percent of map unit:* 4 percent

**Junction**
*Percent of map unit:* 3 percent

## Td—Tobler silty clay loam

**Map Unit Setting**
*National map unit symbol:* j8h3
*Elevation:* 2,500 to 3,500 feet
*Mean annual precipitation:* 10 to 13 inches
*Mean annual air temperature:* 48 to 57 degrees F
*Frost-free period:* 160 to 170 days
*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**
*Tobler and similar soils:* 90 percent
*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Tobler**

**Setting**
*Landform:* Flood plains, valleys
*Landform position (three-dimensional):* Talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear, concave
*Parent material:* Alluvium derived from sandstone and shale

**Typical profile**
*H1 - 0 to 10 inches:* silty clay loam
*H2 - 10 to 13 inches:* fine sandy loam
*H3 - 13 to 38 inches:* fine sandy loam
*H4 - 38 to 60 inches:* fine sandy loam

**Properties and qualities**
*Slope:* 1 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)

*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Moderate (about 7.6 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 2e
*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* C
*Ecological site:* Desert Loam (Creosotebush) (R030XY110UT)
*Hydric soil rating:* No

**Minor Components**

**Tobler**

*Percent of map unit:* 3 percent

**Leeds**

*Percent of map unit:* 3 percent

**Leeds**

*Percent of map unit:* 2 percent

**Leeds**

*Percent of map unit:* 2 percent

## W—Water

**Map Unit Composition**

*Water:* 100 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

## WBD—Winkel gravelly fine sandy loam, 1 to 8 percent slopes

**Map Unit Setting**

*National map unit symbol:* j8h9
*Elevation:* 2,800 to 4,000 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 61 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Winkel and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

## Description of Winkel

### Setting

*Landform:* Mesas
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Calcareous material weathered from basalt, limestone, and wind-deposited sand.

### Typical profile

*H1 - 0 to 1 inches:* gravelly fine sandy loam
*H2 - 1 to 6 inches:* gravelly fine sandy loam
*H3 - 6 to 12 inches:* very gravelly fine sandy loam
*H4 - 12 to 16 inches:* extremely cobbly fine sandy loam
*H5 - 16 to 20 inches:* indurated
*H6 - 20 to 24 inches:* unweathered bedrock

### Properties and qualities

*Slope:* 1 to 8 percent
*Depth to restrictive feature:* 11 to 19 inches to petrocalcic; 14 to 24 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately high (0.00 to 0.60 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 30 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* Very low (about 1.0 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* D
*Ecological site:* Desert Shallow Loam (Creosotebush) (R030XY134UT)
*Hydric soil rating:* No

## Minor Components

### Lava flows

*Percent of map unit:* 5 percent

### Harrisburg

*Percent of map unit:* 5 percent

### Bermesa

*Percent of map unit:* 5 percent

# Soil Information for All Uses

## Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

## Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

### Hydrologic Soil Group (The Lakes)

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.

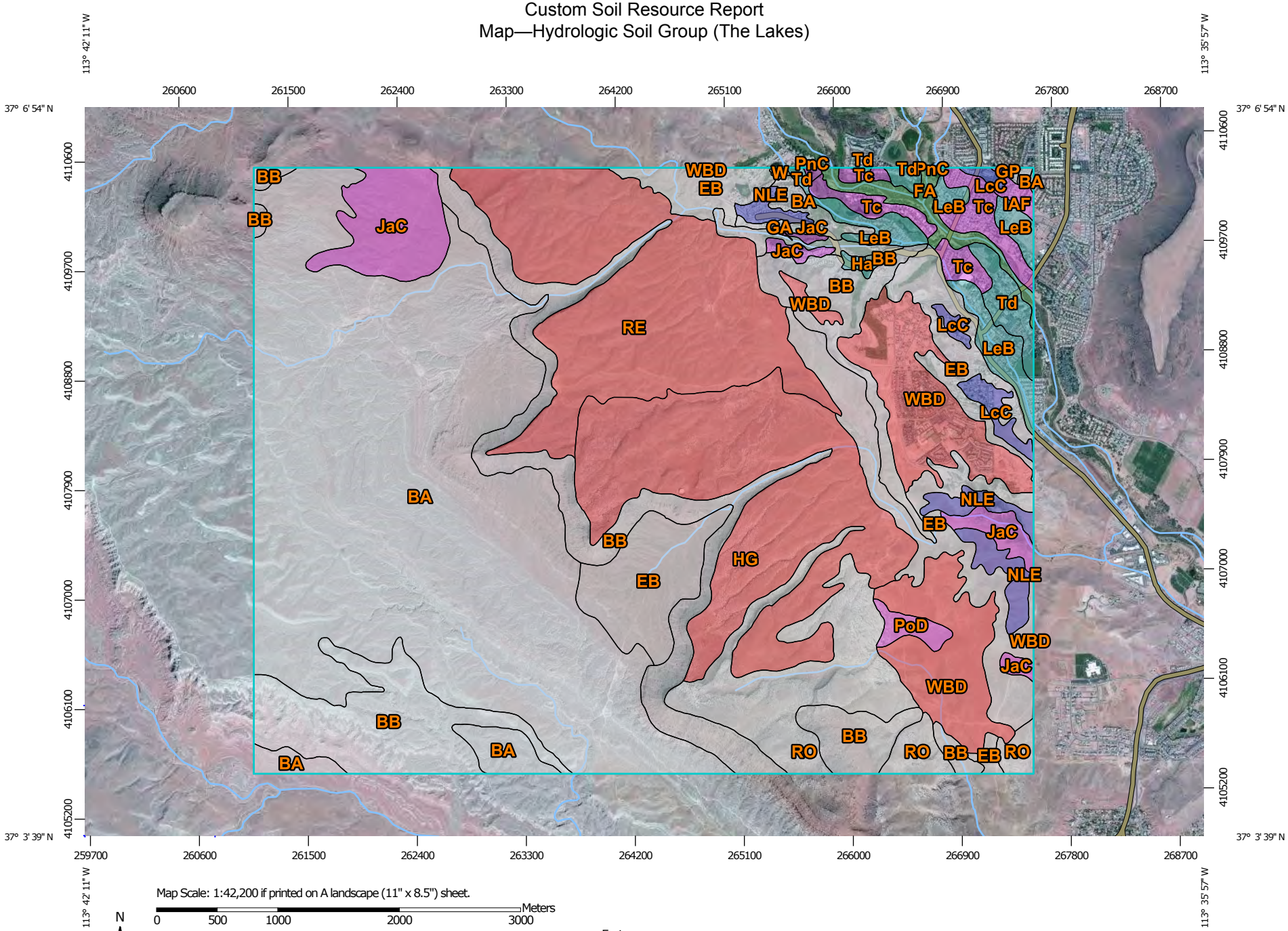
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

# Custom Soil Resource Report
## Map—Hydrologic Soil Group (The Lakes)



## 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.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
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 9, Sep 23, 2015

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

Date(s) aerial images were photographed: Aug 11, 2010—Nov 3, 2010

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.

## Table—Hydrologic Soil Group (The Lakes)

| Hydrologic Soil Group— Summary by Map Unit — Washington County Area, Utah (UT641) | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| BA | Badland | | 2,583.6 | 32.5% |
| BB | Badland, very steep | | 1,031.7 | 13.0% |
| EB | Eroded land-Shalet complex, warm | | 727.4 | 9.1% |
| FA | Fluvaquents and torrifluvents, sandy | A/D | 63.4 | 0.8% |
| GA | Gullied land | | 35.1 | 0.4% |
| GP | Gravel pits | | 4.1 | 0.1% |
| Ha | Hantz silty clay loam | C | 9.7 | 0.1% |
| HG | Hobog-Rock land association | D | 870.7 | 10.9% |
| IAF | Isom cobbly sandy loam, 3 to 30 percent slopes | A | 15.6 | 0.2% |
| JaC | Junction fine sandy loam, 2 to 5 percent slopes | A | 250.5 | 3.1% |
| LcC | Laverkin fine sandy loam, 2 to 5 percent slopes | B | 49.5 | 0.6% |
| LeB | Leeds silty clay loam, 1 to 2 percent slopes | C | 142.6 | 1.8% |
| NLE | Nikey sandy loam, 3 to 15 percent slopes | B | 100.1 | 1.3% |
| PnC | Pintura loamy fine sand, 1 to 5 percent slopes | A | 3.1 | 0.0% |
| PoD | Pintura loamy fine sand, hummocky, 1 to 10 percent slopes | A | 30.4 | 0.4% |
| RE | Renbac-Rock land association | D | 893.1 | 11.2% |
| RO | Rock land | | 431.7 | 5.4% |
| Tc | Tobler fine sandy loam | A | 129.0 | 1.6% |
| Td | Tobler silty clay loam | C | 71.5 | 0.9% |
| W | Water | | 2.7 | 0.0% |
| WBD | Winkel gravelly fine sandy loam, 1 to 8 percent slopes | D | 507.9 | 6.4% |
| **Totals for Area of Interest** | | | **7,953.3** | **100.0%** |

## Rating Options—Hydrologic Soil Group (The Lakes)

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

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ROSENBERG ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS



PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: Drainage Study Hydrology Information CHKD: RMA DATE: 30-Aug-16

**EXISTING PRE-DEVELOPMENT CONDITION**

| Hydraulic Element | | Area | | | Hydraulic Properties | |
|---|---|---|---|---|---|---|
| *(label)* | *(notes)* | *(sq ft)* | *(acre)* | *(sq mi)* | *Lo (ft)* | *S (%)* |
| X1 | Subarea X - Offiste | 625,298 | 14.35 | 0.02243 | 1,480 | 9.00 |
| X2 | Subarea X - Onsite to Plantations | 908,340 | 20.85 | 0.03258 | 1,205 | 8.00 |
| Y1 | Subarea Y - Offsite | 1,925,866 | 44.21 | 0.06908 | 3,500 | 9.00 |
| Y2 | Subarea Y - Onsite to Sentieri | 400,265 | 9.19 | 0.01436 | 802 | 8.00 |
| A1 | Subarea A - Offiste | 3,962,682 | 90.97 | 0.14214 | 3,779 | 7.00 |
| A2 | Subarea A - Onsite to Sentieri | 2,138,492 | 49.09 | 0.07671 | 2,951 | 7.00 |
| A3 | Subarea A - Onsite to Plantations | 1,627,354 | 37.36 | 0.05837 | 1,870 | 4.45 |
| B1 | Subarea B - Offsite | 476,820 | 10.95 | 0.01710 | 450 | 7.80 |
| B2 | Subarea B - Onsite to Lago Vista | 1,670,183 | 38.34 | 0.05991 | 1,495 | 7.80 |
| B3 | Subarea B - Onsite to Plantations | 2,149,110 | 49.34 | 0.07709 | 1,943 | 5.60 |
| B4 | Subarea B - Offsite to Plantations | 528,071 | 12.12 | 0.01894 | 1,880 | 2.00 |
| C1 | Subarea C - Offsite | 465,481 | 10.69 | 0.01670 | 878 | 11.67 |
| C2 | Subarea C - Onsite to Lago Vista | 1,748,993 | 40.15 | 0.06274 | 1,190 | 6.72 |
| C3 | Subarea C - Onsite to Alienta | 4,733,374 | 108.66 | 0.16979 | 4,503 | 2.67 |
| C4 | Subarea C - Offsite to Plantations | 435,932 | 10.01 | 0.01564 | 1,504 | 2.00 |
| C5 | Subarea C - Offsite to Plantations | 979,960 | 22.50 | 0.03515 | 2,040 | 3.00 |
| D1 | Sunarea D - Offsite | 16,555,867 | 380.07 | 0.59386 | 4,694 | 7.48 |
| D2 | Subarea D - Onsite to Lago Vista | 4,179,275 | 95.94 | 0.14991 | 3,297 | 7.80 |
| E1 | Subarea E - Offsite (Gap Wash) | 36,853,282 | 846.03 | 1.32193 | 14,986 | 2.25 |
| E2 | Subarea E - Onsite (Gap Wash) to Lago Vista | 894,958 | 20.55 | 0.03210 | 1,303 | 4.27 |
| E3 | Subarea E - Onsite (Gap Wash) to Plantations | 3,288,611 | 75.50 | 0.11796 | 3,501 | 4.47 |
| E4 | Subarea E - Onsite (Gap Wash) to Plantations | 2,126,723 | 48.82 | 0.07629 | 2,949 | 9.50 |
| F1 | Subarea F - Offsite | 1,869,681 | 42.92 | 0.06707 | 3,213 | 8.42 |
| F2 | Subarea F - Onsite to Lago Vista | 991,181 | 22.75 | 0.03555 | 1,764 | 8.80 |
| G1 | Subarea G - Offsite | 8,038,729 | 184.54 | 0.28835 | 7,531 | 9.56 |
| G2 | Subarea G - Onsite to Lago Vista | 1,486,884 | 34.13 | 0.05333 | 561 | 3.56 |
| H1 | Subarea H - Offsite to Plantations | 590,142 | 13.55 | 0.02117 | 1,924 | 4.20 |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: Drainage Study Hydrology Information CHKD: RMA DATE: 30-Aug-16

**PROPOSED POST-DEVELOPMENT CONDITION**

| Hydraulic Element | | Area | | | Hydraulic Properties | |
|---|---|---|---|---|---|---|
| *(label)* | *(notes)* | *(sq ft)* | *(acre)* | *(sq mi)* | *Lo (ft)* | *S (%)* |
| X1 | Subarea X - Offiste | 625,298 | 14.35 | 0.02243 | 1,480 | 9.00 |
| X2 | Subarea X - Onsite to Plantations | 908,340 | 20.85 | 0.03258 | 1,205 | 8.00 |
| Y1 | Subarea Y - Offsite | 1,925,866 | 44.21 | 0.06908 | 3,500 | 9.00 |
| Y2 | Subarea Y - Onsite to Sentieri | 400,265 | 9.19 | 0.01436 | 802 | 8.00 |
| A1 | Subarea A - Offiste | 3,962,682 | 90.97 | 0.14214 | 3,779 | 7.00 |
| A2 | Subarea A - Onsite to Sentieri | 2,138,492 | 49.09 | 0.07671 | 2,951 | 7.00 |
| A3 | Subarea A - Onsite to Plantations | 1,627,354 | 37.36 | 0.05837 | 1,870 | 4.45 |
| B1 | Subarea B - Offsite | 476,820 | 10.95 | 0.01710 | 450 | 7.80 |
| B2 | Subarea B - Onsite to Lago Vista | 1,670,183 | 38.34 | 0.05991 | 1,495 | 7.80 |
| B3 | Subarea B - Onsite to Plantations | 2,149,110 | 49.34 | 0.07709 | 1,943 | 5.60 |
| B4 | Subarea B - Offsite to Plantations | 528,071 | 12.12 | 0.01894 | 1,880 | 2.00 |
| C1 | Subarea C - Offsite | 465,481 | 10.69 | 0.01670 | 878 | 11.67 |
| C2 | Subarea C - Onsite to Lago Vista | 1,748,993 | 40.15 | 0.06274 | 1,190 | 6.72 |
| C3 | Subarea C - Onsite to Alienta | 4,733,374 | 108.66 | 0.16979 | 4,503 | 2.67 |
| C4 | Subarea C - Offsite to Plantations | 435,932 | 10.01 | 0.01564 | 1,504 | 2.00 |
| C5 | Subarea C - Offsite to Plantations | 979,960 | 22.50 | 0.03515 | 2,040 | 3.00 |
| D1 | Sunarea D - Offsite | 16,555,867 | 380.07 | 0.59386 | 4,694 | 7.48 |
| D2 | Subarea D - Onsite to Lago Vista | 4,179,275 | 95.94 | 0.14991 | 3,297 | 7.80 |
| E1 | Subarea E - Offsite (Gap Wash) | 36,853,282 | 846.03 | 1.32193 | 14,986 | 2.25 |
| E2 | Subarea E - Onsite (Gap Wash) to Lago Vista | 894,958 | 20.55 | 0.03210 | 1,303 | 4.27 |
| E3 | Subarea E - Onsite (Gap Wash) to Plantations | 3,288,611 | 75.50 | 0.11796 | 3,501 | 4.47 |
| E4 | Subarea E - Onsite (Gap Wash) to Plantations | 2,126,723 | 48.82 | 0.07629 | 2,949 | 9.50 |
| F1 | Subarea F - Offsite | 1,869,681 | 42.92 | 0.06707 | 3,213 | 8.42 |
| F2 | Subarea F - Onsite to Lago Vista | 991,181 | 22.75 | 0.03555 | 1,764 | 8.80 |
| G1 | Subarea G - Offsite | 8,038,729 | 184.54 | 0.28835 | 7,531 | 9.56 |
| G2 | Subarea G - Onsite to Lago Vista | 1,486,884 | 34.13 | 0.05333 | 561 | 3.56 |
| H1 | Subarea H - Offsite to Plantations | 590,142 | 13.55 | 0.02117 | 1,924 | 4.20 |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: Hydraulic Links and Routing CHKD: RMA DATE: 30-Aug-16

**JUNCTIONS FOR EXISTING PRE-DEVELOPMENT CONDITION**

| Hydraulic Element | |
|---|---|
| J-A | Collecting A1, A2 |
| J-Y | Collecting Y1, Y2 |
| J-AY | Collecting CulvertY, Culvert A, A3 |
| J-B | Collecting B1, B2 |
| J-B3 | Collecting J-B, B3, B4 |
| Box Canyon | Collecting J-AY, J-B3, X1, X2 |
| J-C2 | Collecting C1, C2 |
| J-C5 | Collecting C4, C5 |
| J-C3 | Collecting J-C2, J-C5 |
| J-D2 | Collecting D1, D2 |
| J-CD | Collecting J-C3, J-D2 |
| J-E2 | Collecting E1, E2 |
| J-F2 | Collecting F1, F2 |
| J-G2 | Collecting G1, G2 |
| J-E3 | Collecting J-E2, J-F2, J-G2, E3, H1 |
| Gap Wash | Collecting J-E3, E4 |

**JUNCTIONS FOR PROPOSED POST-DEVELOPMENT CONDITION**

| Hydraulic Element | |
|---|---|
| J-A | Collecting A1, A2 |
| J-Y | Collecting Y1, Y2 |
| J-AY | Collecting CulvertY, Culvert A, A3 |
| J-B | Collecting B1, B2 |
| J-B3 | Collecting J-B, B3, B4 |
| Box Canyon | Collecting J-AY, J-B3, X1, X2 |
| J-C2 | Collecting C1, C2 |
| J-C5 | Collecting C4, C5 |
| J-C3 | Collecting J-C2, J-C5 |
| J-D2 | Collecting D1, D2 |
| J-CD | Collecting J-C3, J-D2 |
| J-E2 | Collecting E1, E2 |
| J-F2 | Collecting F1, F2 |
| J-G2 | Collecting G1, G2 |
| J-E3 | Collecting J-E2, J-F2, J-G2, E3, H1 |
| Gap Wash | Collecting J-E3, E4 |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: Hydraulic Links and Routing CHKD: RMA DATE: 30-Aug-16

**ROUTING CONDUITS**

| Hydraulic Element | | Routed Length (ft) | Average Slope (%) | Manning's Roughness (n) | Culvert Diameter (in) | Bottom Width (ft) | Side Slopes (H:1V) |
|---|---|---|---|---|---|---|---|
| X to Box | Routing X1 to Box Canyon | 855 | 2.9 | 0.023 | N/A | N/A | 6.50 |
| Y1 to Y2 | Routing Y1 to J-Y | 549 | 3.1 | 0.023 | N/A | N/A | 6.50 |
| Culvert Y | Routing J-Y to J-AY | 900 | 4.5 | 0.023 | N/A | N/A | 6.50 |
| A1 to A2 | Routing A1 to J-A | 2,951 | 7.0 | 0.023 | N/A | N/A | 6.50 |
| Culvert A | Routing J-A to J-AY | 100 | 5.0 | 0.010 | 48 | N/A | N/A |
| A to Box | Routing J-AY to Box Canyon | 855 | 2.9 | 0.023 | N/A | N/A | 6.50 |
| B1 to B2 | Routing B1 to J-B | 1,495 | 7.8 | 0.023 | N/A | N/A | 6.50 |
| B to B3 | Routing J-B to J-B3 | 1,943 | 5.6 | 0.023 | N/A | N/A | 6.50 |
| Culvert B | Routing J-B3 to Box Canyon | 855 | 2.9 | 0.023 | N/A | N/A | 6.50 |
| C to C2 | Routing C1 to J-C2 | 1,189 | 6.7 | 0.023 | N/A | N/A | 6.50 |
| C2 to C3 | Routing J-C2 to J-C3 | 4,503 | 2.7 | 0.023 | N/A | N/A | 6.50 |
| C4 to C5 | Routing C4 to J-C5 | 2,043 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| C5 to C3 | Routing J-C5 to J-C3 | 1,170 | 7.0 | 0.023 | N/A | N/A | 6.50 |
| C to D | Routing J-C3 to J-CD | 3,088 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| D1 to D2 | Routing D1 to J-D2 | 2,390 | 7.8 | 0.023 | N/A | N/A | 6.50 |
| D to E3 | Routing J-D2 to J-CD | 120 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| C to E3 | Routing J-CD to J-E3 | 577 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| E1 to E2 | Routing JE1 to J-E2 | 1,303 | 4.3 | 0.023 | N/A | N/A | 6.50 |
| E2 to E3 | Routing J-E2 to J-E3 | 3,501 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| F1 to F2 | Routing F1 to J-F2 | 1,764 | 8.8 | 0.023 | N/A | N/A | 6.50 |
| F to F3 | Routing J-F2 to J-E3 | 2,651 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| G1 to G2 | Routing G1 to J-G2 | 561 | 2.3 | 0.023 | N/A | N/A | 6.50 |
| G to E3 | Routing J-G2 to J-E3 | 883 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| E3 to E4 | Routing J-E3 to Gap Wash | 2,951 | 2.0 | 0.023 | N/A | N/A | 6.50 |

**TYPICAL MANNING'S n VALUES**

| | |
|---|---|
| 0.013 - Poly Pipe | 0.023 - Dirt |
| 0.017 - CM Pipe | 0.026 - Grass |
| 0.015 - Concrete | 0.035 - Gravel |
| 0.016 - Asphalt | 0.040 - Riprap |

ROSENBERG ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS



PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: NRCS Curve Number CHKD: RMA DATE: 30-Aug-16

**NRCS CURVE NUMBER (CN) CHART**

| Land Use Description | SCS Curve Number (CN) Values | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Group A | | Group B | | Group C | | Group D | |
| | CN | % | CN | % | CN | % | CN | % |
| *Cultivated Land* | | | | | | | | |
| Cultivated Land; Without Conservation Treatment | 72 | | 81 | | 88 | | 91 | |
| Cultivated Land; With Conservation Treatment | 62 | | 71 | | 78 | | 81 | |
| *Pasture or Range Land* | | | | | | | | |
| Pasture or Range Land; Poor Condition | 68 | | 79 | | 86 | | 89 | |
| Pasture or Range Land; Good Condition | 39 | | 61 | | 74 | | 80 | |
| *Open Spaces (Lawns, Parks, etc.)* | | | | | | | | |
| Open Space; Poor Condition; Grass Cover < 50% | 68 | | 79 | | 86 | | 89 | |
| Open Space; Fair Condition; Grass Cover 50% to 75% | 49 | | 69 | | 79 | | 84 | |
| Open Space; Good Condition; Grass Cover > 75% | 39 | | 61 | | 74 | | 80 | |
| *Impervious Areas* | | | | | | | | |
| Impervious Areas; Paved Parking Lots, Roofs, Driveways | 98 | | 98 | | 98 | | 98 | |
| Impervious Areas; Streets and Roads; Paved; Curbs and Storm Sewers | 98 | | 98 | | 98 | | 98 | |
| Impervious Areas; Streets and Roads; Paved; Open Ditches (w/ Right-of-Way) | 83 | | 89 | | 92 | | 93 | |
| Impervious Areas; Streets and Roads; Gravel (w/ Right-of-Way) | 76 | | 85 | | 89 | | 91 | |
| Impervious Areas; Streets and Roads; Dirt (w/ Right-of-Way) | 72 | | 82 | | 87 | | 89 | |
| *Urban Commercial and Industrial Districts* | | | | | | | | |
| Urban Districts; Commercial and Business; Average 85% Impervious | 89 | | 92 | | 94 | | 95 | |
| Urban Districts; Industrial; Average 72% Impervious | 81 | | 88 | | 91 | | 93 | |
| *Residential Districts* | | | | | | | | |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | | 85 | | 90 | | 92 | |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | |
| Residential Districts; 1/3 Acre; Average 30% Impervious | 57 | | 72 | | 81 | | 86 | |
| Residential Districts; 1/2 Acre; Average 25% Impervious | 54 | | 70 | | 80 | | 85 | |
| Residential Districts; 1 Acre; Average 20% Impervious | 51 | | 68 | | 79 | | 84 | |
| Residential Districts; 2 Acre; Average 12% Impervious | 46 | | 65 | | 77 | | 82 | |
| *Western Desert Urban Areas* | | | | | | | | |
| Natural Desert Vegetation (Pervious Areas Only) | 63 | | 77 | | 85 | | 88 | |
| Artificial Desert Landscaping | 96 | | 96 | | 96 | | 96 | |
| *Developing Urban Area (No Vegetation)* | | | | | | | | |
| Newly Graded Area (Pervious Only) | 77 | | 86 | | 91 | | 94 | |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: NRCS Curve Number CHKD: RMA DATE: 30-Aug-16

**NRCS WEIGHTED AVERAGE CN VALUES** **EXISTING PRE-DEVELOPMENT CONDITION**

| Land Use Description | SCS Curve Number (CN) Values | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group A | | Group B | | Group C | | Group D | | Totals | |
| | CN | % | CN | % | CN | % | CN | % | CN | % |
| X1, X2, Y1, Y2, A1, A2, A3, B1, B2, C1, C2, D1, D2, E1, E2, F1, F2, G1, G2, H1 | | | | | | | | | 93 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 50 | 49 | 50 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 50 | 44 | 50 |
| B3, B4, C3, C4, C5 E3 | | | | | | | | | 88 | 100 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 100 | 88 | 100 |
| E4 | | | | | | | | | 79 | 100 |
| Natural Desert Vegetation | 63 | 20 | 77 | 35 | 85 | | 88 | 45 | 79.2 | 100 |

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CIVIL ENGINEERS • LAND SURVEYORS



PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: NRCS Curve Number CHKD: RMA DATE: 30-Aug-16

**NRCS WEIGHTED AVERAGE CN VALUES** **PROPOSED POST-DEVELOPMENT CONDITION**

| Land Use Description | SCS Curve Number (CN) Values | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group A | | Group B | | Group C | | Group D | | Totals | |
| | CN | % | CN | % | CN | % | CN | % | CN | % |
| X1, Y1, A1,B1, C1, D1, E1 F1, G1, H1 | | | | | | | | | 93 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 50 | 49 | 50 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 50 | 44 | 50 |
| X2, Y2 | | | | | | | | | 89 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 13 | 12 | 13 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 75 | 65 | 75 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 12.5 | 11 | 12.5 |
| A2 | | | | | | | | | 90 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 10 | 10 | 10 |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | | 85 | | 90 | | 92 | 35 | 32 | 35 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 45 | 39 | 45 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 10 | 8.8 | 10 |
| A3 | | | | | | | | | 91 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 13 | 12 | 13 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 40 | 35 | 40 |
| Urban Districts; Commercial and Business; Average 85% Impervious | 89 | | 92 | | 94 | | 95 | 35 | 33.3 | 35 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 12.5 | 11 | 12.5 |
| B2 | | | | | | | | | 92 | 100 |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | | 85 | | 90 | | 92 | 100 | 92 | 100 |
| B3 | | | | | | | | | 88 | 100 |
| Urban Districts; Commercial and Business; Average 85% Impervious | 89 | | 92 | | 94 | | 95 | 15 | 14.3 | 15 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 55 | 48 | 55 |
| Open Space; Good Condition; Grass Cover > 75% | 39 | | 61 | | 74 | | 80 | 10 | 8 | 10 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 20 | 17.6 | 20 |
| B4, C4. C5 | | | | | | | | | 87 | 100 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 100 | 87 | 100 |
| C2 | | | | | | | | | 94 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 10 | 10 | 10 |
| Urban Districts; Commercial and Business; Average 85% Impervious | 89 | | 92 | | 94 | | 95 | 45 | 42.8 | 45 |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | | 85 | | 90 | | 92 | 45 | 41 | 45 |
| C3 | | | | | | | | | 91 | 100 |
| Natural Desert Vegetation (NaC Naplene Silt Loam) | 63 | | 77 | | 85 | | 88 | 32 | 28 | 32 |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | | 85 | | 90 | | 92 | 68 | 63 | 68 |

ROSENBERG ASSOCIATES
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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: NRCS Curve Number CHKD: RMA DATE: 30-Aug-16

| Land Use Description | SCS Curve Number (CN) Values | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group A | | Group B | | Group C | | Group D | | Totals | |
| | CN | % | CN | % | CN | % | CN | % | CN | % |
| D2 | | | | | | | | | 91 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 30 | 29 | 30 |
| Urban Districts; Commercial and Business; Average 85% Impervious | 89 | | 92 | | 94 | | 95 | 10 | 9.5 | 10 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 60 | 52 | 60 |
| E2 | | | | | | | | | 92 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 45 | 44 | 45 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 55 | 48 | 55 |
| E3 | | | | | | | | | 87 | 100 |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | | 85 | | 90 | | 92 | 32 | 29 | 32 |
| Open Space; Good Condition; Grass Cover > 75% | 39 | | 61 | | 74 | | 80 | 31 | 25 | 31 |
| Natural Desert Vegetation (NaC Naplene Silt Loam) | 63 | | 77 | | 85 | | 88 | 37 | 32.6 | 37 |
| E4 | | | | | | | | | 84 | 100 |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | 5 | 85 | 35 | 90 | | 92 | 45 | 75 | 85 |
| Natural Desert Vegetation (NaC Naplene Silt Loam) | 63 | 15 | 77 | | 85 | | 88 | | 9.45 | 15 |
| F2 | | | | | | | | | 90 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 29 | 28 | 29 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 71 | 62 | 71 |
| G2 | | | | | | | | | 87 | 100 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 100 | 87 | 100 |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: SCS Lag Time CHKD: RMA DATE: 30-Aug-16

**TIME OF CONCENTRATION**

$$t_c = \frac{1.67\, L_O^{\,0.8} \left( \frac{1000}{CN} - 9 \right)^{0.7}}{1900 \sqrt{S_{percent}}}$$

Where: CN = SCS runoff curve number
S = Average slope in percent
Lo = Length in ft

**SCS LAG TIME**

13.46 SCS Lag = 0.6*$t_c$

**EXISTING PRE-DEVELOPMENT CONDITION**

| Hydrologic Element | SCS CN | Longest Length Lo (ft) | Average Slope S (%) | $t_c$ (hr) | Lag Time (hr) | Lag Time (min) |
|---|---|---|---|---|---|---|
| X1 | 93 | 1,480 | 9.00 | 0.149 | 0.089 | 5.37 |
| X2 | 93 | 1,205 | 8.00 | 0.134 | 0.081 | 4.83 |
| Y1 | 93 | 3,500 | 9.00 | 0.297 | 0.178 | 10.69 |
| Y2 | 93 | 802 | 8.00 | 0.097 | 0.058 | 3.49 |
| A1 | 93 | 3,779 | 7.00 | 0.358 | 0.215 | 12.89 |
| A2 | 93 | 2,951 | 7.00 | 0.294 | 0.176 | 10.58 |
| A3 | 93 | 1,870 | 4.45 | 0.256 | 0.153 | 9.21 |
| B1 | 93 | 450 | 7.80 | 0.062 | 0.037 | 2.23 |
| B2 | 93 | 1,495 | 7.80 | 0.162 | 0.097 | 5.81 |
| B3 | 88 | 1,943 | 5.60 | 0.290 | 0.174 | 10.43 |
| B4 | 88 | 1,880 | 2.00 | 0.472 | 0.283 | 17.01 |
| C1 | 93 | 878 | 11.67 | 0.086 | 0.052 | 3.11 |
| C2 | 93 | 1,190 | 6.72 | 0.145 | 0.087 | 5.22 |
| C3 | 88 | 4,503 | 2.67 | 0.822 | 0.493 | 29.60 |
| C4 | 88 | 1,504 | 2.00 | 0.395 | 0.237 | 14.23 |
| C5 | 88 | 2,040 | 3.00 | 0.412 | 0.247 | 14.82 |
| D1 | 93 | 4,694 | 7.48 | 0.412 | 0.247 | 14.83 |
| D2 | 93 | 3,297 | 7.80 | 0.304 | 0.182 | 10.95 |
| E1 | 93 | 14,986 | 2.25 | 1.901 | 1.141 | 68.44 |
| E2 | 93 | 1,303 | 4.27 | 0.196 | 0.117 | 7.04 |
| E3 | 88 | 3,501 | 4.47 | 0.520 | 0.312 | 18.71 |
| E4 | 79 | 2,949 | 9.50 | 0.420 | 0.252 | 15.12 |
| F1 | 93 | 3,213 | 8.42 | 0.287 | 0.172 | 10.32 |
| F2 | 93 | 1,764 | 8.80 | 0.174 | 0.104 | 6.25 |
| G1 | 93 | 7,531 | 9.56 | 0.532 | 0.319 | 19.15 |
| G2 | 93 | 561 | 3.56 | 0.109 | 0.065 | 3.93 |
| H1 | 93 | 1,924 | 4.20 | 0.269 | 0.162 | 9.70 |

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PROJECT NO. 1286-14-014

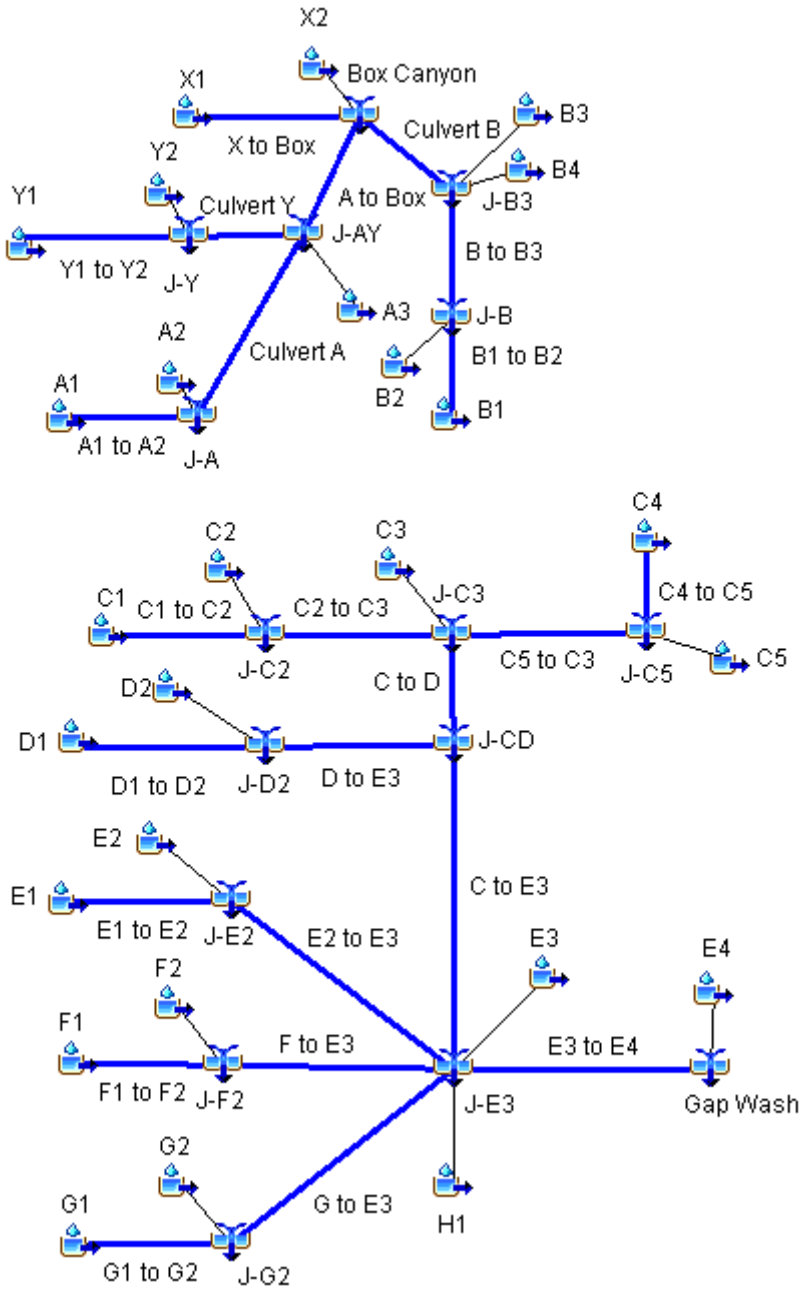
PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: SCS Lag Time CHKD: RMA DATE: 30-Aug-16

**PROPOSED POST-DEVELOPMENT CONDITION**

| Hydrologic Element | SCS CN | Longest Length Lo (ft) | Average Slope S (%) | $t_c$ (hr) | Lag Time (hr) | Lag Time (min) |
|---|---|---|---|---|---|---|
| X1 | 93 | 1,480 | 9.00 | 0.149 | 0.089 | 5.37 |
| X2 | 89 | 1,205 | 8.00 | 0.162 | 0.097 | 5.84 |
| Y1 | 93 | 3,500 | 9.00 | 0.297 | 0.178 | 10.69 |
| Y2 | 89 | 802 | 8.00 | 0.117 | 0.070 | 4.22 |
| A1 | 93 | 3,779 | 7.00 | 0.358 | 0.215 | 12.89 |
| A2 | 90 | 2,951 | 7.00 | 0.335 | 0.201 | 12.07 |
| A3 | 91 | 1,870 | 4.45 | 0.276 | 0.166 | 9.93 |
| B1 | 93 | 450 | 7.80 | 0.062 | 0.037 | 2.23 |
| B2 | 92 | 1,495 | 7.80 | 0.169 | 0.101 | 6.08 |
| B3 | 88 | 1,943 | 5.60 | 0.293 | 0.176 | 10.55 |
| B4 | 87 | 1,880 | 2.00 | 0.490 | 0.294 | 17.66 |
| C1 | 93 | 878 | 11.67 | 0.086 | 0.052 | 3.11 |
| C2 | 94 | 1,190 | 6.72 | 0.139 | 0.083 | 4.99 |
| C3 | 91 | 4,503 | 2.67 | 0.737 | 0.442 | 26.55 |
| C4 | 87 | 1,504 | 2.00 | 0.410 | 0.246 | 14.77 |
| C5 | 87 | 2,040 | 3.00 | 0.428 | 0.257 | 15.39 |
| D1 | 93 | 4,694 | 7.48 | 0.412 | 0.247 | 14.83 |
| D2 | 91 | 3,297 | 7.80 | 0.331 | 0.198 | 11.91 |
| E1 | 93 | 14,986 | 2.25 | 1.901 | 1.141 | 68.44 |
| E2 | 92 | 1,303 | 4.27 | 0.205 | 0.123 | 7.38 |
| E3 | 87 | 3,501 | 4.47 | 0.544 | 0.326 | 19.57 |
| E4 | 84 | 2,949 | 9.50 | 0.353 | 0.212 | 12.72 |
| F1 | 93 | 3,213 | 8.42 | 0.287 | 0.172 | 10.32 |
| F2 | 90 | 1,764 | 8.80 | 0.196 | 0.118 | 7.06 |
| G1 | 93 | 7,531 | 9.56 | 0.532 | 0.319 | 19.15 |
| G2 | 87 | 561 | 3.56 | 0.140 | 0.084 | 5.03 |
| H1 | 93 | 1,924 | 4.20 | 0.269 | 0.162 | 9.70 |

# HEC-HMS Model



Project: The Lakes Master Simulation Run: N Pre 10 3hr

Start of Run: 01Jan2000, 12:00 Basin Model: Pre
End of Run: 01Jan2000, 20:00 Meteorologic Model: 10-3
Compute Time: 30Aug2016, 13:54:22 Control Specifications: 10-3

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 148.6 | 01Jan2000, 13:00 | 0.45 |
| A1 | 0.14214 | 59.6 | 01Jan2000, 12:55 | 0.45 |
| A1 to A2 | 0.14214 | 59.4 | 01Jan2000, 13:00 | 0.45 |
| A2 | 0.07671 | 35.5 | 01Jan2000, 12:55 | 0.45 |
| A3 | 0.05837 | 27.7 | 01Jan2000, 12:55 | 0.45 |
| Box Canyon | 0.58871 | 223.2 | 01Jan2000, 12:55 | 0.41 |
| B to B3 | 0.07701 | 40.7 | 01Jan2000, 12:50 | 0.45 |
| B1 | 0.01710 | 10.5 | 01Jan2000, 12:45 | 0.45 |
| B1 to B2 | 0.01710 | 9.9 | 01Jan2000, 12:50 | 0.45 |
| B2 | 0.05991 | 32.5 | 01Jan2000, 12:50 | 0.45 |
| B3 | 0.07709 | 18.1 | 01Jan2000, 12:55 | 0.25 |
| B4 | 0.01894 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| Culvert A | 0.21885 | 91.0 | 01Jan2000, 13:00 | 0.45 |
| Culvert B | 0.17304 | 56.5 | 01Jan2000, 12:55 | 0.31 |
| Culvert Y | 0.08344 | 35.4 | 01Jan2000, 12:55 | 0.45 |
| C to D | 0.30002 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C to E3 | 1.04382 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C1 | 0.01670 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C1 to C2 | 0.01670 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C2 | 0.06274 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C2 to C3 | 0.07944 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C3 | 0.16979 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C4 | 0.01564 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C4 to C5 | 0.01564 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C5 | 0.03515 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C5 to C3 | 0.05079 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| D1 | 0.59389 | 0.0 | 01Jan2000, 12:00 | 0.00 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 to D2 | 0.59389 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| D2 | 0.14991 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| D2 to C3 | 0.74380 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E1 | 1.32193 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E1 to E2 | 1.32193 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E2 | 0.03210 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E2 to E3 | 1.35403 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E3 | 0.11796 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E3 to E4 | 3.02244 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E4 | 0.07629 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| F to E3 | 0.14378 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| F1 | 0.06707 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| F1 to F2 | 0.06707 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| F2 | 0.07671 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| Gap Wash | 3.02244 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| G to E3 | 0.34168 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| G1 | 0.28835 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| G1 to G2 | 0.28835 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| G2 | 0.05333 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| H1 | 0.02117 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-A | 0.21885 | 91.0 | 01Jan2000, 13:00 | 0.45 |
| J-AY | 0.36066 | 149.0 | 01Jan2000, 12:55 | 0.45 |
| J-B | 0.07701 | 42.4 | 01Jan2000, 12:50 | 0.45 |
| J-B3 | 0.17304 | 57.2 | 01Jan2000, 12:55 | 0.31 |
| J-CD | 1.04382 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-C2 | 0.07944 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-C3 | 0.30002 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-C5 | 0.05079 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-D2 | 0.74380 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-E2 | 1.35403 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-E4 | 3.09873 | 0.0 | 01Jan2000, 12:00 | 0.00 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-G2 | 0.34168 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-Y | 0.08344 | 36.3 | 01Jan2000, 12:55 | 0.45 |
| X to Box | 0.02243 | 12.0 | 01Jan2000, 12:50 | 0.45 |
| X1 | 0.02243 | 12.3 | 01Jan2000, 12:50 | 0.45 |
| X2 | 0.03258 | 18.0 | 01Jan2000, 12:50 | 0.45 |
| Y1 | 0.06908 | 31.9 | 01Jan2000, 12:55 | 0.45 |
| Y1 to Y2 | 0.06908 | 30.9 | 01Jan2000, 12:55 | 0.45 |
| Y2 | 0.01436 | 8.4 | 01Jan2000, 12:45 | 0.45 |

Project: The Lakes Master Simulation Run: N Pre 10 24hr

Start of Run: 01Jan2000, 12:00 Basin Model: Pre
End of Run: 03Jan2000, 00:30 Meteorologic Model: 10-24hr
Compute Time: 30Aug2016, 13:54:14 Control Specifications: 24-Hour

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 141.2 | 02Jan2000, 00:00 | 1.03 |
| A1 | 0.14214 | 61.6 | 02Jan2000, 00:00 | 1.03 |
| A1 to A2 | 0.14214 | 54.7 | 02Jan2000, 00:00 | 1.03 |
| A2 | 0.07671 | 33.2 | 02Jan2000, 00:00 | 1.03 |
| A3 | 0.05837 | 25.3 | 02Jan2000, 00:00 | 1.03 |
| Box Canyon | 0.58871 | 218.4 | 02Jan2000, 00:00 | 0.98 |
| B to B3 | 0.07701 | 29.7 | 02Jan2000, 00:00 | 1.03 |
| B1 | 0.01710 | 7.4 | 02Jan2000, 00:00 | 1.03 |
| B1 to B2 | 0.01710 | 6.7 | 02Jan2000, 00:00 | 1.03 |
| B2 | 0.05991 | 26.0 | 02Jan2000, 00:00 | 1.03 |
| B3 | 0.07709 | 22.0 | 02Jan2000, 00:00 | 0.71 |
| B4 | 0.01894 | 5.1 | 02Jan2000, 00:00 | 0.71 |
| Culvert A | 0.21885 | 87.8 | 02Jan2000, 00:00 | 1.03 |
| Culvert B | 0.17304 | 54.1 | 02Jan2000, 00:00 | 0.86 |
| Culvert Y | 0.08344 | 33.3 | 02Jan2000, 00:00 | 1.03 |
| C to D | 0.30002 | 65.9 | 02Jan2000, 00:30 | 0.80 |
| C to E3 | 1.04382 | 350.4 | 02Jan2000, 00:00 | 0.97 |
| C1 | 0.01670 | 7.2 | 02Jan2000, 00:00 | 1.03 |
| C1 to C2 | 0.01670 | 6.7 | 02Jan2000, 00:00 | 1.03 |
| C2 | 0.06274 | 27.2 | 02Jan2000, 00:00 | 1.03 |
| C2 to C3 | 0.07944 | 23.6 | 02Jan2000, 00:00 | 1.03 |
| C3 | 0.16979 | 34.1 | 02Jan2000, 00:30 | 0.71 |
| C4 | 0.01564 | 4.5 | 02Jan2000, 00:00 | 0.71 |
| C4 to C5 | 0.01564 | 3.3 | 02Jan2000, 00:00 | 0.72 |
| C5 | 0.03515 | 10.0 | 02Jan2000, 00:00 | 0.71 |
| C5 to C3 | 0.05079 | 12.4 | 02Jan2000, 00:00 | 0.72 |
| D1 | 0.59389 | 257.3 | 02Jan2000, 00:00 | 1.03 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 to D2 | 0.59389 | 241.9 | 02Jan2000, 00:00 | 1.03 |
| D2 | 0.14991 | 65.0 | 02Jan2000, 00:00 | 1.03 |
| D2 to C3 | 0.74380 | 305.4 | 02Jan2000, 00:00 | 1.03 |
| E1 | 1.32193 | 266.6 | 02Jan2000, 01:00 | 1.03 |
| E1 to E2 | 1.32193 | 264.1 | 02Jan2000, 01:00 | 1.03 |
| E2 | 0.03210 | 13.9 | 02Jan2000, 00:00 | 1.03 |
| E2 to E3 | 1.35403 | 258.5 | 02Jan2000, 01:00 | 1.03 |
| E3 | 0.11796 | 29.7 | 02Jan2000, 00:00 | 0.71 |
| E3 to E4 | 3.02244 | 596.6 | 02Jan2000, 00:30 | 1.00 |
| E4 | 0.07629 | 7.5 | 02Jan2000, 00:00 | 0.35 |
| F to E3 | 0.14378 | 50.3 | 02Jan2000, 00:00 | 1.03 |
| F1 | 0.06707 | 29.1 | 02Jan2000, 00:00 | 1.03 |
| F1 to F2 | 0.06707 | 26.9 | 02Jan2000, 00:00 | 1.03 |
| F2 | 0.07671 | 33.2 | 02Jan2000, 00:00 | 1.03 |
| Gap Wash | 3.02244 | 644.2 | 02Jan2000, 00:00 | 0.99 |
| G to E3 | 0.34168 | 124.3 | 02Jan2000, 00:00 | 1.03 |
| G1 | 0.28835 | 109.3 | 02Jan2000, 00:00 | 1.03 |
| G1 to G2 | 0.28835 | 106.8 | 02Jan2000, 00:00 | 1.03 |
| G2 | 0.05333 | 23.1 | 02Jan2000, 00:00 | 1.03 |
| H1 | 0.02117 | 9.2 | 02Jan2000, 00:00 | 1.03 |
| J-A | 0.21885 | 88.0 | 02Jan2000, 00:00 | 1.03 |
| J-AY | 0.36066 | 146.4 | 02Jan2000, 00:00 | 1.03 |
| J-B | 0.07701 | 32.7 | 02Jan2000, 00:00 | 1.03 |
| J-B3 | 0.17304 | 56.7 | 02Jan2000, 00:00 | 0.86 |
| J-CD | 1.04382 | 358.2 | 02Jan2000, 00:00 | 0.96 |
| J-C2 | 0.07944 | 33.9 | 02Jan2000, 00:00 | 1.03 |
| J-C3 | 0.30002 | 66.6 | 02Jan2000, 00:30 | 0.80 |
| J-C5 | 0.05079 | 13.3 | 02Jan2000, 00:00 | 0.72 |
| J-D2 | 0.74380 | 306.9 | 02Jan2000, 00:00 | 1.03 |
| J-E2 | 1.35403 | 267.1 | 02Jan2000, 01:00 | 1.03 |
| J-E4 | 3.09873 | 602.2 | 02Jan2000, 00:30 | 0.98 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 60.2 | 02Jan2000, 00:00 | 1.03 |
| J-G2 | 0.34168 | 129.9 | 02Jan2000, 00:00 | 1.03 |
| J-Y | 0.08344 | 34.9 | 02Jan2000, 00:00 | 1.03 |
| X to Box | 0.02243 | 9.0 | 02Jan2000, 00:00 | 1.03 |
| X1 | 0.02243 | 9.7 | 02Jan2000, 00:00 | 1.03 |
| X2 | 0.03258 | 14.1 | 02Jan2000, 00:00 | 1.03 |
| Y1 | 0.06908 | 29.9 | 02Jan2000, 00:00 | 1.03 |
| Y1 to Y2 | 0.06908 | 28.7 | 02Jan2000, 00:00 | 1.03 |
| Y2 | 0.01436 | 6.2 | 02Jan2000, 00:00 | 1.03 |

Project: The Lakes Master Simulation Run: N Pre 100 3hr

Start of Run: 01Jan2000, 12:00 Basin Model: Pre
End of Run: 01Jan2000, 18:30 Meteorologic Model: 100-3
Compute Time: 30Aug2016, 13:54:38 Control Specifications: 100-3

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 344.2 | 01Jan2000, 12:55 | 0.99 |
| A1 | 0.14214 | 139.2 | 01Jan2000, 12:55 | 0.99 |
| A1 to A2 | 0.14214 | 135.5 | 01Jan2000, 13:00 | 0.99 |
| A2 | 0.07671 | 80.3 | 01Jan2000, 12:55 | 0.99 |
| A3 | 0.05837 | 64.4 | 01Jan2000, 12:50 | 0.99 |
| Box Canyon | 0.58871 | 541.9 | 01Jan2000, 12:55 | 0.94 |
| B to B3 | 0.07701 | 94.8 | 01Jan2000, 12:50 | 0.99 |
| B1 | 0.01710 | 23.5 | 01Jan2000, 12:40 | 0.99 |
| B1 to B2 | 0.01710 | 23.4 | 01Jan2000, 12:45 | 0.99 |
| B2 | 0.05991 | 73.1 | 01Jan2000, 12:45 | 0.99 |
| B3 | 0.07709 | 53.9 | 01Jan2000, 12:55 | 0.68 |
| B4 | 0.01894 | 10.6 | 01Jan2000, 13:05 | 0.68 |
| Culvert A | 0.21885 | 208.0 | 01Jan2000, 12:55 | 0.99 |
| Culvert B | 0.17304 | 145.8 | 01Jan2000, 12:55 | 0.82 |
| Culvert Y | 0.08344 | 82.4 | 01Jan2000, 12:55 | 0.99 |
| C to D | 0.30002 | 152.5 | 01Jan2000, 13:05 | 0.76 |
| C to E3 | 1.04382 | 815.0 | 01Jan2000, 13:00 | 0.93 |
| C1 | 0.01670 | 22.7 | 01Jan2000, 12:45 | 0.99 |
| C1 to C2 | 0.01670 | 22.1 | 01Jan2000, 12:45 | 0.99 |
| C2 | 0.06274 | 79.6 | 01Jan2000, 12:45 | 0.99 |
| C2 to C3 | 0.07944 | 98.2 | 01Jan2000, 12:55 | 0.98 |
| C3 | 0.16979 | 71.3 | 01Jan2000, 13:20 | 0.68 |
| C4 | 0.01564 | 9.6 | 01Jan2000, 13:00 | 0.68 |
| C4 to C5 | 0.01564 | 9.4 | 01Jan2000, 13:05 | 0.69 |
| C5 | 0.03515 | 21.3 | 01Jan2000, 13:00 | 0.68 |
| C5 to C3 | 0.05079 | 29.4 | 01Jan2000, 13:05 | 0.69 |
| D1 | 0.59389 | 540.9 | 01Jan2000, 13:00 | 0.99 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 to D2 | 0.59389 | 537.5 | 01Jan2000, 13:00 | 0.99 |
| D2 | 0.14991 | 156.1 | 01Jan2000, 12:55 | 0.99 |
| D2 to C3 | 0.74380 | 671.7 | 01Jan2000, 13:00 | 0.99 |
| E1 | 1.32193 | 456.4 | 01Jan2000, 14:00 | 0.99 |
| E1 to E2 | 1.32193 | 456.3 | 01Jan2000, 14:00 | 0.99 |
| E2 | 0.03210 | 38.3 | 01Jan2000, 12:50 | 0.99 |
| E2 to E3 | 1.35403 | 456.8 | 01Jan2000, 14:05 | 0.99 |
| E3 | 0.11796 | 63.8 | 01Jan2000, 13:05 | 0.68 |
| E3 to E4 | 3.02244 | 1331.1 | 01Jan2000, 13:05 | 0.95 |
| E4 | 0.07629 | 19.5 | 01Jan2000, 13:05 | 0.33 |
| F to E3 | 0.14378 | 152.6 | 01Jan2000, 12:55 | 0.99 |
| F1 | 0.06707 | 70.4 | 01Jan2000, 12:55 | 0.99 |
| F1 to F2 | 0.06707 | 69.9 | 01Jan2000, 12:55 | 0.99 |
| F2 | 0.07671 | 92.3 | 01Jan2000, 12:50 | 0.99 |
| Gap Wash | 3.02244 | 1353.9 | 01Jan2000, 13:00 | 0.96 |
| G to E3 | 0.34168 | 255.8 | 01Jan2000, 13:05 | 0.99 |
| G1 | 0.28835 | 232.1 | 01Jan2000, 13:05 | 0.99 |
| G1 to G2 | 0.28835 | 231.6 | 01Jan2000, 13:05 | 0.99 |
| G2 | 0.05333 | 71.5 | 01Jan2000, 12:45 | 0.99 |
| H1 | 0.02117 | 22.7 | 01Jan2000, 12:50 | 0.99 |
| J-A | 0.21885 | 208.4 | 01Jan2000, 12:55 | 0.99 |
| J-AY | 0.36066 | 351.9 | 01Jan2000, 12:55 | 0.99 |
| J-B | 0.07701 | 96.5 | 01Jan2000, 12:45 | 0.99 |
| J-B3 | 0.17304 | 148.6 | 01Jan2000, 12:50 | 0.82 |
| J-CD | 1.04382 | 821.0 | 01Jan2000, 13:00 | 0.92 |
| J-C2 | 0.07944 | 101.7 | 01Jan2000, 12:45 | 0.99 |
| J-C3 | 0.30002 | 153.6 | 01Jan2000, 13:00 | 0.76 |
| J-C5 | 0.05079 | 29.6 | 01Jan2000, 13:00 | 0.68 |
| J-D2 | 0.74380 | 672.3 | 01Jan2000, 13:00 | 0.99 |
| J-E2 | 1.35403 | 457.9 | 01Jan2000, 14:00 | 0.99 |
| J-E4 | 3.09873 | 1350.6 | 01Jan2000, 13:05 | 0.94 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 154.2 | 01Jan2000, 12:50 | 0.99 |
| J-G2 | 0.34168 | 256.5 | 01Jan2000, 13:05 | 0.99 |
| J-Y | 0.08344 | 82.6 | 01Jan2000, 12:55 | 0.99 |
| X to Box | 0.02243 | 27.5 | 01Jan2000, 12:50 | 0.99 |
| X1 | 0.02243 | 28.2 | 01Jan2000, 12:45 | 0.99 |
| X2 | 0.03258 | 42.3 | 01Jan2000, 12:45 | 0.99 |
| Y1 | 0.06908 | 72.2 | 01Jan2000, 12:55 | 0.99 |
| Y1 to Y2 | 0.06908 | 71.6 | 01Jan2000, 12:55 | 0.99 |
| Y2 | 0.01436 | 19.4 | 01Jan2000, 12:45 | 0.99 |

Project: The Lakes Master Simulation Run: N Pre 100 24hr

Start of Run: 01Jan2000, 12:00 Basin Model: Pre
End of Run: 03Jan2000, 00:30 Meteorologic Model: 100-24hr
Compute Time: 30Aug2016, 13:54:31 Control Specifications: 24-Hour

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 251.4 | 02Jan2000, 00:00 | 1.80 |
| A1 | 0.14214 | 107.9 | 02Jan2000, 00:00 | 1.79 |
| A1 to A2 | 0.14214 | 97.7 | 02Jan2000, 00:00 | 1.80 |
| A2 | 0.07671 | 58.2 | 02Jan2000, 00:00 | 1.79 |
| A3 | 0.05837 | 44.3 | 02Jan2000, 00:00 | 1.79 |
| Box Canyon | 0.58871 | 396.1 | 02Jan2000, 00:00 | 1.73 |
| B to B3 | 0.07701 | 52.9 | 02Jan2000, 00:00 | 1.80 |
| B1 | 0.01710 | 13.0 | 02Jan2000, 00:00 | 1.79 |
| B1 to B2 | 0.01710 | 12.0 | 02Jan2000, 00:00 | 1.80 |
| B2 | 0.05991 | 45.5 | 02Jan2000, 00:00 | 1.79 |
| B3 | 0.07709 | 44.8 | 02Jan2000, 00:00 | 1.39 |
| B4 | 0.01894 | 10.3 | 02Jan2000, 00:00 | 1.39 |
| Culvert A | 0.21885 | 155.7 | 02Jan2000, 00:00 | 1.80 |
| Culvert B | 0.17304 | 104.0 | 02Jan2000, 00:00 | 1.58 |
| Culvert Y | 0.08344 | 59.2 | 02Jan2000, 00:00 | 1.80 |
| C to D | 0.30002 | 124.8 | 02Jan2000, 00:30 | 1.51 |
| C to E3 | 1.04382 | 637.6 | 02Jan2000, 00:00 | 1.71 |
| C1 | 0.01670 | 12.7 | 02Jan2000, 00:00 | 1.79 |
| C1 to C2 | 0.01670 | 11.8 | 02Jan2000, 00:00 | 1.80 |
| C2 | 0.06274 | 47.6 | 02Jan2000, 00:00 | 1.79 |
| C2 to C3 | 0.07944 | 44.4 | 02Jan2000, 00:00 | 1.80 |
| C3 | 0.16979 | 68.0 | 02Jan2000, 00:30 | 1.39 |
| C4 | 0.01564 | 9.1 | 02Jan2000, 00:00 | 1.39 |
| C4 to C5 | 0.01564 | 7.2 | 02Jan2000, 00:00 | 1.40 |
| C5 | 0.03515 | 20.4 | 02Jan2000, 00:00 | 1.39 |
| C5 to C3 | 0.05079 | 26.2 | 02Jan2000, 00:00 | 1.40 |
| D1 | 0.59389 | 451.0 | 02Jan2000, 00:00 | 1.79 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 to D2 | 0.59389 | 428.0 | 02Jan2000, 00:00 | 1.80 |
| D2 | 0.14991 | 113.8 | 02Jan2000, 00:00 | 1.79 |
| D2 to C3 | 0.74380 | 539.6 | 02Jan2000, 00:00 | 1.79 |
| E1 | 1.32193 | 466.2 | 02Jan2000, 01:00 | 1.79 |
| E1 to E2 | 1.32193 | 462.8 | 02Jan2000, 01:00 | 1.79 |
| E2 | 0.03210 | 24.4 | 02Jan2000, 00:00 | 1.79 |
| E2 to E3 | 1.35403 | 455.8 | 02Jan2000, 01:00 | 1.79 |
| E3 | 0.11796 | 60.9 | 02Jan2000, 00:00 | 1.39 |
| E3 to E4 | 3.02244 | 1088.8 | 02Jan2000, 00:00 | 1.75 |
| E4 | 0.07629 | 23.8 | 02Jan2000, 00:00 | 0.84 |
| F to E3 | 0.14378 | 91.3 | 02Jan2000, 00:00 | 1.80 |
| F1 | 0.06707 | 50.9 | 02Jan2000, 00:00 | 1.79 |
| F1 to F2 | 0.06707 | 47.8 | 02Jan2000, 00:00 | 1.80 |
| F2 | 0.07671 | 58.2 | 02Jan2000, 00:00 | 1.79 |
| Gap Wash | 3.02244 | 1182.9 | 02Jan2000, 00:00 | 1.75 |
| G to E3 | 0.34168 | 220.4 | 02Jan2000, 00:00 | 1.79 |
| G1 | 0.28835 | 192.0 | 02Jan2000, 00:00 | 1.79 |
| G1 to G2 | 0.28835 | 188.3 | 02Jan2000, 00:00 | 1.79 |
| G2 | 0.05333 | 40.5 | 02Jan2000, 00:00 | 1.79 |
| H1 | 0.02117 | 16.1 | 02Jan2000, 00:00 | 1.79 |
| J-A | 0.21885 | 155.9 | 02Jan2000, 00:00 | 1.80 |
| J-AY | 0.36066 | 259.2 | 02Jan2000, 00:00 | 1.80 |
| J-B | 0.07701 | 57.5 | 02Jan2000, 00:00 | 1.79 |
| J-B3 | 0.17304 | 108.1 | 02Jan2000, 00:00 | 1.57 |
| J-CD | 1.04382 | 649.6 | 02Jan2000, 00:00 | 1.71 |
| J-C2 | 0.07944 | 59.5 | 02Jan2000, 00:00 | 1.79 |
| J-C3 | 0.30002 | 125.6 | 02Jan2000, 00:00 | 1.50 |
| J-C5 | 0.05079 | 27.7 | 02Jan2000, 00:00 | 1.39 |
| J-D2 | 0.74380 | 541.8 | 02Jan2000, 00:00 | 1.79 |
| J-E2 | 1.35403 | 467.8 | 02Jan2000, 01:00 | 1.79 |
| J-E4 | 3.09873 | 1112.6 | 02Jan2000, 00:00 | 1.73 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 106.0 | 02Jan2000, 00:00 | 1.79 |
| J-G2 | 0.34168 | 228.8 | 02Jan2000, 00:00 | 1.79 |
| J-Y | 0.08344 | 61.5 | 02Jan2000, 00:00 | 1.79 |
| X to Box | 0.02243 | 16.0 | 02Jan2000, 00:00 | 1.79 |
| X1 | 0.02243 | 17.0 | 02Jan2000, 00:00 | 1.79 |
| X2 | 0.03258 | 24.7 | 02Jan2000, 00:00 | 1.79 |
| Y1 | 0.06908 | 52.5 | 02Jan2000, 00:00 | 1.79 |
| Y1 to Y2 | 0.06908 | 50.6 | 02Jan2000, 00:00 | 1.79 |
| Y2 | 0.01436 | 10.9 | 02Jan2000, 00:00 | 1.79 |

Project: The Lakes Master Simulation Run: Post 10-3

Start of Run: 01Jan2000, 12:00 Basin Model: Post
End of Run: 01Jan2000, 20:00 Meteorologic Model: 10-3
Compute Time: 30Aug2016, 13:54:54 Control Specifications: 10-3

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 132.3 | 01Jan2000, 13:00 | 0.40 |
| A1 | 0.14214 | 59.6 | 01Jan2000, 12:55 | 0.45 |
| A1 to A2 | 0.14214 | 59.4 | 01Jan2000, 13:00 | 0.45 |
| A2 | 0.07671 | 22.3 | 01Jan2000, 13:00 | 0.32 |
| A3 | 0.05837 | 21.3 | 01Jan2000, 12:55 | 0.36 |
| Box Canyon | 0.58871 | 199.4 | 01Jan2000, 13:00 | 0.37 |
| B to B3 | 0.07701 | 35.9 | 01Jan2000, 12:50 | 0.41 |
| B1 | 0.01710 | 10.5 | 01Jan2000, 12:45 | 0.45 |
| B1 to B2 | 0.01710 | 9.9 | 01Jan2000, 12:50 | 0.45 |
| B2 | 0.05991 | 28.5 | 01Jan2000, 12:50 | 0.40 |
| B3 | 0.07709 | 18.0 | 01Jan2000, 12:55 | 0.25 |
| B4 | 0.01894 | 3.1 | 01Jan2000, 13:05 | 0.22 |
| Culvert A | 0.21885 | 81.6 | 01Jan2000, 13:00 | 0.40 |
| Culvert B | 0.17304 | 54.4 | 01Jan2000, 12:55 | 0.32 |
| Culvert Y | 0.08344 | 33.9 | 01Jan2000, 12:55 | 0.42 |
| C to D | 0.30002 | 76.2 | 01Jan2000, 13:10 | 0.37 |
| C to E3 | 1.04382 | 346.1 | 01Jan2000, 13:05 | 0.42 |
| C1 | 0.01670 | 10.0 | 01Jan2000, 12:45 | 0.45 |
| C1 to C2 | 0.01670 | 9.5 | 01Jan2000, 12:50 | 0.45 |
| C2 | 0.06274 | 39.0 | 01Jan2000, 12:45 | 0.50 |
| C2 to C3 | 0.07944 | 48.0 | 01Jan2000, 12:55 | 0.49 |
| C3 | 0.16979 | 39.4 | 01Jan2000, 13:15 | 0.36 |
| C4 | 0.01564 | 2.8 | 01Jan2000, 13:05 | 0.22 |
| C4 to C5 | 0.01564 | 2.8 | 01Jan2000, 13:10 | 0.22 |
| C5 | 0.03515 | 6.2 | 01Jan2000, 13:05 | 0.22 |
| C5 to C3 | 0.05079 | 8.6 | 01Jan2000, 13:10 | 0.22 |
| D to E3 | 0.74380 | 280.4 | 01Jan2000, 13:00 | 0.43 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 | 0.59389 | 238.8 | 01Jan2000, 13:00 | 0.45 |
| D1 to D2 | 0.59389 | 231.9 | 01Jan2000, 13:00 | 0.45 |
| D2 | 0.14991 | 52.7 | 01Jan2000, 12:55 | 0.36 |
| E1 | 1.32193 | 204.8 | 01Jan2000, 14:00 | 0.45 |
| E1 to E2 | 1.32193 | 204.2 | 01Jan2000, 14:00 | 0.45 |
| E2 | 0.03210 | 14.7 | 01Jan2000, 12:50 | 0.40 |
| E2 to E3 | 1.35403 | 204.7 | 01Jan2000, 14:05 | 0.45 |
| E3 | 0.11796 | 19.2 | 01Jan2000, 13:10 | 0.22 |
| E3 to E4 | 3.02244 | 551.9 | 01Jan2000, 13:10 | 0.42 |
| E4 | 0.07629 | 8.7 | 01Jan2000, 13:05 | 0.15 |
| F to E3 | 0.14378 | 55.0 | 01Jan2000, 13:00 | 0.38 |
| F1 | 0.06707 | 31.3 | 01Jan2000, 12:55 | 0.45 |
| F1 to F2 | 0.06707 | 30.0 | 01Jan2000, 12:55 | 0.45 |
| F2 | 0.07671 | 27.8 | 01Jan2000, 12:50 | 0.32 |
| Gap Wash | 3.09873 | 560.5 | 01Jan2000, 13:10 | 0.41 |
| G to E3 | 0.34168 | 107.2 | 01Jan2000, 13:05 | 0.42 |
| G1 | 0.28835 | 102.5 | 01Jan2000, 13:05 | 0.45 |
| G1 to G2 | 0.28835 | 101.5 | 01Jan2000, 13:05 | 0.45 |
| G2 | 0.05333 | 14.2 | 01Jan2000, 12:50 | 0.22 |
| H1 | 0.02117 | 10.0 | 01Jan2000, 12:55 | 0.45 |
| J-A | 0.21885 | 81.7 | 01Jan2000, 13:00 | 0.40 |
| J-AY | 0.36066 | 133.7 | 01Jan2000, 13:00 | 0.40 |
| J-B | 0.07701 | 38.4 | 01Jan2000, 12:50 | 0.41 |
| J-B3 | 0.17304 | 55.9 | 01Jan2000, 12:55 | 0.32 |
| J-CD | 1.04382 | 346.3 | 01Jan2000, 13:05 | 0.42 |
| J-C2 | 0.07944 | 48.1 | 01Jan2000, 12:50 | 0.49 |
| J-C3 | 0.30002 | 77.0 | 01Jan2000, 13:00 | 0.37 |
| J-C5 | 0.05079 | 8.6 | 01Jan2000, 13:10 | 0.22 |
| J-D2 | 0.74380 | 281.4 | 01Jan2000, 13:00 | 0.43 |
| J-E2 | 1.35403 | 205.1 | 01Jan2000, 14:00 | 0.45 |
| J-E3 | 3.02244 | 561.0 | 01Jan2000, 13:05 | 0.42 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 55.5 | 01Jan2000, 12:55 | 0.38 |
| J-G2 | 0.34168 | 109.4 | 01Jan2000, 13:05 | 0.42 |
| J-Y | 0.08344 | 35.1 | 01Jan2000, 12:55 | 0.42 |
| X to Box | 0.02243 | 12.0 | 01Jan2000, 12:50 | 0.45 |
| X1 | 0.02243 | 12.3 | 01Jan2000, 12:50 | 0.45 |
| X2 | 0.03258 | 10.5 | 01Jan2000, 12:50 | 0.28 |
| Y1 | 0.06908 | 31.9 | 01Jan2000, 12:55 | 0.45 |
| Y1 to Y2 | 0.06908 | 31.1 | 01Jan2000, 12:55 | 0.45 |
| Y2 | 0.01436 | 5.0 | 01Jan2000, 12:50 | 0.28 |

Project: The Lakes Master Simulation Run: Post 10-24

Start of Run: 01Jan2000, 12:00 Basin Model: Post
End of Run: 02Jan2000, 12:00 Meteorologic Model: 10-24hr
Compute Time: 30Aug2016, 13:54:45 Control Specifications: 24hr

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 129.3 | 02Jan2000, 00:00 | 0.95 |
| A1 | 0.14214 | 61.6 | 02Jan2000, 00:00 | 1.02 |
| A1 to A2 | 0.14214 | 54.7 | 02Jan2000, 00:00 | 1.02 |
| A2 | 0.07671 | 26.1 | 02Jan2000, 00:00 | 0.82 |
| A3 | 0.05837 | 21.6 | 02Jan2000, 00:00 | 0.88 |
| Box Canyon | 0.58871 | 200.2 | 02Jan2000, 00:00 | 0.90 |
| B to B3 | 0.07701 | 27.8 | 02Jan2000, 00:00 | 0.97 |
| B1 | 0.01710 | 7.4 | 02Jan2000, 00:00 | 1.02 |
| B1 to B2 | 0.01710 | 6.7 | 02Jan2000, 00:00 | 1.02 |
| B2 | 0.05991 | 24.0 | 02Jan2000, 00:00 | 0.95 |
| B3 | 0.07709 | 22.0 | 02Jan2000, 00:00 | 0.71 |
| B4 | 0.01894 | 4.5 | 02Jan2000, 00:00 | 0.65 |
| Culvert A | 0.21885 | 80.7 | 02Jan2000, 00:00 | 0.95 |
| Culvert B | 0.17304 | 51.8 | 02Jan2000, 00:00 | 0.82 |
| Culvert Y | 0.08344 | 31.9 | 02Jan2000, 00:00 | 0.98 |
| C to D | 0.30002 | 75.9 | 02Jan2000, 00:30 | 0.90 |
| C to E3 | 1.04382 | 350.7 | 02Jan2000, 00:00 | 0.96 |
| C1 | 0.01670 | 7.2 | 02Jan2000, 00:00 | 1.02 |
| C1 to C2 | 0.01670 | 6.7 | 02Jan2000, 00:00 | 1.02 |
| C2 | 0.06274 | 29.3 | 02Jan2000, 00:00 | 1.09 |
| C2 to C3 | 0.07944 | 25.4 | 02Jan2000, 00:00 | 1.08 |
| C3 | 0.16979 | 42.8 | 02Jan2000, 00:30 | 0.88 |
| C4 | 0.01564 | 4.1 | 02Jan2000, 00:00 | 0.66 |
| C4 to C5 | 0.01564 | 3.0 | 02Jan2000, 00:00 | 0.66 |
| C5 | 0.03515 | 9.0 | 02Jan2000, 00:00 | 0.66 |
| C5 to C3 | 0.05079 | 11.2 | 02Jan2000, 00:00 | 0.66 |
| D to E3 | 0.74380 | 295.9 | 02Jan2000, 00:00 | 0.99 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 | 0.59389 | 257.3 | 02Jan2000, 00:00 | 1.02 |
| D1 to D2 | 0.59389 | 241.9 | 02Jan2000, 00:00 | 1.02 |
| D2 | 0.14991 | 55.4 | 02Jan2000, 00:00 | 0.88 |
| E1 | 1.32193 | 266.6 | 02Jan2000, 01:00 | 1.00 |
| E1 to E2 | 1.32193 | 264.1 | 02Jan2000, 01:00 | 1.00 |
| E2 | 0.03210 | 12.9 | 02Jan2000, 00:00 | 0.95 |
| E2 to E3 | 1.35403 | 258.3 | 02Jan2000, 01:00 | 1.00 |
| E3 | 0.11796 | 27.0 | 02Jan2000, 00:00 | 0.65 |
| E3 to E4 | 3.02244 | 590.6 | 02Jan2000, 00:30 | 0.97 |
| E4 | 0.07629 | 14.5 | 02Jan2000, 00:00 | 0.52 |
| F to E3 | 0.14378 | 44.0 | 02Jan2000, 00:00 | 0.92 |
| F1 | 0.06707 | 29.1 | 02Jan2000, 00:00 | 1.02 |
| F1 to F2 | 0.06707 | 26.9 | 02Jan2000, 00:00 | 1.02 |
| F2 | 0.07671 | 26.1 | 02Jan2000, 00:00 | 0.82 |
| Gap Wash | 3.09873 | 599.6 | 02Jan2000, 00:30 | 0.95 |
| G to E3 | 0.34168 | 115.3 | 02Jan2000, 00:00 | 0.96 |
| G1 | 0.28835 | 109.3 | 02Jan2000, 00:00 | 1.01 |
| G1 to G2 | 0.28835 | 106.8 | 02Jan2000, 00:00 | 1.02 |
| G2 | 0.05333 | 13.8 | 02Jan2000, 00:00 | 0.66 |
| H1 | 0.02117 | 9.2 | 02Jan2000, 00:00 | 1.02 |
| J-A | 0.21885 | 80.8 | 02Jan2000, 00:00 | 0.95 |
| J-AY | 0.36066 | 134.2 | 02Jan2000, 00:00 | 0.94 |
| J-B | 0.07701 | 30.7 | 02Jan2000, 00:00 | 0.96 |
| J-B3 | 0.17304 | 54.3 | 02Jan2000, 00:00 | 0.82 |
| J-CD | 1.04382 | 358.5 | 02Jan2000, 00:00 | 0.96 |
| J-C2 | 0.07944 | 36.0 | 02Jan2000, 00:00 | 1.08 |
| J-C3 | 0.30002 | 76.1 | 02Jan2000, 00:00 | 0.89 |
| J-C5 | 0.05079 | 12.0 | 02Jan2000, 00:00 | 0.66 |
| J-D2 | 0.74380 | 297.4 | 02Jan2000, 00:00 | 0.99 |
| J-E2 | 1.35403 | 267.0 | 02Jan2000, 01:00 | 1.00 |
| J-E3 | 3.02244 | 625.5 | 02Jan2000, 00:00 | 0.96 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 53.0 | 02Jan2000, 00:00 | 0.91 |
| J-G2 | 0.34168 | 120.6 | 02Jan2000, 00:00 | 0.96 |
| J-Y | 0.08344 | 33.4 | 02Jan2000, 00:00 | 0.97 |
| X to Box | 0.02243 | 9.0 | 02Jan2000, 00:00 | 1.02 |
| X1 | 0.02243 | 9.7 | 02Jan2000, 00:00 | 1.02 |
| X2 | 0.03258 | 10.2 | 02Jan2000, 00:00 | 0.76 |
| Y1 | 0.06908 | 29.9 | 02Jan2000, 00:00 | 1.02 |
| Y1 to Y2 | 0.06908 | 28.9 | 02Jan2000, 00:00 | 1.02 |
| Y2 | 0.01436 | 4.5 | 02Jan2000, 00:00 | 0.76 |

Project: The Lakes Master Simulation Run: Post 100-3

Start of Run: 01Jan2000, 12:00 Basin Model: Post
End of Run: 01Jan2000, 18:30 Meteorologic Model: 100-3
Compute Time: 30Aug2016, 13:55:09 Control Specifications: 100-3

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 311.8 | 01Jan2000, 13:00 | 0.92 |
| A1 | 0.14214 | 139.2 | 01Jan2000, 12:55 | 0.99 |
| A1 to A2 | 0.14214 | 135.5 | 01Jan2000, 13:00 | 0.99 |
| A2 | 0.07671 | 60.1 | 01Jan2000, 12:55 | 0.79 |
| A3 | 0.05837 | 52.7 | 01Jan2000, 12:55 | 0.86 |
| Box Canyon | 0.58871 | 498.1 | 01Jan2000, 12:55 | 0.87 |
| B to B3 | 0.07701 | 88.1 | 01Jan2000, 12:50 | 0.93 |
| B1 | 0.01710 | 23.5 | 01Jan2000, 12:40 | 0.99 |
| B1 to B2 | 0.01710 | 23.4 | 01Jan2000, 12:45 | 0.99 |
| B2 | 0.05991 | 67.0 | 01Jan2000, 12:50 | 0.92 |
| B3 | 0.07709 | 53.8 | 01Jan2000, 12:55 | 0.68 |
| B4 | 0.01894 | 9.6 | 01Jan2000, 13:05 | 0.63 |
| Culvert A | 0.21885 | 191.9 | 01Jan2000, 13:00 | 0.92 |
| Culvert B | 0.17304 | 139.9 | 01Jan2000, 12:55 | 0.79 |
| Culvert Y | 0.08344 | 80.7 | 01Jan2000, 12:55 | 0.95 |
| C to D | 0.30002 | 182.0 | 01Jan2000, 13:05 | 0.87 |
| C to E3 | 1.04382 | 820.9 | 01Jan2000, 13:00 | 0.94 |
| C1 | 0.01670 | 22.7 | 01Jan2000, 12:45 | 0.99 |
| C1 to C2 | 0.01670 | 22.1 | 01Jan2000, 12:45 | 0.99 |
| C2 | 0.06274 | 88.4 | 01Jan2000, 12:45 | 1.06 |
| C2 to C3 | 0.07944 | 104.5 | 01Jan2000, 12:55 | 1.04 |
| C3 | 0.16979 | 97.0 | 01Jan2000, 13:15 | 0.86 |
| C4 | 0.01564 | 8.7 | 01Jan2000, 13:00 | 0.63 |
| C4 to C5 | 0.01564 | 8.4 | 01Jan2000, 13:05 | 0.63 |
| C5 | 0.03515 | 19.1 | 01Jan2000, 13:00 | 0.63 |
| C5 to C3 | 0.05079 | 26.6 | 01Jan2000, 13:05 | 0.63 |
| D to E3 | 0.74380 | 654.3 | 01Jan2000, 13:00 | 0.96 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 | 0.59389 | 540.9 | 01Jan2000, 13:00 | 0.99 |
| D1 to D2 | 0.59389 | 537.5 | 01Jan2000, 13:00 | 0.99 |
| D2 | 0.14991 | 132.9 | 01Jan2000, 12:55 | 0.86 |
| E1 | 1.32193 | 456.4 | 01Jan2000, 14:00 | 0.99 |
| E1 to E2 | 1.32193 | 456.3 | 01Jan2000, 14:00 | 0.99 |
| E2 | 0.03210 | 35.4 | 01Jan2000, 12:50 | 0.92 |
| E2 to E3 | 1.35403 | 456.7 | 01Jan2000, 14:05 | 0.99 |
| E3 | 0.11796 | 58.6 | 01Jan2000, 13:05 | 0.63 |
| E3 to E4 | 3.02244 | 1317.2 | 01Jan2000, 13:05 | 0.94 |
| E4 | 0.07629 | 31.7 | 01Jan2000, 13:00 | 0.50 |
| F to E3 | 0.14378 | 134.7 | 01Jan2000, 12:55 | 0.89 |
| F1 | 0.06707 | 70.4 | 01Jan2000, 12:55 | 0.99 |
| F1 to F2 | 0.06707 | 69.9 | 01Jan2000, 12:55 | 0.99 |
| F2 | 0.07671 | 73.2 | 01Jan2000, 12:50 | 0.79 |
| Gap Wash | 3.09873 | 1348.4 | 01Jan2000, 13:05 | 0.93 |
| G to E3 | 0.34168 | 249.4 | 01Jan2000, 13:05 | 0.94 |
| G1 | 0.28835 | 232.1 | 01Jan2000, 13:05 | 0.99 |
| G1 to G2 | 0.28835 | 231.6 | 01Jan2000, 13:05 | 0.99 |
| G2 | 0.05333 | 41.6 | 01Jan2000, 12:50 | 0.63 |
| H1 | 0.02117 | 22.7 | 01Jan2000, 12:50 | 0.99 |
| J-A | 0.21885 | 191.9 | 01Jan2000, 13:00 | 0.92 |
| J-AY | 0.36066 | 321.4 | 01Jan2000, 12:55 | 0.92 |
| J-B | 0.07701 | 88.1 | 01Jan2000, 12:45 | 0.94 |
| J-B3 | 0.17304 | 140.3 | 01Jan2000, 12:50 | 0.79 |
| J-CD | 1.04382 | 828.6 | 01Jan2000, 13:00 | 0.94 |
| J-C2 | 0.07944 | 110.5 | 01Jan2000, 12:45 | 1.05 |
| J-C3 | 0.30002 | 182.6 | 01Jan2000, 13:00 | 0.87 |
| J-C5 | 0.05079 | 26.8 | 01Jan2000, 13:05 | 0.63 |
| J-D2 | 0.74380 | 655.1 | 01Jan2000, 13:00 | 0.96 |
| J-E2 | 1.35403 | 457.8 | 01Jan2000, 14:00 | 0.99 |
| J-E3 | 3.02244 | 1331.5 | 01Jan2000, 13:00 | 0.95 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 135.0 | 01Jan2000, 12:50 | 0.89 |
| J-G2 | 0.34168 | 250.6 | 01Jan2000, 13:05 | 0.93 |
| J-Y | 0.08344 | 81.3 | 01Jan2000, 12:55 | 0.95 |
| X to Box | 0.02243 | 27.5 | 01Jan2000, 12:50 | 0.99 |
| X1 | 0.02243 | 28.2 | 01Jan2000, 12:45 | 0.99 |
| X2 | 0.03258 | 29.0 | 01Jan2000, 12:50 | 0.74 |
| Y1 | 0.06908 | 72.2 | 01Jan2000, 12:55 | 0.99 |
| Y1 to Y2 | 0.06908 | 71.7 | 01Jan2000, 12:55 | 0.99 |
| Y2 | 0.01436 | 13.3 | 01Jan2000, 12:45 | 0.74 |

Project: The Lakes Master Simulation Run: Post 100-24

Start of Run: 01Jan2000, 12:00 Basin Model: Post
End of Run: 03Jan2000, 00:30 Meteorologic Model: 100-24hr
Compute Time: 30Aug2016, 13:55:01 Control Specifications: 24-Hour

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 237.5 | 02Jan2000, 00:00 | 1.70 |
| A1 | 0.14214 | 107.9 | 02Jan2000, 00:00 | 1.79 |
| A1 to A2 | 0.14214 | 97.7 | 02Jan2000, 00:00 | 1.80 |
| A2 | 0.07671 | 50.0 | 02Jan2000, 00:00 | 1.54 |
| A3 | 0.05837 | 40.1 | 02Jan2000, 00:00 | 1.62 |
| Box Canyon | 0.58871 | 374.8 | 02Jan2000, 00:00 | 1.65 |
| B to B3 | 0.07701 | 50.9 | 02Jan2000, 00:00 | 1.73 |
| B1 | 0.01710 | 13.0 | 02Jan2000, 00:00 | 1.79 |
| B1 to B2 | 0.01710 | 12.0 | 02Jan2000, 00:00 | 1.80 |
| B2 | 0.05991 | 43.3 | 02Jan2000, 00:00 | 1.70 |
| B3 | 0.07709 | 44.8 | 02Jan2000, 00:00 | 1.39 |
| B4 | 0.01894 | 9.5 | 02Jan2000, 00:00 | 1.32 |
| Culvert A | 0.21885 | 147.5 | 02Jan2000, 00:00 | 1.71 |
| Culvert B | 0.17304 | 101.2 | 02Jan2000, 00:00 | 1.54 |
| Culvert Y | 0.08344 | 57.5 | 02Jan2000, 00:00 | 1.74 |
| C to D | 0.30002 | 136.8 | 02Jan2000, 00:30 | 1.65 |
| C to E3 | 1.04382 | 640.6 | 02Jan2000, 00:00 | 1.73 |
| C1 | 0.01670 | 12.7 | 02Jan2000, 00:00 | 1.79 |
| C1 to C2 | 0.01670 | 11.8 | 02Jan2000, 00:00 | 1.80 |
| C2 | 0.06274 | 49.9 | 02Jan2000, 00:00 | 1.88 |
| C2 to C3 | 0.07944 | 46.4 | 02Jan2000, 00:00 | 1.88 |
| C3 | 0.16979 | 78.0 | 02Jan2000, 00:30 | 1.62 |
| C4 | 0.01564 | 8.6 | 02Jan2000, 00:00 | 1.32 |
| C4 to C5 | 0.01564 | 6.8 | 02Jan2000, 00:00 | 1.33 |
| C5 | 0.03515 | 19.0 | 02Jan2000, 00:00 | 1.32 |
| C5 to C3 | 0.05079 | 24.4 | 02Jan2000, 00:00 | 1.33 |
| D to E3 | 0.74380 | 528.7 | 02Jan2000, 00:00 | 1.76 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 | 0.59389 | 451.0 | 02Jan2000, 00:00 | 1.79 |
| D1 to D2 | 0.59389 | 428.0 | 02Jan2000, 00:00 | 1.80 |
| D2 | 0.14991 | 103.0 | 02Jan2000, 00:00 | 1.62 |
| E1 | 1.32193 | 466.2 | 02Jan2000, 01:00 | 1.79 |
| E1 to E2 | 1.32193 | 462.8 | 02Jan2000, 01:00 | 1.79 |
| E2 | 0.03210 | 23.2 | 02Jan2000, 00:00 | 1.70 |
| E2 to E3 | 1.35403 | 455.6 | 02Jan2000, 01:00 | 1.79 |
| E3 | 0.11796 | 57.3 | 02Jan2000, 00:00 | 1.32 |
| E3 to E4 | 3.02244 | 1069.7 | 02Jan2000, 00:00 | 1.74 |
| E4 | 0.07629 | 34.5 | 02Jan2000, 00:00 | 1.12 |
| F to E3 | 0.14378 | 83.8 | 02Jan2000, 00:00 | 1.67 |
| F1 | 0.06707 | 50.9 | 02Jan2000, 00:00 | 1.79 |
| F1 to F2 | 0.06707 | 47.8 | 02Jan2000, 00:00 | 1.80 |
| F2 | 0.07671 | 50.0 | 02Jan2000, 00:00 | 1.54 |
| Gap Wash | 3.09873 | 1104.2 | 02Jan2000, 00:00 | 1.73 |
| G to E3 | 0.34168 | 209.4 | 02Jan2000, 00:00 | 1.72 |
| G1 | 0.28835 | 192.0 | 02Jan2000, 00:00 | 1.79 |
| G1 to G2 | 0.28835 | 188.3 | 02Jan2000, 00:00 | 1.79 |
| G2 | 0.05333 | 29.2 | 02Jan2000, 00:00 | 1.32 |
| H1 | 0.02117 | 16.1 | 02Jan2000, 00:00 | 1.79 |
| J-A | 0.21885 | 147.6 | 02Jan2000, 00:00 | 1.71 |
| J-AY | 0.36066 | 245.0 | 02Jan2000, 00:00 | 1.70 |
| J-B | 0.07701 | 55.3 | 02Jan2000, 00:00 | 1.72 |
| J-B3 | 0.17304 | 105.2 | 02Jan2000, 00:00 | 1.53 |
| J-CD | 1.04382 | 652.6 | 02Jan2000, 00:00 | 1.73 |
| J-C2 | 0.07944 | 61.8 | 02Jan2000, 00:00 | 1.86 |
| J-C3 | 0.30002 | 145.1 | 02Jan2000, 00:00 | 1.64 |
| J-C5 | 0.05079 | 25.8 | 02Jan2000, 00:00 | 1.32 |
| J-D2 | 0.74380 | 530.9 | 02Jan2000, 00:00 | 1.76 |
| J-E2 | 1.35403 | 467.6 | 02Jan2000, 01:00 | 1.79 |
| J-E3 | 3.02244 | 1162.8 | 02Jan2000, 00:00 | 1.74 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 97.7 | 02Jan2000, 00:00 | 1.66 |
| J-G2 | 0.34168 | 217.5 | 02Jan2000, 00:00 | 1.72 |
| J-Y | 0.08344 | 59.8 | 02Jan2000, 00:00 | 1.74 |
| X to Box | 0.02243 | 16.0 | 02Jan2000, 00:00 | 1.79 |
| X1 | 0.02243 | 17.0 | 02Jan2000, 00:00 | 1.79 |
| X2 | 0.03258 | 20.1 | 02Jan2000, 00:00 | 1.46 |
| Y1 | 0.06908 | 52.5 | 02Jan2000, 00:00 | 1.79 |
| Y1 to Y2 | 0.06908 | 51.0 | 02Jan2000, 00:00 | 1.79 |
| Y2 | 0.01436 | 8.8 | 02Jan2000, 00:00 | 1.46 |

# Worksheet for Culvert 1

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 36 | in |
| Discharge | 80.70 | $ft^3/s$ |

## Results

| | | |
|---|---|---|
| Normal Depth | 2.29 | ft |
| Flow Area | 5.79 | $ft^2$ |
| Wetted Perimeter | 6.38 | ft |
| Hydraulic Radius | 0.91 | ft |
| Top Width | 2.55 | ft |
| Critical Depth | 2.78 | ft |
| Percent Full | 76.4 | % |
| Critical Slope | 0.00750 | ft/ft |
| Velocity | 13.93 | ft/s |
| Velocity Head | 3.02 | ft |
| Specific Energy | 5.31 | ft |
| Froude Number | 1.63 | |
| Maximum Discharge | 93.27 | $ft^3/s$ |
| Discharge Full | 86.70 | $ft^3/s$ |
| Slope Full | 0.00866 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 76.36 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 1

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 2.29 | ft |
| Critical Depth | 2.78 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00750 | ft/ft |

# Worksheet for Culvert 2

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 48 | in |
| Discharge | 191.90 | ft³/s |

## Results

| | | |
|---|---|---|
| Normal Depth | 3.39 | ft |
| Flow Area | 11.35 | ft² |
| Wetted Perimeter | 9.35 | ft |
| Hydraulic Radius | 1.21 | ft |
| Top Width | 2.88 | ft |
| Critical Depth | 3.82 | ft |
| Percent Full | 84.7 | % |
| Critical Slope | 0.00917 | ft/ft |
| Velocity | 16.91 | ft/s |
| Velocity Head | 4.44 | ft |
| Specific Energy | 7.83 | ft |
| Froude Number | 1.50 | |
| Maximum Discharge | 200.86 | ft³/s |
| Discharge Full | 186.73 | ft³/s |
| Slope Full | 0.01056 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 84.70 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 2

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 3.39 | ft |
| Critical Depth | 3.82 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00917 | ft/ft |

# Worksheet for Culvert 3

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 36 | in |
| Discharge | 88.10 | $ft^3/s$ |

## Results

| | | |
|---|---|---|
| Normal Depth | 2.50 | ft |
| Flow Area | 6.31 | $ft^2$ |
| Wetted Perimeter | 6.91 | ft |
| Hydraulic Radius | 0.91 | ft |
| Top Width | 2.23 | ft |
| Critical Depth | 2.83 | ft |
| Percent Full | 83.5 | % |
| Critical Slope | 0.00893 | ft/ft |
| Velocity | 13.97 | ft/s |
| Velocity Head | 3.03 | ft |
| Specific Energy | 5.54 | ft |
| Froude Number | 1.46 | |
| Maximum Discharge | 93.27 | $ft^3/s$ |
| Discharge Full | 86.70 | $ft^3/s$ |
| Slope Full | 0.01032 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 83.50 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 3

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 2.50 | ft |
| Critical Depth | 2.83 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00893 | ft/ft |

# Worksheet for Culvert 4

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 42 | in |
| Discharge | 139.90 | ft³/s |

## Results

| | | |
|---|---|---|
| Normal Depth | 3.18 | ft |
| Flow Area | 9.18 | ft² |
| Wetted Perimeter | 8.85 | ft |
| Hydraulic Radius | 1.04 | ft |
| Top Width | 2.01 | ft |
| Critical Depth | 3.35 | ft |
| Percent Full | 90.9 | % |
| Critical Slope | 0.00995 | ft/ft |
| Velocity | 15.23 | ft/s |
| Velocity Head | 3.61 | ft |
| Specific Energy | 6.79 | ft |
| Froude Number | 1.26 | |
| Maximum Discharge | 140.69 | ft³/s |
| Discharge Full | 130.79 | ft³/s |
| Slope Full | 0.01144 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 90.89 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 4

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 3.18 | ft |
| Critical Depth | 3.35 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00995 | ft/ft |

# Worksheet for Culvert 5

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 42 | in |
| Discharge | 104.50 | ft³/s |

## Results

| | | |
|---|---|---|
| Normal Depth | 2.37 | ft |
| Flow Area | 6.92 | ft² |
| Wetted Perimeter | 6.76 | ft |
| Hydraulic Radius | 1.02 | ft |
| Top Width | 3.28 | ft |
| Critical Depth | 3.12 | ft |
| Percent Full | 67.6 | % |
| Critical Slope | 0.00567 | ft/ft |
| Velocity | 15.10 | ft/s |
| Velocity Head | 3.54 | ft |
| Specific Energy | 5.91 | ft |
| Froude Number | 1.83 | |
| Maximum Discharge | 140.69 | ft³/s |
| Discharge Full | 130.79 | ft³/s |
| Slope Full | 0.00638 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 67.60 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 5

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 2.37 | ft |
| Critical Depth | 3.12 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00567 | ft/ft |

# Worksheet for Culvert 6

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 84 | in |
| Discharge | 654.30 | ft³/s |

## Results

| | | |
|---|---|---|
| Normal Depth | 4.68 | ft |
| Flow Area | 27.37 | ft² |
| Wetted Perimeter | 13.41 | ft |
| Hydraulic Radius | 2.04 | ft |
| Top Width | 6.59 | ft |
| Critical Depth | 6.43 | ft |
| Percent Full | 66.9 | % |
| Critical Slope | 0.00539 | ft/ft |
| Velocity | 23.91 | ft/s |
| Velocity Head | 8.88 | ft |
| Specific Energy | 13.57 | ft |
| Froude Number | 2.07 | |
| Maximum Discharge | 893.31 | ft³/s |
| Discharge Full | 830.44 | ft³/s |
| Slope Full | 0.00621 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 66.91 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 6

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 4.68 | ft |
| Critical Depth | 6.43 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00539 | ft/ft |

# Worksheet for Culvert 7

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 84 | in |
| Discharge | 810.00 | ft³/s |

## Results

| | | |
|---|---|---|
| Normal Depth | 5.59 | ft |
| Flow Area | 32.94 | ft² |
| Wetted Perimeter | 15.47 | ft |
| Hydraulic Radius | 2.13 | ft |
| Top Width | 5.62 | ft |
| Critical Depth | 6.73 | ft |
| Percent Full | 79.8 | % |
| Critical Slope | 0.00830 | ft/ft |
| Velocity | 24.59 | ft/s |
| Velocity Head | 9.40 | ft |
| Specific Energy | 14.99 | ft |
| Froude Number | 1.79 | |
| Maximum Discharge | 893.31 | ft³/s |
| Discharge Full | 830.44 | ft³/s |
| Slope Full | 0.00951 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 79.83 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 7

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 5.59 | ft |
| Critical Depth | 6.73 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00830 | ft/ft |

# Worksheet for Culvert 8

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 72 | in |
| Discharge | 456.70 | ft³/s |

## Results

| | | |
|---|---|---|
| Normal Depth | 4.17 | ft |
| Flow Area | 20.98 | ft² |
| Wetted Perimeter | 11.83 | ft |
| Hydraulic Radius | 1.77 | ft |
| Top Width | 5.52 | ft |
| Critical Depth | 5.55 | ft |
| Percent Full | 69.5 | % |
| Critical Slope | 0.00596 | ft/ft |
| Velocity | 21.77 | ft/s |
| Velocity Head | 7.37 | ft |
| Specific Energy | 11.54 | ft |
| Froude Number | 1.97 | |
| Maximum Discharge | 592.21 | ft³/s |
| Discharge Full | 550.53 | ft³/s |
| Slope Full | 0.00688 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 69.51 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 8

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 4.17 | ft |
| Critical Depth | 5.55 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00596 | ft/ft |

# Worksheet for Culvert 9

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 42 | in |
| Discharge | 134.70 | $ft^3/s$ |

## Results

| | | |
|---|---|---|
| Normal Depth | 2.97 | ft |
| Flow Area | 8.71 | $ft^2$ |
| Wetted Perimeter | 8.21 | ft |
| Hydraulic Radius | 1.06 | ft |
| Top Width | 2.50 | ft |
| Critical Depth | 3.33 | ft |
| Percent Full | 84.9 | % |
| Critical Slope | 0.00919 | ft/ft |
| Velocity | 15.46 | ft/s |
| Velocity Head | 3.72 | ft |
| Specific Energy | 6.69 | ft |
| Froude Number | 1.46 | |
| Maximum Discharge | 140.69 | $ft^3/s$ |
| Discharge Full | 130.79 | $ft^3/s$ |
| Slope Full | 0.01061 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 84.95 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 9

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 2.97 | ft |
| Critical Depth | 3.33 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00919 | ft/ft |

# Worksheet for Culvert 10

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 60 | in |
| Discharge | 249.40 | $ft^3/s$ |

## Results

| | | |
|---|---|---|
| Normal Depth | 3.19 | ft |
| Flow Area | 13.23 | $ft^2$ |
| Wetted Perimeter | 9.25 | ft |
| Hydraulic Radius | 1.43 | ft |
| Top Width | 4.81 | ft |
| Critical Depth | 4.42 | ft |
| Percent Full | 63.8 | % |
| Critical Slope | 0.00486 | ft/ft |
| Velocity | 18.85 | ft/s |
| Velocity Head | 5.52 | ft |
| Specific Energy | 8.72 | ft |
| Froude Number | 2.00 | |
| Maximum Discharge | 364.19 | $ft^3/s$ |
| Discharge Full | 338.56 | $ft^3/s$ |
| Slope Full | 0.00543 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 63.82 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 10

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 3.19 | ft |
| Critical Depth | 4.42 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00486 | ft/ft |

# Exhibit D

Executive Geotechnical Summary

July 5, 2005 1286-04-ZC

City of St. George
175 East 200 North
St. George, Utah 84790

Attn: Hillside Review Committee

Subject: Executive Summary
Geotechnical Site Evaluation
Lakes At St. George Development

Gentlemen:

**Introduction**

The purpose of this letter is to provide a summary of the general geologic and soil conditions at the subject site, and general geotechnical requirements for development. The project site (previously known as the Plantations Development site), is approximately 730 acres in area and is located within and along a relatively small valley west of the Green Valley and Sunbrook developments in St. George, Utah. Development of the site will be in phases and will consist of a 9-hole golf course, three to four lakes, and residential construction.

Previous geotechnical investigations conducted on the project site were referenced for this summary. The following geotechnical reports were reviewed.

2001 Geotechnical Investigation
Plantations at St. George, Phase 1
Residential Pods 12A, 12B & 15
Rosenberg Associates Project No. 95-1198-01

1995 Geotechnical Investigation
The Plantations, Phase 1
Black, Miller & Associates Project No. 95-1198-01

1992 Preliminary Geotechnical Site Assessment
730-Acre Plantations Project
Kleinfelder Project No. 31-800570

## General Geologic Conditions

The majority of the site consists of a northwest trending valley flanked by a broad, shallow dip slope to the west and a plateau to the east. The southern-most portion of the site occupies a smaller, east-west trending valley separated from the remaining portion of the site by a south trending spur. The northern third of the site drains to the northeast through a series of subparallel tributary washes that join and exit the site in the northeast corner. The southern two-thirds of the site drains to the southwest from the west through a major tributary wash which enters the site through a feature known as "The Gap". The main wash flows to the south and then to the east, meandering back and forth across the southern site boundary.

Geologic deposits ranging in age from Triassic to Recent are found at the site (see Drawing No. 1 enclosed at the end of this letter). Bedrock consists chiefly of the Triassic Chinle Formation. The lower Shinarump Member consisting of sandstones and conglomerates outcrops extensively on the western portion of the site. The upper Petrified Forest Member (locally known as "Blue Clay"), underlies most of the central alluvial basin deposits and which outcrops on the eastern side of the site. Quaternary deposits consisting of Older gravels, Recent alluvial deposits, and possible landslide deposits are also present on the site as shown on Drawing No. 1 (Christenson and Deen, 1983).

## General Subsurface Soil Conditions

For the purpose of this letter, we have separated the subject site into the four (4) general areas based on soil type (see Drawing No. 1). The subsurface conditions encountered on the western portion of the site (see orange colored area on Drawing No. 1), generally consisted of ½ to 1½ feet of loose, surficial silty sand or soft sandy clay soils overlying moderately hard to hard sandstone bedrock. Although generally jointed and fractured, the sandstones have a high shear strength, are relatively incompressible, and provide favorable foundation support characteristics.

The subsurface conditions at the base of the western slopes in the central and along the low ridges of the eastern portion of the site generally consist of varying thicknesses of alluvial soils (soft to stiff clayey soils, or loose to medium dense gravelly soils) overlying red-brown and green-gray highly plastic clays and mudstone bedrock associated with the Petrified Forest Member of the Chinle Formation (see the purple areas on Drawing No. 1). The Petrified Forest Member, or clay soils derived from erosion of this unit, generally have a high to critical swell potential with changes in moisture content, are of relatively low strength, and experience considerable reductions in strength when exposed to moisture.

In the northern portion of the site (see gray colored area on Drawing No. 1), the subsurface conditions generally consist predominantly of green-gray shales. The red-brown and purple mudstones, locally known as "Blue Clay" were not encountered within this area.. Clayey soils derived from the green-gray shales generally have low to moderate swell potentials.

On the plateau area to the east, the subsurface conditions are expected to consist of slightly to very well indurated (naturally cemented) sands, gravels, and cobbles associated with an Older Quaternary gravel formation. The sand and gravel deposits (see the green area on Drawing No. 2) generally provide favorable subgrade characteristics.

Groundwater was encountered during the 1992 preliminary assessment performed by Kleinfelder in the southeastern portion of the property at depths of about 4 to 12½ feet below the existing ground surface.

**General Geotechnical Requirements**

Based on the subsurface conditions encountered during at the site, and our experience with similar soil conditions, it is our opinion (from a geotechnical view point) that with proper preparation and design the subject site can be utilized for the proposed developments.

In the northern and western portions of the site (see orange and gray colored areas on Drawing No. 1), site grading will generally consist of reworking the existing surficial soils. The proposed structures should receive adequate support from conventional spread footings founded on competent undisturbed medium dense to dense native soils, on properly placed and compacted structural fill, or entirely on undisturbed non-expansive bedrock. The main geotechnical constraint within this area is the presence of moderately hard to hard bedrock. Rock excavating techniques should be anticipated where these materials are encountered during site grading and utility trench excavation. Steel reinforcing is recommended for footings and floor slabs constructed within the gray area due to the localized presence of low to moderately expansive soils.

Where the Petrified Forest Member of the Chinle Formation is present (see purple colored areas on Drawing No. 1), the most significant constraints to the development are related to the overall instability and generally poor foundation support characteristics this formation. Where this formation is present within slopes, the integrity of the slopes can be impaired by grading activities as well as loading and the introduction of water. Special grading and foundation considerations will be required where the Petrified Forest Member will be present within 15 feet of the planned rough pad elevations. We recommend that the structures be supported by a deep foundation systems with grade beams to support wall loads, and a raised structural floor system. Where conventional foundation systems are desired within expansive clay areas, any expansive clay soils or bedrock located within 15 feet of the final building pad elevations would require overexcavation and replacement with approved structural fill materials. Within exterior flatwork and street improvement areas, expansive native materials present within 3 feet of the planned subgrade elevation should be overexcavated and replaced with structural fill.

Older Quaternary gravels at the site (see green colored areas in the southeast portion of the site) occur primarily as a cap overlying the Petrified Forest Member in the plateau areas to the east. These materials consist of slightly to very well cemented sands, gravels, and cobbles. The sand and gravel deposits are generally anticipated to provide favorable foundation support

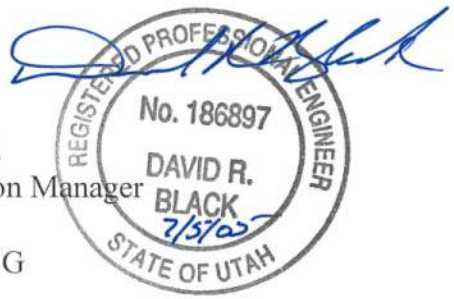
characteristics. However, in the vicinity of slopes, overall stability anticipated to be a consideration for portions of the development within this area due to the underlying presence of the Petrified Forest Member.

**Closure**

It is our pleasure to be of continued service on this project. If you have any questions concerning the information contained in this letter, please contact us at your convenience.

Sincerely,

ROSENBERG ASSOCIATES

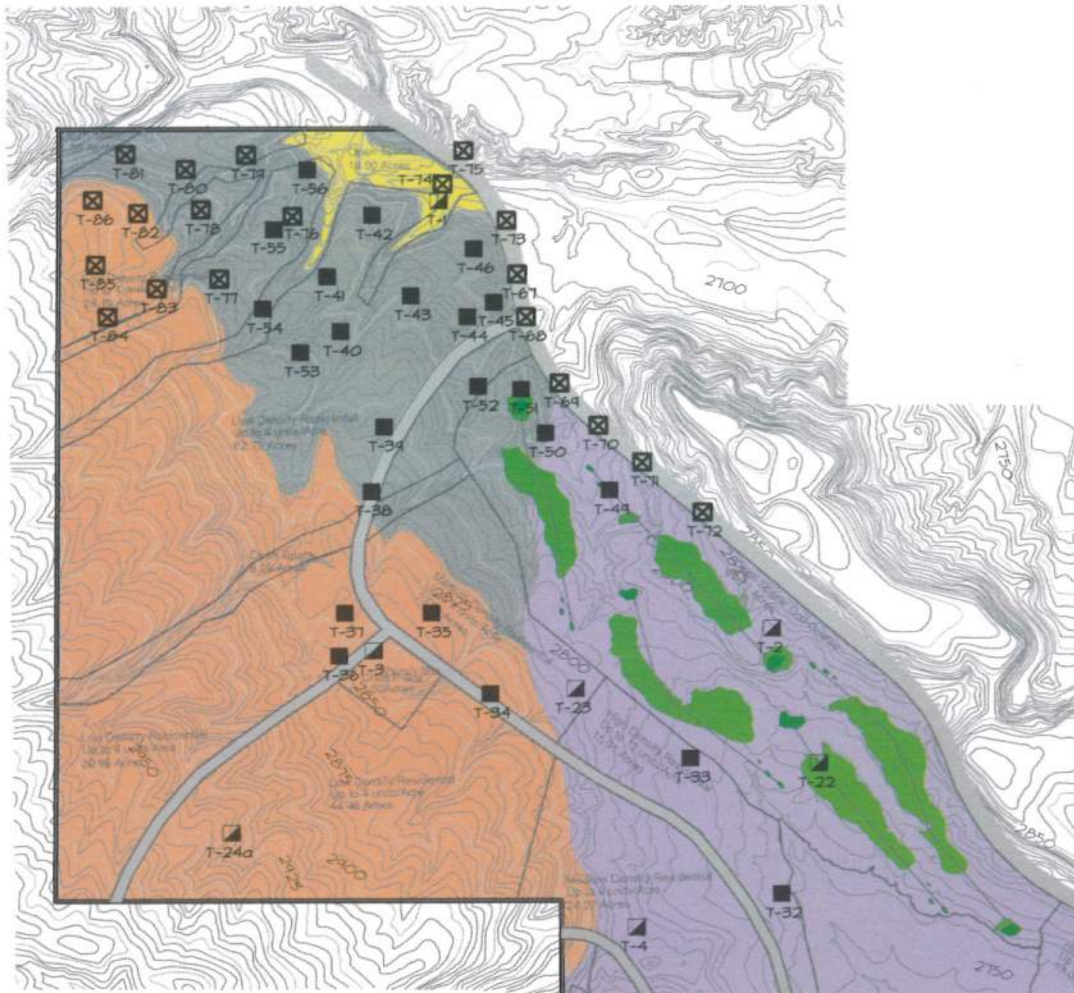
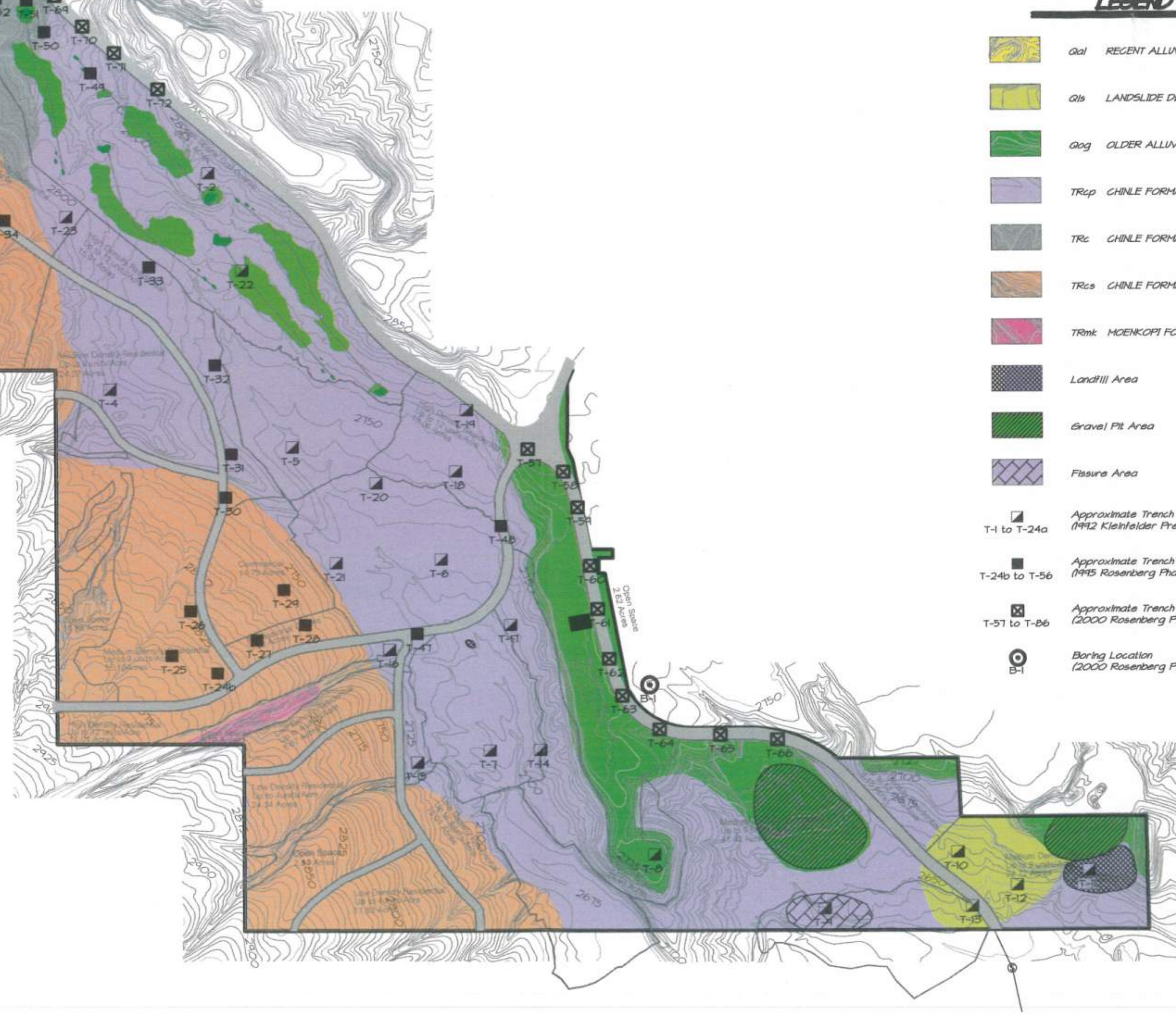



David R. Black, P.E.
Geotechnical Division Manager

DRB/RTR/05R-137.G

# SOILS MAP

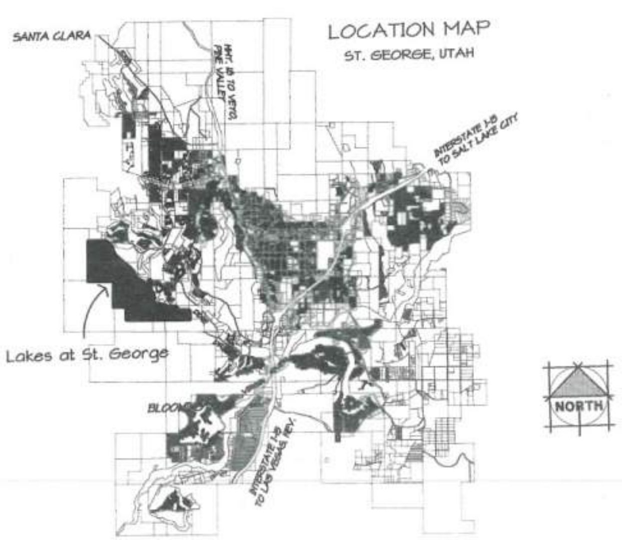
## LAKES AT ST. GEORGE





CONTOUR INTERVAL = 5'




### LEGEND

| | | |
|---|---|---|
| | Qal | RECENT ALLUVIAL SANDS AND GRAVELS |
| | Qls | LANDSLIDE DEBRIS |
| | Qog | OLDER ALLUVIAL GRAVEL |
| | TRcp | CHINLE FORMATION, PETRIFIED FOREST MEMBER (WITHIN 12 FEET) |
| | TRc | CHINLE FORMATION, GREEN/GRAY SHALE BEDS |
| | TRcs | CHINLE FORMATION, SHINARUMP MEMBER |
| | TRmk | MOENKOPI FORMATION, UPPER RED MEMBER |
| | | Landfill Area |
| | | Gravel Pit Area |
| | | Fissure Area |
| T-1 to T-24a | | Approximate Trench Locations (1992 Kleinfelder Preliminary Site Assessment) |
| T-24b to T-56 | | Approximate Trench Locations (1995 Rosenberg Phase I Geotechnical Investigation) |
| T-57 to T-86 | | Approximate Trench Locations (2000 Rosenberg Plantations Drive Investigation) |
| B-1 | | Boring Location (2000 Rosenberg Plantations Drive Investigation) |

09-24-04
DATE:

1286-04
JOB NUMBER:

1" = 500'
SCALE:

T.J.F.
DRAWN BY:

CHECKED BY:

DATE

REVISIONS


ROSENBERG ASSOCIATES
CONSULTING ENGINEERS AND LAND SURVEYORS
352 East Riverside Drive, Suite A2
St. George, Utah 84790 - (435) 673-8586


SOILS MAP
PLANTATIONS AT ST. GEORGE
CITY OF ST. GEORGE
WASHINGTON COUNTY, UTAH

DRAWING NAME:
1286SoilTyp

SHEET
1
OF 1 SHEETS

St.George
Community Development

# ITEM 2

## Hillside Permit

HILLSIDE REVIEW BOARD AGENDA REPORT: **02/23/2022**

HILLSIDE DEVELOPMENT PERMIT
**Divario (Formerly "The Lakes") PA-18**
Case No. 2022-HS-004

**Request:** This is a request for a Hillside Development Permit to allow the applicant to construct in the area shown on the slope map labeled 20-29% and open space. This is specifically in the PA-18 area which is situated in the northern portion of the Divario development.

**Hillside History:**

**1) 2005 -** Case No. 2005-HS-013 "The Lakes" (7/21/2005 - agenda item #2) – An overall conceptual hillside development permit review for 730 acres. Rosenberg Associates.

**2) 2008** - Case No. 2008-HS-006 "PA-17" The Lakes (7/16/2008) – 12.30 acres. Rosenberg Associates.

**3) 2008** - Case No. 2008-HS-012 (10/30/2008) Determine which PA areas have sensitive slopes and will require future hillside meetings for subdivisions; being PA-3, PA-4, PA-12, PA-13, PA-14, PA-15, PA-16, and PA-17 will require HS review (*Note: PA's # 1, 2, 4, 5, 6, 7, 8, 9 (if less than 10 ft.), 10, 11, & 18 will not require hillside review*).

**4) 2016 -** Case No. 2016-HS-001 (1/20/2016) – Approx. 45.73 acres. The Hillside Review Board met and reviewed PA-14 and PA-16 and at that time approved the exclusion of washes and rock outcroppings in these 2 areas. However, following that review meeting, Rosenberg Associates met with City staff to revisit two additional rock outcroppings that were not looked at as closely by the board. One of these was located in PA-14, labeled as Item #1. Following the meeting with City staff it was determined to re-design the lot layout and grading around the feature and preserve it as a subdivision amenity in order to avoid scheduling another hillside review board meeting. The project design proceeded with that feature preserved.

**5) 2021** – Case No. 2021-HS-001 (01/27/2021) – Approx. 19.78 acres. The Hillside Review Board reviewed a request for PA-9 to allow cuts and fills in excess of 10 feet in height. This was a requirement from the original hillside review in 2008. This was ultimately approved by the City Council.

6) **2022** – Case No. 2022-HS-003 (01/26/2022) – Approx. 36.64 acres. At the time of writhing this staff report, this application is still under review. At the meeting in January, the Hillside Review Board requested that the plans be

adjusted to incorporate and save a wash. The applicant was amenable and has revised the drawings. It is anticipated that these two applications will follow the same timeline.

**Exhibits Provided:**

1) Exhibit A - Overall Slope Analysis – Sheet 1
"Exhibit 1" in the packet shows the overall slope analysis for the entire PA (Planning Areas). *Note: There is a chart "Hillside Review" on the sheet that shows which PA areas will require a hillside review and which will not. Even though PA-18 is in an area not requiring further review, because the applicant is requesting to incorporate a portion of the open space, there is a portion of that property that is in the 20-29% slope range thus requiring a recommendation by the Hillside Review Board.*

2) Exhibit B – Concept Plan
"Exhibit B" depicts the proposed grading and layout for PA-18 at Divario. Additionally, Grading and Cross Sections are a part of that plan.

3) Exhibit C - Drainage Report
August 2016 – Drainage report produce by Rosenberg Associates.

4) Exhibit D – Executive Geotechnical Report
July 2005 – This was produced during the initial review of the Lakes development in 2005. Produced by Rosenberg Associates.

**Background:**

Open Space - The total proposed undisturbed open space and improved open space area for "The Lakes" will be 30% of the total space of the project. Out of 735 acres, that will equal approximately 220 acres.

Manmade Slopes - Manmade slopes were identified and excluded (see blue area in "Exhibit A")

Exclusions - The hillside board allowed exclusions for small washes and rock outcroppings (see pink area in "Exhibit A")

Future Hillside Review - In 2008 the Hillside Board didn't visit all the small washes and outcroppings but left them for future consideration as plans would be submitted (with subdivisions). It was determined that some would require further review by the Hillside Board. Again, PA-18 was one of those areas that was excluded from further review but is required now due to incursion into the open space/sloped area.

**Owner:** St George 730, LLC

**Engineer:** Rosenberg Associates

**Location:** PA-18 is generally located south of the Gap Canyon Drive/Divario Canyon Drive intersection.

**Acreage:** 9.47 Acres

**Zoning:** R-1-10

**Powers & Duties:** Section 10-13A-8.B.1 of the "Hillside Review Board Powers and Duties" states that the hillside board can make recommendations to "adopt, modify or reject a proposal" to the Planning Commission (PC).

**Permit required:** Section 10-13A-7 requires that all major development (i.e., cut greater than 4', etc.) on slopes above 20% requires a 'hillside development permit' granted by the City Council upon recommendation from the Hillside Review Board and the Planning Commission.

**Applicable Ordinance(s):**
*(Selected portions)*

10-13A-1: Density and Disturbance Standards

A. The hillside development overlay zone (HDOZ) limits development densities and provides specific development incentives to transfer underlying zone densities from hillsides (sending areas), to less steep slopes or more safe development areas (receiving areas), within a development.

| Percent Natural Slope | Dwelling Units (DU) / Acre |
|---|---|
| 0-19 | See underlying zone |
| 20-29 | 2 DU/acre, provided the units are clustered on 30 percent (30%) or less of the land area within this slope category. 70 percent of this slope category shall remain undisturbed. The 70 percent area is based upon the overall area/development rather than per lot. Also see subsections A1, A2, and A3 of this section. |
| 30-39 | 1 DU/10 acres, provided no more than 5 percent (5%) of the site is disturbed, and 95 percent of the site remains undisturbed. If the cumulative area is at least 1 acre but less than 10 acres, the cumulative area shall be allowed 1 DU. |
| 40 | Development is not permitted (0%), **except** as provided for in subsection A4 of this section. |

Section 10-13A-1: Density and Disturbance Standards

F. The applicant may:

1. Transfer all development density from steeper slope categories (sending areas), to areas within the development with natural slopes of twenty percent (20%) or less (receiving areas); and

2. Develop additional bonus density, calculated from each slope category, as follows:
    a. Natural slopes twenty percent (20%) or less transferred on a one-to-one (1:1) unit basis; plus
    b. One (1) additional density unit for each density unit transferred from natural slopes of twenty-one percent (21%) to thirty percent (30%); plus
    c. Two (2) additional density units for each density unit transferred from natural slopes of thirty-one percent (31%) to forty percent (40%).
3. Unit calculation for the receiving area shall be based on the requirements of the sending area zone.

G. Density transfers to the receiving area may occur without a zone change within the receiving area even though the resulting density or configuration may exceed the density limits of the receiving area zone. Other than density, the receiving area's zoning requirements apply to development in the receiving area. For instance, lot sizes may vary, but single-family zoning districts only allow single-family detached dwellings.

H. If the applicant proposes to develop within the twenty-one percent (21%) to forty percent (40%) slope area, the applicant cannot employ partial density transfers from the sending area and must propose a design, site development plans, and a grading plan that blends and harmonizes all aspects of the proposed development into the natural topography, and that minimizes road cuts and fills.

I. Non-disturb areas within a residential lot as shown on the slope analysis map shall not be used to calculate minimum lot size.

J. Disturbance standards do not apply to the city for limited city facilities: trails, parks, and utilities.

**HSRB Motion Options:** The Hillside Review Board can recommend several different options to the Planning Commission and the City Council:

1. Denial
2. Approval as presented
3. Approval with specific conditions and comments added as required.

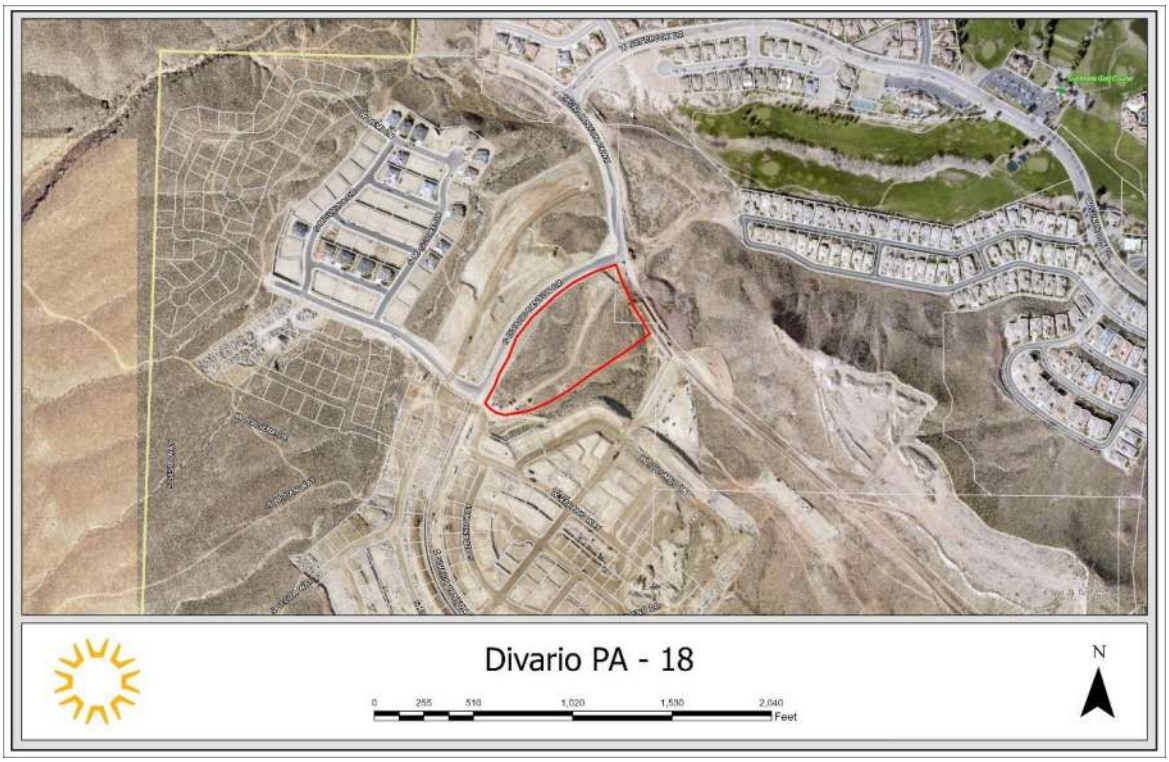
**Example Motion:** The hillside board recommends _____ of the request for a Hillside Development Permit to allow development of PA-18 as requested and outlined the staff report and has the following comments:

1. _____

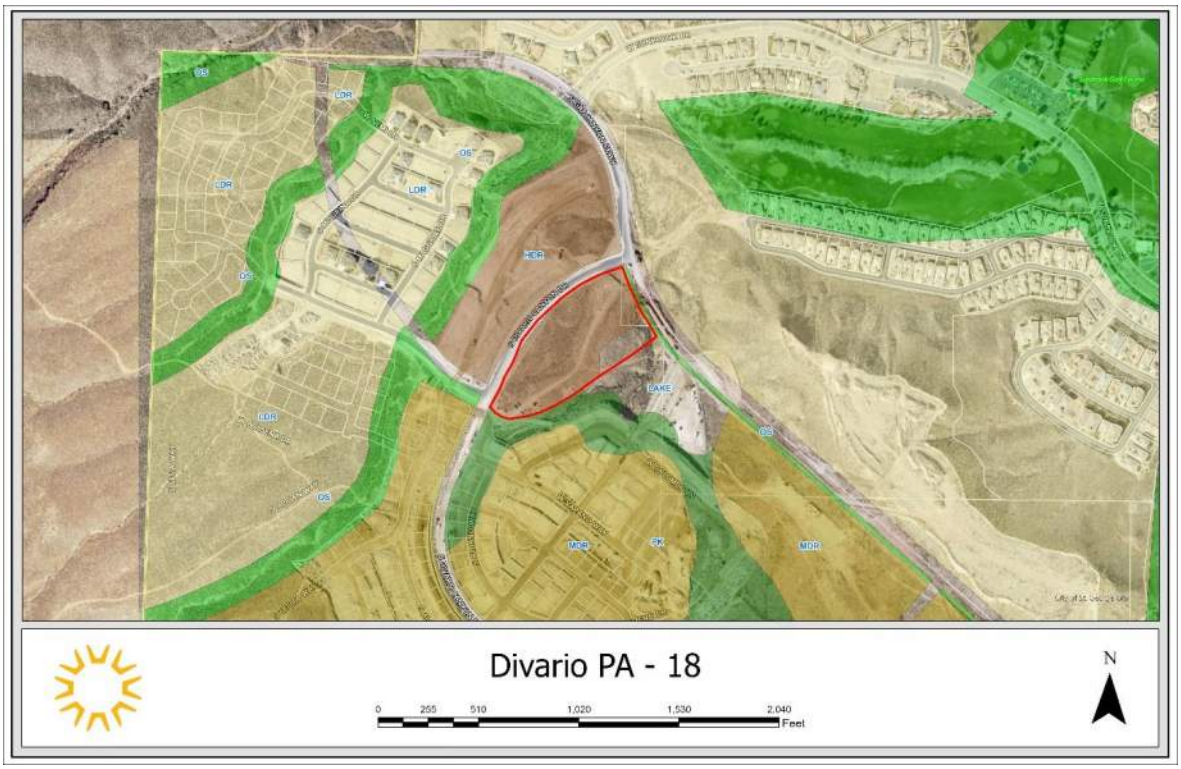
2. _____

3. _____

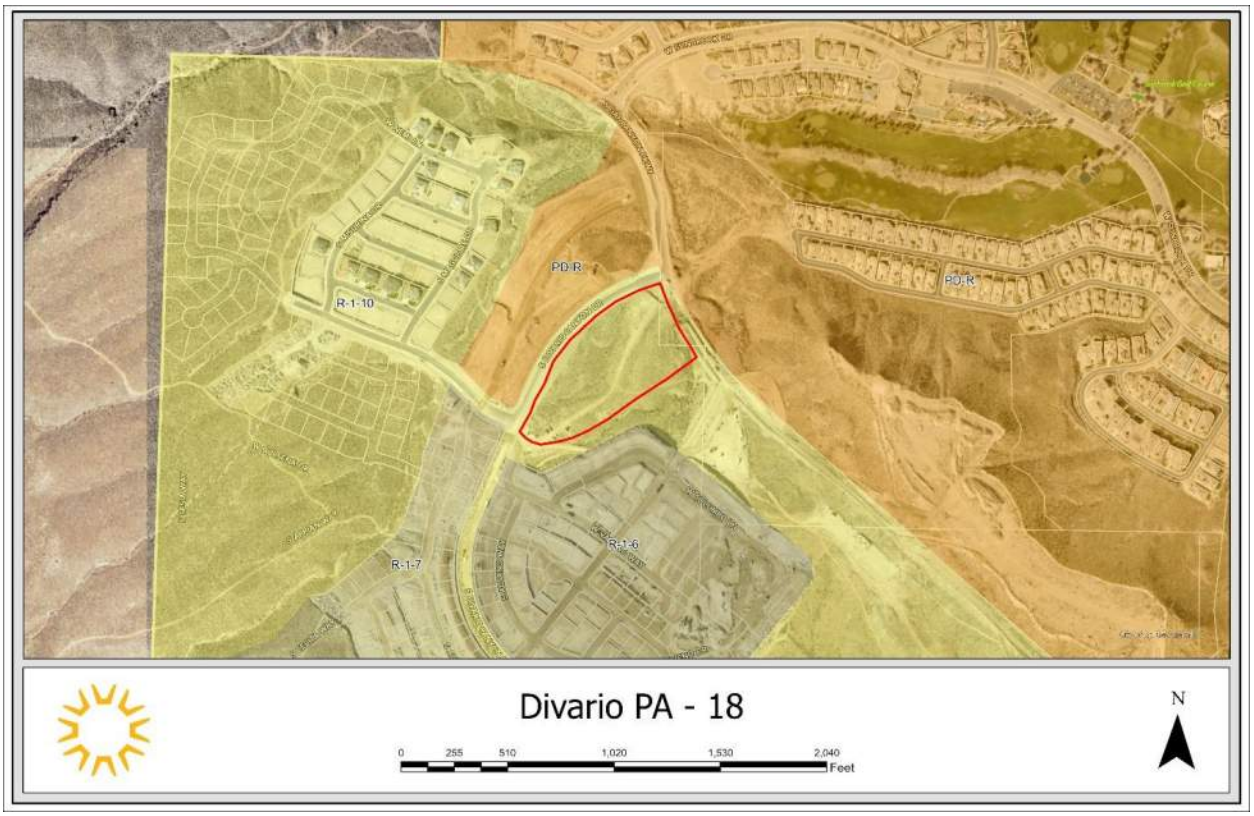
# Vicinity Map




# General Plan = LDR

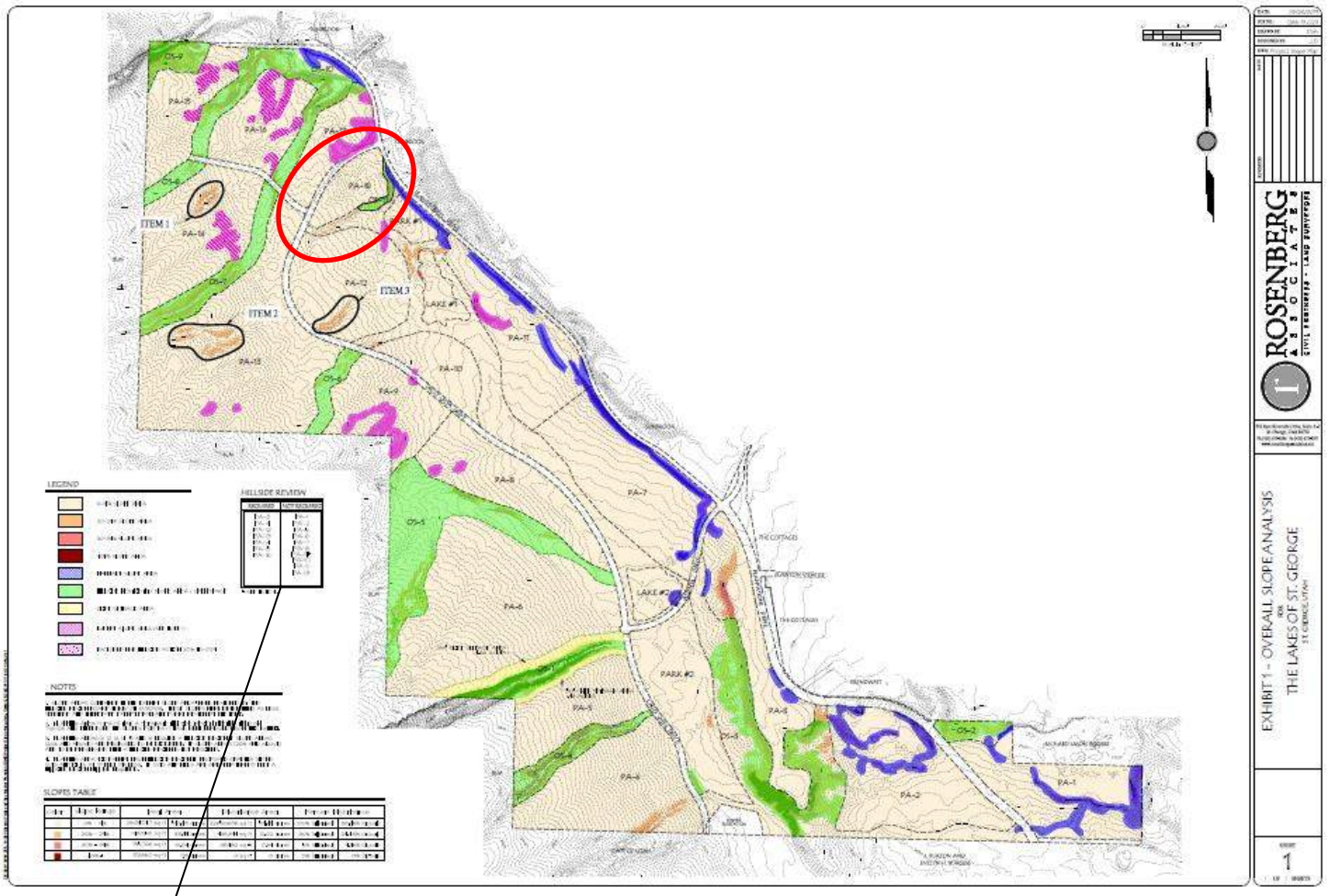


# Zoning = R-1-10


PD:R
PD:R
R-1-10
R-1-7
R-1-6
Divario PA - 18
0 255 510 1,020 1,530 2,040
Feet
N

# Exhibit A

Slope Map




## HILLSIDE REVIEW

| REQUIRED | NOT REQUIRED |
|---|---|
| PA-3 | PA-1 |
| PA-4 | PA-2 |
| PA-12 | PA-5 |
| PA-13 | PA-6 |
| PA-14 | PA-7 |
| PA-15 | PA-8 |
| PA-16 | PA-9* |
| | PA-10 |
| | PA-11 |
| | PA-18 |

* SEE NOTE 4.

## NOTES

1. SLOPE AREAS CONTAINED IN THE 'EXEMPT SLOPE AREA' WERE REVIEWED BY THE HILLSIDE REVIEW BOARD (HSRB) ON 10/30/08. THESE SLOPES WERE DETERMINED AS LESS SENSITIVE AND THEREFORE EXEMPT FROM ANY FUTURE REVIEW BY THE HSRB.

2. PLANNING AREA 17 (PA-17) HAD A SEPARATE HILLSIDE REVIEW MEETING HELD ON 7-16-08 AND THEREFORE THE SLOPES FOR PA-17 HAVE BEEN REMOVED FROM THIS EXHIBIT.

3. PLANNING AREAS 3, 12, 13, 14, 15 AND 16 REQUIRE A HILLSIDE REVIEW IF SLOPE AREAS (20% AND ABOVE) ARE PROPOSED TO BE DISTURBED. IF SLOPE AREAS (20% AND ABOVE) ARE TO BE PRESERVED, THEN A HILLSIDE REVIEW IS NOT REQUIRED.

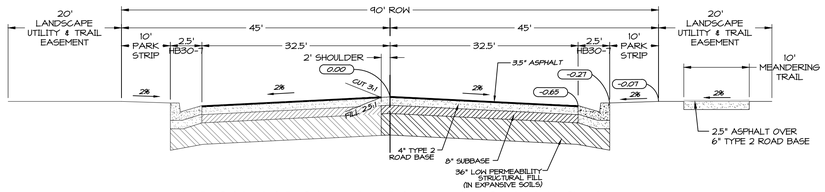
4. PLANNING AREA 9 IS EXEMPT FROM HILLSIDE REVIEW IF PROPOSED GRADING SHOWS CUTS AND FILLS AT 10 FEET OR LESS. IF CUTS AND FILLS ARE GREATER THAN 10 FEET A HILLSIDE REVIEW WILL BE REQUIRED.

# Exhibit B

Concept Plan

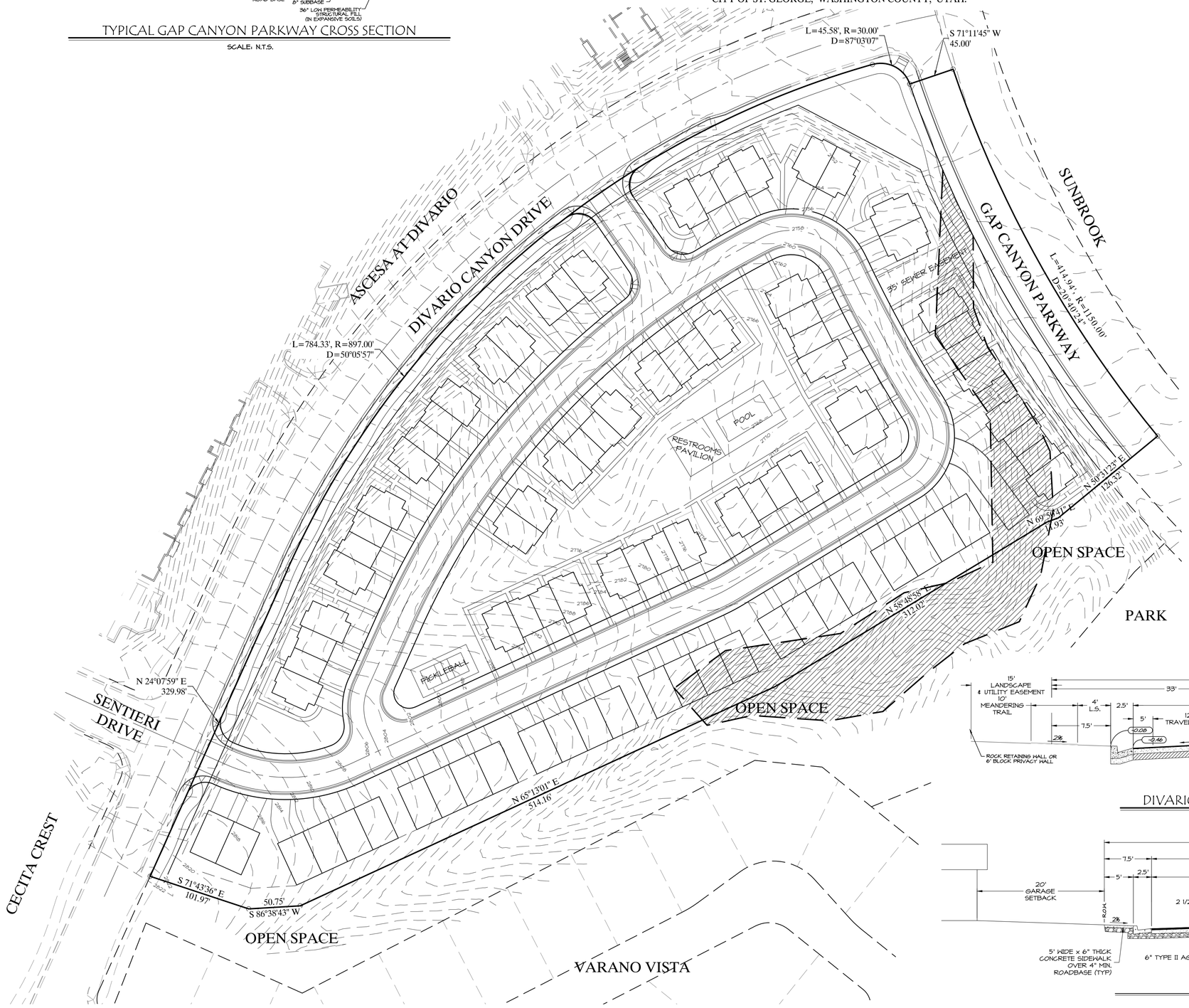
# SITE PLAN
# BECCO CREEK AT DIVARIO, ST. GEORGE, UTAH

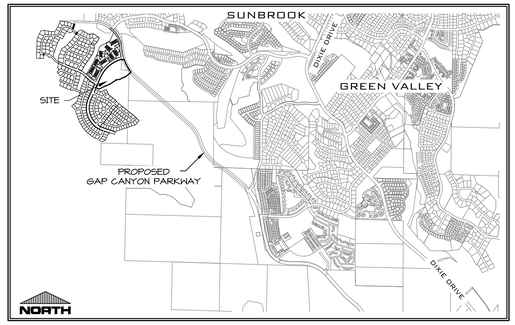
LOCATED IN SECTION 28, TOWNSHIP 42 SOUTH, RANGE 16 WEST OF THE SALT LAKE BASE AND MERIDIAN
CITY OF ST. GEORGE, WASHINGTON COUNTY, UTAH.




TYPICAL GAP CANYON PARKWAY CROSS SECTION

SCALE: N.T.S.



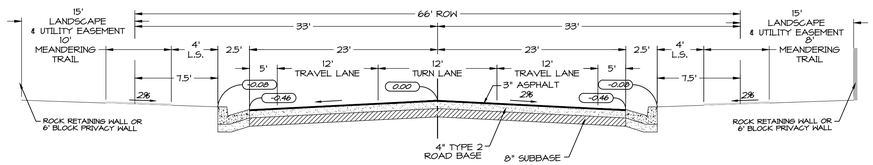




VICINITY MAP - GREEN VALLEY
WASHINGTON COUNTY, UTAH:

SCALE: 1"=2000'

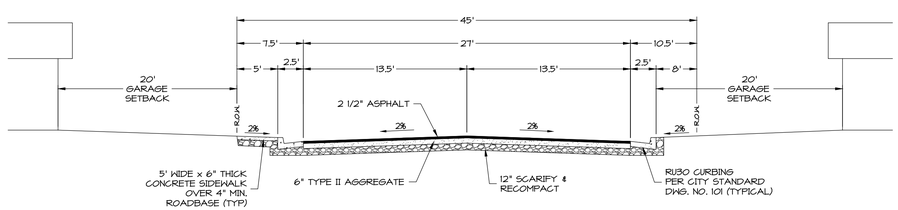
0 50' 100'

SCALE: 1"=50'




DIVARIO CANYON DRIVE CROSS-SECTION

SCALE: N.T.S.




45' STREET SECTION

SCALE: N.T.S.

## PROJECT ENGINEER

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ST. GEORGE, UT 84790
CONTACT: ALLEN HALL
(435) 673-8586

## PROJECT OWNER/ DEVELOPER

J FISHER COMPANY
1216 WEST LEGACY CROSSING BLVD. SUITE 300
CENTERVILLE, UT 84104
CONTACT: BROCK LOOMIS
(801) 814-1914

## GEOTECHNICAL ENGINEER

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC. (AGEC)
1420 SOUTH 270 EAST
ST. GEORGE, UT 84790
CONTACT: WAYNE ROGERS
(435) 673-6850

DATE: 1/7/22
JOB NO.: 1286-21-053
DESIGNED BY: AMH
CHECKED BY:
DWG: Site Plan
DATE
REVISIONS

ROSENBERG ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS
352 East Riverside Drive, Suite A-2
St. George, Utah 84790
Ph (435) 673-8586 Fx (435) 673-8397
www.racivil.com

CONCEPT SITE PLAN
FOR
BECCO CREEK AT DIVARIO (PA-18)
ST. GEORGE
UTAH

SHEET
1
1 OF 1 SHEETS

# Exhibit C

Drainage Report

# TECHNICAL DRAINAGE CONTROL REPORT

**Project Land Use Planning, Offsite Road Construction, and Mass Grading**
**The Lakes Master Plan Community**
**St. George, Utah**

Prepared For:

**730 St. George, LLC**
1636 Indian Wells Drive
Boulder City, Nevada 89005

**Rosenberg Associates**
352 East Riverside Drive, Suite A-2
St. George, Utah 84790




August 30, 2016

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ROSENBERG ASSOCIATES
CIVIL ENGINEERS LAND SURVEYORS

# TABLE OF CONTENTS


1.0 PROJECT LOCATION ..... 1

2.0 PROPERTY DESCRIPTION ..... 2

3.0 EXISTING OFF-SITE DRAINAGE DESCRIPTION ..... 2

3.1 Upstream Drainage ..... 2
3.2 Downstream Drainage ..... 3

4.0 EXISTING ON-SITE DRAINAGE DESCRIPTION ..... 3

5.0 MASTER PLANNED DRAINAGE CONSIDERATIONS ..... 3

5.1 Master Plan Hydrologic Model ..... 3
5.2 Master Plan Drainage Infrastructure ..... 3

6.0 FEMA AND OTHER REGULATORY REQUIREMENTS ..... 4

6.1 FEMA 100-Year Floodplain Delineation ..... 4
6.2 Erosion Hazard Zone ..... 4

7.0 OTHER DRAINAGE STUDIES IMPACTING THE SITE ..... 5

8.0 PROPOSED DRAINAGE FACILITIES ..... 5

8.1 Mass Grading ..... 5
8.2 Detail Grading ..... 6
8.3 Offsite Roadways ..... 6
8.4 Open Channels ..... 6
8.5 Regional Detention Facilities ..... 7

9.0 PROPOSED DRAINAGE FACILITIES DRAINAGE COMPLIANCE ..... 7

10.0 DESIGN RUNOFF COMPUTATIONS ..... 8

10.1 Hydrologic Calculations ..... 8
10.2 Comparison of Peak Flow Values ..... 9

11.0 PROPOSED DRAINAGE FACILITIES DESIGN COMPUTATIONS ..... 9

11.1 Culvert and Channel Capacity Design ..... 9
11.2 Street Capacity Design ..... 10
11.3 Storage Facilities Design ..... 10

12.0 REQUIRED EASEMENTS AND RIGHT-OF-WAY ..... 11

13.0 FEMA FLOODWAY AND FLOODPLAIN CALCULATIONS ..... 11

14.0 CONCLUSIONS AND STATEMENT OF COMPLIANCE ..... 11

15.0 APPENDIX ..... 12

*Figure 1 – Land Use Plan for The Lakes at St. George*
*Figure 2 – Watershed Map for The Lakes at St. George*
*Figure 3 – FEMA Regulatory 100-Year Floodplain*
*Figure 4 – Proposed Culvert Crossings*
*Figure 5 – Custom Soil Resource Report for Washington County Area*

Watershed Hydrology Model Input Spreadsheets
Watershed Hydrology Model Hydraulic Routing Spreadsheets
Watershed Hydrology Model Curve Number Spreadsheets
Watershed Hydrology Model Lag Time Spreadsheets
HEC-HMS Model and Output Tables
Culvert Calculation Worksheets

# 1.0 PROJECT LOCATION

The following Drainage Control Plan and Report is submitted in support of The Lakes at St. George Master Plan Community, a proposed project, located along Plantations Drive in western St. George, Utah, spanning the distance between the Sunbrook Community at the end of Sunbrook Drive to the north, and near the Tonaquint Business Park to the South. The site is located within Sections 27, 28, 34 and 35 in Township 42 South, Range 16 West, Salt Lake Base and Meridian.

This report has been prepared to evaluate regional storm flows at key locations within the project area in order to perform mass grading operations, and to construct the following proposed off-site roadways to access the proposed development/planning areas:

- Plantations Drive
- Lago Vista Drive
- Alienta Drive
- Sentieri Vista Drive

This report has been prepared in accordance with the requirements and procedures outlined in the *Washington County Flood Control Authority Storm Drainage Systems Design and Management Manual*[1]. Conclusions and recommendations are made herein regarding drainage improvements required, floodplain impacts, and general conformance to city ordinances. Separate drainage studies will be prepared for each specific planning area to address localized drainage concerns and compliance with the city's drainage requirements.

The following supplemental figures have been prepared and included in the Appendix for reference and illustration information:

- *Figure 1 – Land Use Plan for The Lakes at St. George*, illustrating project location, project planning areas, and proposed planning area land uses and densities.
- *Figure 2 – Watershed Map for The Lakes at St. George*, illustrating the major watershed boundaries impacting the site.
- *Figure 3 – FEMA Regulatory 100-Year Floodplain Exhibit Map*, illustrating the drainage channels subject to the regulatory requirements of the Federal Emergency Management Agency (FEMA).
- *Figure 4 –Culvert Crossings*, showing the approximate location, minimum pipe diameter, and minimum slope requirements of culvert crossings and storm drain pipelines for the offsite roads including Plantations Drive, Lago Vista Drive, Alienta Drive, and Sentieri Vista Drive.
- *Figure 5 – Custom Soil Resource Report for Washington County Area*, showing soils and soil properties on the subject property.

[1] Bowen, Collins and Associates, Washington County Flood Control Authority Storm Drainage Design and Management Manual, Draft v0.3.

# 2.0 PROPERTY DESCRIPTION

The proposed Lakes at St. George is a 731-acre master plan community that is planned to be comprised of single-family residences, multi-family residences, parks and open spaces, commercial areas, public buildings such as churches, and associated streets of various right-of-way widths. *Figure 1 – Land Use Plan*, shows an overall view of the property. The proposed project is divided into 16 individual planning areas noted as PA-1, PA-2, etc. A legend on Figure 1 lists the master planned land uses and densities proposed for each planning area as follows:

- Low Density Residential: up to 4 units per acre, includes PA-4, PA-5, PA-6, PA-14, PA-15, and PA-16 covering approximately 174 acres.
- Medium Density Residential: up to 9 units per acre, includes PA-2, PA-3, PA-7, PA-9, PA-10, PA-11, PA-12, and PA-13 covering approximately 236 acres.
- High Density Residential: up to 15 units per acre, includes PA-1, PA-17, and PA-18 covering approximately 48 acres.
- Commercial/Mixed Use: includes PA-8 covering approximately 27 acres.

The remainder of the property will remain as undisturbed or improved open spaces to consist of parks, trails and other recreational facilities. These open spaces provide a natural break between each planning area, and most of them are located to accommodate the existing naturally flowing drainage patterns. The focal point of the open spaces will be two 5-acre lakes that will be used for detention, and to provide storage facilities for the City of St. George re-use water network.

# 3.0 EXISTING OFF-SITE DRAINAGE DESCRIPTION

## 3.1 UPSTREAM DRAINAGE

Storm water impacting the project from upstream sources generally originates on undeveloped desert land and drain in a sheet flow manner towards ephemeral washes that carry the concentrated water to the project property from the west and south.

The watershed impacting the proposed Lakes at St. George is illustrated in *Figure 2 – Watershed Map*. As seen in the exhibit, the total watershed area has been divided into a number of subareas to better pinpoint runoff amounts at specific locations within the project. Most off-site storm water enters the project from property belonging to the Bureau of Land Management (BLM). A small amount of off-site storm water enters the project along Plantations Drive from property belonging to the Sunbrook master plan community.

### 3.2 DOWNSTREAM DRAINAGE

In both the existing and proposed developed condition, storm water will exit the property in either the Box Canyon Wash, draining the northern portion of the property consisting of subarea Groups X, Y, A and B; or the Gap Wash, draining the rest of the property to the south and east. Flows leaving the project in the Box Canyon Wash travel through the Sunbrook Golf Course a distance of approximately 6,000 feet before discharging to the Santa Clara River just upstream of the Dixie Drive crossing at Mathis Park. Flows leaving the project in the Gap Wash travel eastward toward the Tonaquint Business Park, covering a total distance of approximately 4,800 feet before discharging to the Santa Clara River just north of the City of St. George Tonaquint Cemetery.

## 4.0 EXISTING ON-SITE DRAINAGE DESCRIPTION

In the undeveloped condition, the study area drains by sheet flow and washes to the Box Canyon Wash and the Gap Wash as shown in Figure 2. In the developed condition, storm water runoff will drain to the same major washes preserved in the designated open space corridors, as in the undeveloped condition.

## 5.0 MASTER PLANNED DRAINAGE CONSIDERATIONS

### 5.1 MASTER PLAN HYDROLOGIC MODEL

The Lakes property has been included in the hydrologic model prepared for the city's drainage master plan summarized in the *City of St. George Storm Drain Master Plan Update*[2]. Referencing Figure 2, Subareas A1, A2, A3, B1, B2, B3, B4, X1, X2, Y1, and Y2 in this report are part of the Box Canyon Wash BC100 master plan subarea. Subareas C1, C2, C3, C4, C5, D1, D2 in this report are part of the Gap Wash G20 master plan subarea. Subareas E1, E2, E3, E4, F1, F2, G1, G2, and H1 are part of the Gap Wash watershed G40 master plan subarea.

### 5.2 MASTER PLAN DRAINAGE INFRASTRUCTURE

Existing master planned drainage infrastructure impacting The Lakes project is limited to one 36-inch diameter pipe, labeled Pipe G50-2 in the city master plan and noted to carry a design flow of 65 cubic feet per second (cfs). This pipe conveys drainage from the Las Palmas and Worldmark Resort properties along 1790 West Street, discharging into the project property along the Plantations Drive right-of-way.

Proposed master planned drainage infrastructure impacting The Lakes project includes two proposed pipes linking to Pipe G50-2:

[2] Bowen, Collins and Associates and John H. Humphrey, City of St. George Storm Drain Master Plan Update, July, 2009.

- Pipe G50-1, a proposed 30-inch diameter pipe noted to carry a design flow of 65 cfs, to convey storm water along the Plantations Drive right-of-way along the Worldmark Resort frontage, and connecting to existing Pipe G50-2 at the intersection of 1790 West Street.
- Pipe G50-3, a proposed 42-inch diameter pipe noted to carry a design flow of 196 cfs, to combine flows from G50-1 and G50-2 and convey storm water south and eastward along the future Plantations Drive right-of-way.

The above existing and proposed pipelines were factored into this report analysis with some modifications to suit the drainage patterns and open space corridors proposed in The Lakes land use plan.

# 6.0 FEMA AND OTHER REGULATORY REQUIREMENTS

## 6.1 FEMA 100-YEAR FLOODPLAIN DELINEATION

Two drainage washes are located within the 100-year floodplain that are subject to the regulatory requirements of the Federal Emergency Management Agency (FEMA) including the Box Canyon Wash and the Gap Wash, as noted on the current FEMA Flood Insurance Rate Maps[3]. The 100-year floodplain boundaries for these two washes are shown in *Figure 3 – FEMA Regulatory 100-Year Floodplain Exhibit Map*.

Box Canyon Wash clips the north side of the property and receives drainage from Subareas A1, A2, A3, B1, B2, B3, Y1, Y2, X1, and X2. The remaining Subareas drain to the Gap Wash. Figure 3 illustrates the location of regulatory Zone A for both the Box Canyon and Gap washes, which is defined as the 100-year floodplain Special Flood Hazard Area with no base flood elevations established. All areas noted as Zone A are located within the designated open spaces for The Lakes master plan community. Areas proposed for development are all located within Zone X, which is defined to be outside the 0.2% annual floodplain.

## 6.2 EROSION HAZARD ZONE

The subject property is not located within an "Erosion Hazard Zone" as defined by the City of St. George.

[3] Federal Emergency Management Agency (FEMA) National Flood Insurance Program, Flood Insurance Rate Map, Washington County, Utah Map Numbers 49053C1007G and 49053C1009G, Effective Date April 2, 2009.

# 7.0 OTHER DRAINAGE STUDIES IMPACTING THE SITE

The following studies were referenced in preparing this report:

- The Lakes at St. George Hydrology Report, prepared by Rosenberg Associates, dated May 15, 2008. This report is a general overview of major drainage patterns encompassing the entire Lakes planned development property boundary. This report updates the earlier report to current city analysis and drainage design standards.
- Four Dams at The Lakes Preliminary Drainage Evaluation, prepared by Rosenberg Associates, dated September 14, 2005. This report is a hydrologic analysis of the proposed "lakes" to be constructed in the master plan community open space.
- Box Canyon Wash Hydraulic Modeling, performed by Rosenberg Associates in 2008. This work resulted in the delineation of the 100-year floodplain along the Box Canyon Wash.

# 8.0 PROPOSED DRAINAGE FACILITIES

Drainage facilities proposed for The Lakes master plan community will convey water through the planning areas and connecting roads by a combination of grading, street improvements, and storm drain infrastructure. Specific routing, sizing, and placement of storm drain infrastructure will be proposed during the detailed design stage of each planning area; however, this report has been prepared to evaluate regional storm flows at key locations within the project area in order to perform mass grading operations, and to construct the following proposed off-site roadways to access the proposed development/planning areas:

- Plantations Drive: Extending from the north property boundary and heading in a southeasterly direction approximately 12,400 feet to the southeastern property boundary.
- Lago Vista Drive: Extending from the point of intersection with Plantations Drive on the northwest side of the parcel, and extending in a southeasterly direction approximately 8,900 feet to the southwestern property boundary.
- Alienta Drive: Extending from Lago Vista Drive northward approximately 2,400 feet where it ties to the existing Alienta Drive.
- Sentieri Vista Drive: Extending from Lago Vista Drive in the northwest area of the project and heading in a westward direction approximately 1,300 feet through planning areas PA-14, Pa-16, and terminating in PA-15.

## 8.1 MASS GRADING

It is the desire of the project developers to conduct mass grading operations on portions of the master plan project. The purpose of this is to be able to move earth materials between the planning areas. Planning areas with an abundance of quality material that can be used for general fill, structural fill, and/or utility trench bedding will be mined and the excess material moved to planning areas where additional fill material is needed.

Limited grading design will be performed for various phases of mass grading. Plans will be submitted to the City of St. George engineering department and processed for a grading permit before any grading operations begin. Mass grading design will focus on maintaining the existing drainage patterns by picking up storm water offsite flows, routing storm water through the mass graded planning area to be discharged back into the open space areas as close as practicable to the historic point of discharge.

## 8.2 DETAIL GRADING

Detailed grading plans will be submitted with the project development plans for each planning area to include individual lot and/or building pad grading, interior road plan and profile drawings, and underground storm drain plan and profile where needed.

A detailed drainage study will be prepared for the proposed development and submitted with the project construction plans for each individual planning area.

## 8.3 OFFSITE ROADWAYS

Construction of the offsite roadways including Plantations Drive, Lago Vista Drive, Alienta Drive, and Sentieri Vista Drive, as noted above, will occur in phases as needed to service the development of the planning areas. The peak storm water runoff values in this drainage study were used to evaluate roadway cross section conveyance capacity, to size in-line underground storm water pipelines, and to locate and size offsite roadway culvert crossings. The approximate location, minimum pipe diameter sizing, and minimum slope requirements of culvert crossings and storm drain pipelines are illustrated in *Figure 4 – Proposed Offsite Road Culvert Crossing and Storm Drain Facilities*. Detailed construction plans for all offsite roadway drainage improvements will be submitted with the applicable planning area construction plans.

## 8.4 OPEN CHANNELS

Construction of open channels are proposed to convey storm water through the disturbed open space areas. The proposed routing location, size, minimum design slope and capacity of these channels will be addressed with the detailed drainage design of the adjacent planning areas or design of open space area. The channels are generally located as follows:

- Between Lake 1 and Lake 2 adjacent to Lago Vista Drive
- Routing the Gap Wash through Park 2 adjacent to Lago Vista Drive, between Lake 2 and the power substation.
- Routing the Gap Wash through planning areas PA-1 and PA-2 inside the boundaries of the delineated floodplain.

Additional temporary man-made open channels may need to be constructed to route storm water through mass-graded planning areas, then directed back into the natural drainages located in the adjacent open space areas. The peak flow values of this report will be used to

size these temporary channels, which will be called out as needed on the individual mass grading construction plans. Once the planning area goes into final design, these channels will be replaced with improved streets, storm drains, or culverts.

### 8.5 REGIONAL DETENTION

It is the desire of the project developers to detain increased storm water caused by development. Rather than design numerous smaller detention facilities for each planning area, storm water will be routed into regional facilities adjacent to the two 5-acre lake amenities, as discussed below. Storm water won't be routed directly in the lake amenities, but into a containment area next to the lake to help maintain the quality of the city's re-use water that will be stored in the lake facilities. Master Plan Model results indicate that detention may be minimal or not required. Finalization of detention needs will be addressed with detailed drainage design of each planning area.

- Lake 1 Detention Basin: Increased storm water runoff generated in Subareas B2 and B3 will be routed directly into a detention basin adjacent to Lake 1, then discharged into the Box Canyon Wash. Additional capacity and outlet control facilities will be installed in this detention basin to also detain the total combined increase from Subareas A2, A3, X2, and Y2. This will allow the increase from these subareas to discharge directly to Box Canyon Wash while limiting the total peak flow discharging from the property to the peak "pre-developed" design condition.
- Lake 2 Detention Basin: Increased storm water runoff generated in Subareas C2, C3 and D2 will be routed directly into a detention basin adjacent to Lake 2, then discharged into the Gap Wash. Additional capacity and outlet control facilities will be installed in this detention basin to also detain the total combined increase from Subareas E2, E3, E4, F2 and G2. This will allow the increase from these subareas to discharge directly to the Gap Wash while limiting the total peak flow discharging from the property to the peak "pre-developed" design condition.

## 9.0 PROPOSED DRAINAGE FACILITIES COMPLIANCE

The hydrologic and hydraulic analysis utilized for design of The Lakes master plan community storm water drainage facilities were performed in accordance with the requirements of the Washington County Flood Control Authority (WCFCA) *Storm drainage Systems Design and Management Manual*. Specific compliance measures were as follows:

- Hydrologic Analysis: The hydraulic analyses performed for The Lakes off-site and on-site watershed was performed in accordance with Section 4 of the drainage manual utilizing the US Army Corps of Engineers HEC-HMS Version 4.1[4] modeling software. The hydrologic

[4] U.S. Army Corps of Engineers, Hydraulic Engineering Circular Hydrologic Modeling System (HEC-HMS) software, Version 3.5.

analysis is discussed in greater detail in Section 10 of this report, with detailed information included in the appendix.

- Street Design: Street drainage design was performed in accordance with Section 3 of the drainage manual assuming that Sentieri Vista Drive is a minor collector, Lago Vista Drive and Alienta Drive are major collectors, and Plantations Drive is a major arterial in accordance with Table 3-1.
- Storm Drain Design: Storm drain design for Sentieri Vista Drive, Lago Vista Drive, Alienta Drive, and Plantations Drive was performed in accordance with Section 3 of the drainage manual assuming an open-channel flow condition.
- Culvert Design: Culverts for the offsite road system were designed in accordance with Section 3 of the drainage manual to fully convey the 100-year design storm event in an open channel flow condition.
- Open Channel Design: Open channels conveying storm water from detention areas to the Box Canyon Wash and Gap Wash, and conveying flows adjacent to Lago Vista Drive, will be designed with future phases. Open channels will be designed to match the natural channel flow characteristics of the existing channels.
- Storage Facilities Design: The two regional detention facilities have been sited and will designed with future phases as needed.

# 10.0 DESIGN RUNOFF COMPUTATIONS

## 10.1 HYDROLOGIC CALCULATIONS

The US Army Corps of Engineers HEC-HMS Version 4.1 was used to perform the hydrologic analysis for this study. The Farmer-Fletcher distribution is used for the 3-hour storm events and the SCS Type II distribution is used for the 24-hour storm events. The SCS Composite Curve Number method was utilized to determine the runoff curve number since all areas within the watershed evaluated are currently undeveloped.

Tables summarizing model input for the following values have been included in the appendix:

- Watershed areas, longest length, and average slope for the pre-developed and proposed post-developed condition.
- SCS composite curve number values for the pre-developed and proposed post-developed condition.
- Hydrologic model junction and routing characteristics.
- Calculated times of concentration and lag time.

### 10.2 COMPARISON OF PEAK FLOW VALUES

Modeling for The Lakes master plan development considered both the existing pre-developed condition and the assumed post-developed condition, in order to size storm drainage facilities and to compare impacts to storm water peak flow values caused by proposed development. HEC-HMS model peak storm values for all subareas, junctions, and routing conditions for the pre-developed and proposed post-developed condition are included in the appendix.

Post-developed conditions were assumed to match the proposed uses and densities described in Section 2 of this report and illustrated in *Figure 1 – Land Use Plan*. Since exact layout for each of the 16 individual planning areas is not known at this point, detailed drainage study update reports will be submitted with the development of each planning area.

## 11.0 PROPOSED DRAINAGE FACILITIES DESIGN COMPUTATIONS

Computations for the hydraulic design of The Lakes master plan community storm water drainage facilities were performed in accordance with the requirements of the Washington County Flood Control Authority *Storm Drainage Systems Design and Management Manual*. Output tables for calculations are included in the appendix.

### 11.1 CULVERT AND CHANNEL CAPACITY DESIGN

Culvert and channel capacities utilized Manning's equation for open channel flow:[5]

$$Q = \frac{1.49\,(A)^{5/3}(S)^{1/2}}{n(P)^{2/3}}$$

Where
- Q = Hydraulic Capacity, in cubic feet per second (cfs)
- A = Cross Sectional Flow Area, in square feet
- S = Average Slope, in feet per foot
- n = Manning's Roughness Coefficient
- P = Wetted Perimeter, in feet

[5] Flammer, Jeppson, and Keedy, Fundamental Principles and Applications of Fluid Mechanics, Utah State University, 1986, p. 289.

Table 11-1 lists the Manning's roughness coefficients used in the model evaluation:

**TABLE 11-1: MANNING'S ROUGHNESS COEFFICIENTS**

| Surface Description | Manning's n Value |
|---|---|
| High Density Polyethylene Pipe (HDPE) | 0.010 |
| Concrete Pipe (RCP) | 0.013 |
| Open Channels | 0.078 |
| Asphalt Pavement | 0.015 |

The following parameters were assumed for each evaluation:

- All culvert capacities were evaluated as flowing full in the open channel flow condition, assuming no surcharge.
- The slope of each culvert was assumed to be the average slope of the drainage basin or routing, unless additional information was known to justify a different value.
- If existing drainage or future road drainage infrastructure was determined to be inadequate to accommodate the modeled design storm, the culvert or open channel was sized to accommodate the full modeled design storm value.

## 11.2 STREET CAPACITY DESIGN

Street capacities were modeled using Manning's equation for open channel flow based on the master planned street cross-section, assuming full street improvements were constructed. Minimum slopes for all street sections were assumed to be at 0.5%.

## 11.3 STORAGE FACILITIES DESIGN

The two regional detention facilities are proposed, as discussed in Section 8.5. The master plan calculations summarized in this report do not include a proposed size for these two facilities, since overall post-development values do not exceed the pre-development values. If localized post-developed drainage values are determined to exceed pre-developed values during detailed drainage design of the planning areas, the storage facilities will be designed utilizing HEC-HMS output files, sizing for the 10-year 24-hour design storm, and sizing for the worst-case condition (whichever yielded the greatest volume) of the 100-year 3-hour design storm or the 100-year 24-hour design storm. Since not all subareas will be able to be routed directly through one of the detention basins, it is assumed that the regional facilities may need to be oversized to compensate for the total increased flow where storm water exits the property in the Box Canyon Wash for Lake 1, or in the Gap Wash for Lake 2, as discussed in Section 8.5 of this report.

## 12.0 REQUIRED EASEMENTS AND RIGHTS-OF-WAY

No additional easements or rights-of-way are being proposed for storm water drainage with the master plan, mass grading, or construction of offsite roadways. Major drainage channels within the proposed project are to remain in the open space areas shown in Figure 1, the master land use plan. Specific drainage easements, if needed within the individual planning areas, will be noted with the submittal of the planning area detailed drainage study report and project construction plans.

## 13.0 FEMA FLOODWAY AND FLOODPLAIN CALCULATIONS

No additional hydrologic or hydraulic calculations were performed for the purposes of modifying the existing floodplain as delineated on the FEMA flood insurance rate maps. It is the intention of the project developer to leave all designated floodplain areas for the Box Canyon Wash and Gap Wash out of the residential development areas.

## 14.0 CONCLUSIONS AND STATEMENT OF COMPLIANCE

This report for the drainage design of The Lakes Master Plan was prepared under my direct supervision in accordance with the provisions of Washington County Flood Control Authority (WCFCA) Storm Drainage Systems Design and Management Manual, and was designed to comply with the provisions thereof. I understand that the City of St. George and WCFCA do not and will not assume liability for drainage facilities design.

# APPENDIX

*Figure 1 – Land Use Plan for The Lakes at St. George*
*Figure 2 – Watershed Map for The Lakes at St. George*
*Figure 3 – FEMA Regulatory 100-Year Floodplain*
*Figure 4 – Proposed Culvert Crossing Calculations*
*Figure 5 – Custom Soil Resource Report for Washington County Area*

Watershed Hydrology Model Input Spreadsheets
Watershed Hydrology Model Hydraulic Routing Spreadsheets
Watershed Hydrology Model Curve Number Spreadsheets
Watershed Hydrology Model Lag Time Spreadsheets
HEC-HMS Model and Output Tables
Culvert Calculation Worksheets

## AREA TOTALS

| | | |
|---|---|---|
| | = 173.80 ACRES | 23.8% |
| | = 236.12 ACRES | 32.3% |
| | = 48.43 ACRES | 6.6% |
| | = 27.04 ACRES | 3.7% |
| | = 202.84 ACRES | 27.8% |
| | = 42.48 ACRES | 5.8% |
| TOTAL | = 730.71 ACRES | 100% |

## NOTE

THE BOUNDARIES DESIGNATED FOR LAKES AND PARKS ARE SUBJECT TO CHANGE AT THE DEVELOPERS DISCRETION.

## LEGEND

- LOW DENSITY RESIDENTIAL (UP TO 4 UNITS PER ACRES)
- MEDIUM DENSITY RESIDENTIAL (UP TO 9 UNITS PER ACRE)
- HIGH DENSITY RESIDENTIAL (UP TO 15 UNITS PER ACRE)
- COMMERCIAL/MIXED USE
- OPEN SPACE / PARKS / LAKES (SEE NOTE BELOW)
- ROADWAYS / CITY PROPERTY
- MAJOR ARTERIALS
- MINOR ARTERIALS
- REGIONAL TRAILS (PAVED)
- LOCAL TRAILS (PAVED)
- RECREATION TRAILS (DIRT)
- FUTURE ROADWAYS
- PROPERTY LINE
- WASHES
- TRAILHEAD SITE

## PLANNING AREAS

| AREA | ZONE | ACRES | DENSITY |
|---|---|---|---|
| P.A.-1 | HDR | 28.09 | UP TO 15 UNITS/ACRE |
| P.A.-2 | MDR | 35.96 | UP TO 9 UNITS/ACRE |
| P.A.-3 | MDR | 24.10 | UP TO 9 UNITS/ACRE |
| P.A.-4 | LDR | 33.52 | UP TO 4 UNITS/ACRE |
| P.A.-5 | LDR | 19.37 | UP TO 4 UNITS/ACRE |
| P.A.-6 | LDR | 59.74 | UP TO 4 UNITS/ACRE |
| P.A.-7 | MDR | 35.93 | UP TO 9 UNITS/ACRE |
| P.A.-8 | MIXED USE | 27.04 | UP TO 10 UNITS/ACRE |
| P.A.-9 | MDR | 13.30 | UP TO 9 UNITS/ACRE |
| P.A.-10 | MDR | 11.33 | UP TO 9 UNITS/ACRE |
| P.A.-11 | MDR | 27.17 | UP TO 9 UNITS/ACRE |
| P.A.-12 | MDR | 26.88 | UP TO 9 UNITS/ACRE |
| P.A.-13 | MDR | 61.45 | UP TO 9 UNITS/ACRE |
| P.A.-14 | LDR | 28.44 | UP TO 4 UNITS/ACRE |
| P.A.-15 | LDR | 16.35 | UP TO 4 UNITS/ACRE |
| P.A.-16 | LDR | 16.38 | UP TO 4 UNITS/ACRE |
| P.A.-17 | HDR | 12.31 | UP TO 15 UNITS/ACRE |
| P.A.-18 | HDR | 8.03 | UP TO 15 UNITS/ACRE |

BLM
SANTA CLARA CITY

FUTURE CONNECTION TO WESTERN CORRIDOR

SUNBROOK DR.

BOX CANYON WASH

OPEN SPACE
4.29 ACRES

P.A.-15
16.35 ACRES

P.A.-16
16.38 ACRES

P.A.-17
12.31 ACRES

P.A.-18
8.03 ACRES

OPEN SPACE
2.44 ACRES

P.A.-14
28.44 ACRES

SUNBROOK

BLM
(NON-INCORPORATED)

PARK #1
4.29 ACRES

PLANTATIONS DR.

P.A.-12
26.88 ACRES

LAKE #1
5.00 ACRES

OPEN SPACE
8.84 ACRES

P.A.-13
61.45 ACRES

OPEN SPACE
3.92 ACRES

P.A.-9
13.30 ACRES

P.A.-10
11.33 ACRES

P.A.-11
27.17 ACRES

P.A.-8
27.04 ACRES

PARK #3
2.75 ACRES

P.A.-7
35.93 ACRES

OPEN SPACE
0.33 ACRES

SUNBROOK DR.

LUCE DEL SOL DR.

ALIENTA DR.

HIGHLANDS

ALIENTA DR.

OPEN SPACE
1.92 ACRES

PROPOSED FIRE STATION

COTTAGES NORTH

SALES CENTER

CANYON VIEW DR.

(FUTURE)

OPEN SPACE
29.01 ACRES

P.A.-6
59.74 ACRES

LAKE #2
5.07 ACRES

P.A.-3
24.10 ACRES

COTTAGES SOUTH

OPEN SPACE
1.79 ACRES

EXISTING SUBSTATION (TO BE REMOVED)

EXISTING BLM TRAILHEAD

OPEN SPACE
12.41 ACRES

PARK #2
25.00 ACRES

OPEN SPACE
40.44 ACRES

LAS PALMAS

TRENDWEST

P.A.-5
19.37 ACRES

OPEN SPACE
6.82 ACRES

P.A.-4
33.52 ACRES

SUBSTATION
3.24 ACRES

OPEN SPACE
3.43 ACRES

RICHARD JASON ROGERS

P.A.-2
35.96 ACRES

PLANTATIONS DR.

DIXIE DR.

P.A.-1
28.09 ACRES

TRAILHEAD

J. BURTON & EVELYN H. BURGESS

(FUTURE)

HWY. 18 TO VEYO.
PINE VALLEY
DUKE DOWNS RD.
SUNSET BLVD.
VIEW DR.
VALLEY
GREEN VALLEY
DUKE DR.
ST. GEORGE BLVD.
DOWNTOWN
BLUFF ST.
INTERSTATE I-15 TO SALT LAKE CITY
DIXIE
VIRGIN RIVER
BLOOMINGTON
BLOOMINGTON HILLS
INTERSTATE I-15 TO LAS VEGAS, NEV.

The Lakes at St. George

NORTH

LOCATION MAP
ST. GEORGE, UTAH

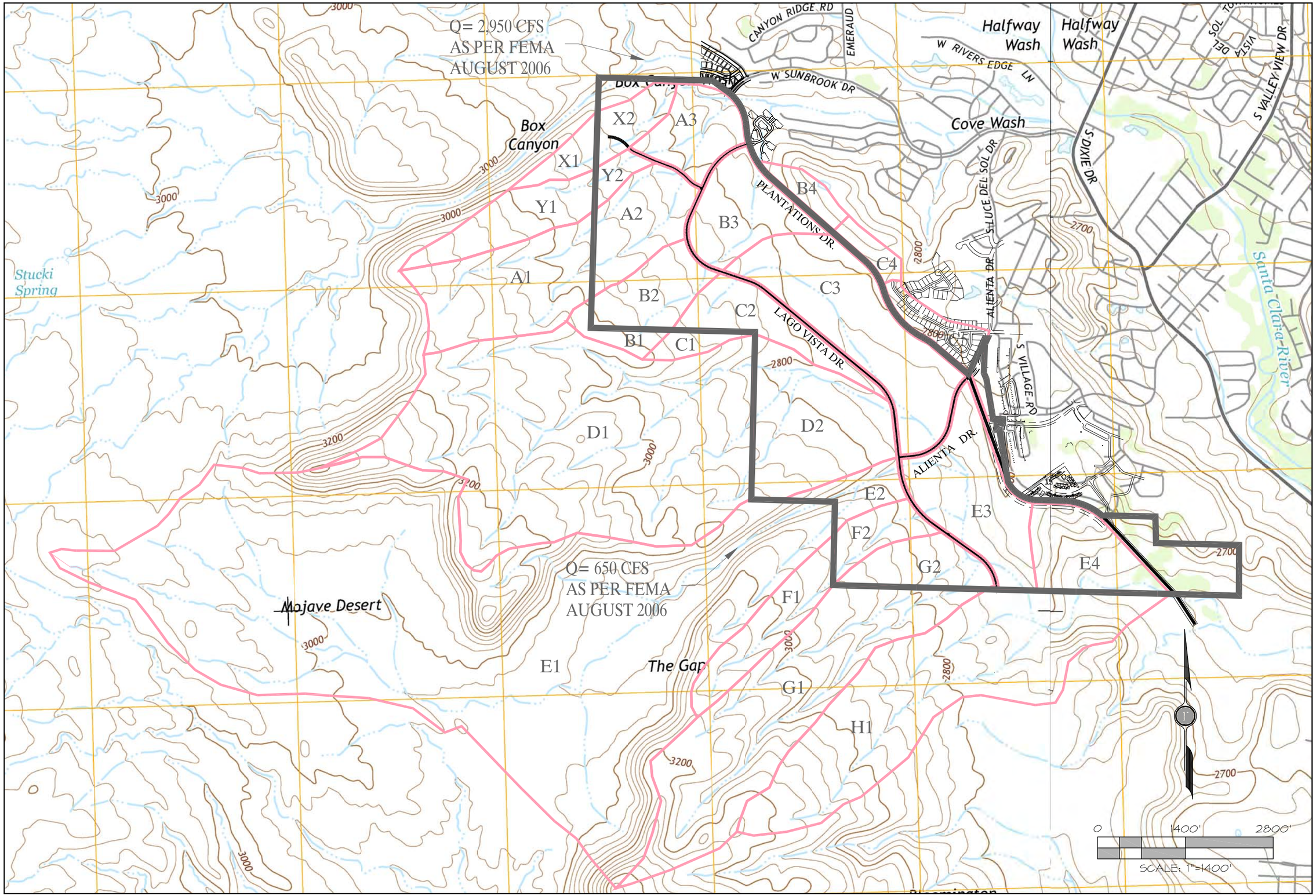
DATE: 8/31/2016
JOB NO.: 1286-14-014
DESIGNED BY: JLW
CHECKED BY: RMA
DWG: Land Use Plan

REVISIONS
DATE

ROSENBERG ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS
352 East Riverside Drive, Suite A-2
St. George, Utah 84790
Ph (435) 673-8586 Fx (435) 673-8397
www.racivil.com

# Land Use Plan
FOR
# The Lakes at St. George
St. George, Utah

SHEET
Fig. 1
1 OF 1 SHEETS




DATE: 4-14-08
JOB NO.: 1286-PDA
DRAWN BY: JRH
DESIGNED BY:
DWG: WATERSHED MAP

REVISIONS
DATE

ROSENBERG ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS

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# FIGURE 2 WATERSHED MAP
FOR
# THE LAKES AT ST. GEORGE
ST. GEORGE, UTAH

SHEET
Fig. 2
1 OF 1 SHEETS

## NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Floodway Data table shown on this FIRM.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) Zone 12N. **Horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, NNGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov/.

**Base map** information shown on this FIRM was provided in digital format by the U.S. Farm Service National Agriculture Imagery Program (NAIP), dated summer 2004, and by the U.S. Geological Survey Digital Orthophoto Quadrangles, dated 1993 and later, produced at a scale of 1:24000. The data was obtained from the State Geographic Information Dataset (SGID) maintained by the Automated Geographic Reference Center (AGRC).

Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

**Corporate limits** shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip/.

NFIP — NATIONAL FLOOD INSURANCE PROGRAM

**PANEL 1007G**

# FIRM
FLOOD INSURANCE RATE MAP

**WASHINGTON COUNTY, UTAH**
**AND INCORPORATED AREAS**

**PANEL 1007 OF 1225**
(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| SANTA CLARA, CITY OF | 490179 | 1007 | G |
| ST. GEORGE, CITY OF | 490177 | 1007 | G |
| WASHINGTON COUNTY | 490224 | 1007 | G |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
49053C1007G
EFFECTIVE DATE
APRIL 2, 2009

Federal Emergency Management Agency

NFIP — NATIONAL FLOOD INSURANCE PROGRAM

**PANEL 1009G**

# FIRM
FLOOD INSURANCE RATE MAP

**WASHINGTON COUNTY, UTAH**
**AND INCORPORATED AREAS**

**PANEL 1009 OF 1225**
(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| ST. GEORGE, CITY OF | 490177 | 1009 | G |
| WASHINGTON COUNTY | 490224 | 1009 | G |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
49053C1009G
EFFECTIVE DATE
APRIL 2, 2009

Federal Emergency Management Agency

NFIP — NATIONAL FLOOD INSURANCE PROGRAM

**PANEL 1028G**

# FIRM
FLOOD INSURANCE RATE MAP

**WASHINGTON COUNTY, UTAH**
**AND INCORPORATED AREAS**

**PANEL 1028 OF 1225**
(SEE LOCATOR DIAGRAM OR MAP INDEX FOR FIRM PANEL LAYOUT)

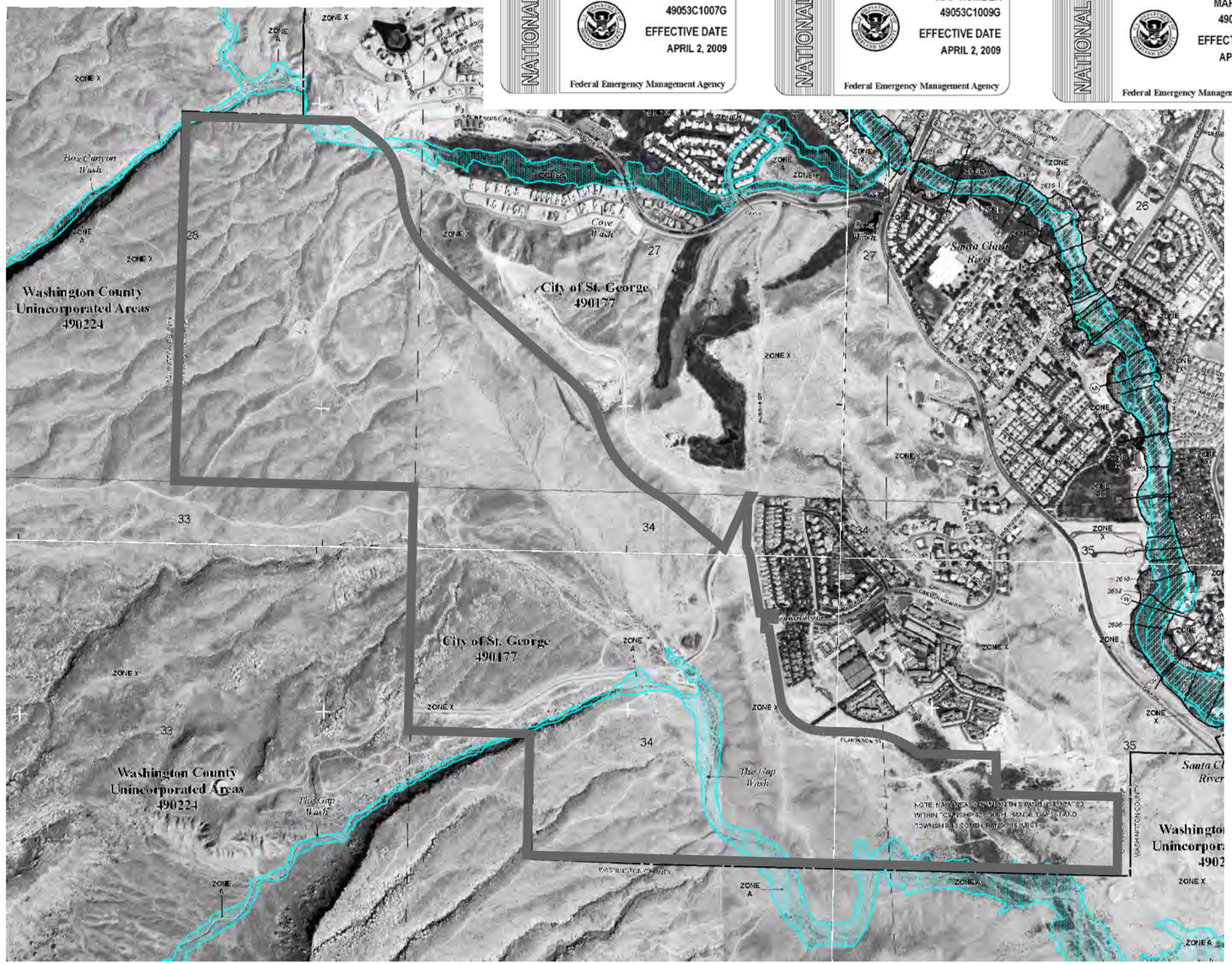
CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| ST. GEORGE, CITY OF | 490177 | 1028 | G |
| WASHINGTON COUNTY | 490224 | 1028 | G |

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
49053C1028G
EFFECTIVE DATE
APRIL 2, 2009

Federal Emergency Management Agency




## LEGEND

**SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

- ZONE A — No Base Flood Elevations determined.
- ZONE AE — Base Flood Elevations determined.
- ZONE AH — Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO — Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR — Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99 — Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V — Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE — Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

**FLOODWAY AREAS IN ZONE AE**

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

**OTHER FLOOD AREAS**

- ZONE X — Area of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

**OTHER AREAS**

- ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.
- ZONE D — Areas in which flood hazards are undetermined, but possible.

**COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**

**OTHERWISE PROTECTED AREAS (OPAS)**

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL. 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

- (A)—(A) — Cross section line
- (23)—(23) — Transect line
- 87°07'45", 32°22'30" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 4376 000 m E — 1000-meter Universal Transverse Mercator grid values, zone 12
- 600000 FT — 5000-foot grid ticks: Utah State Plane coordinate system, south zone (FIPSZONE 4302), Lambert Conformal Conic projection
- DX5510 × — Bench mark (See explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
APRIL 2, 2009

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

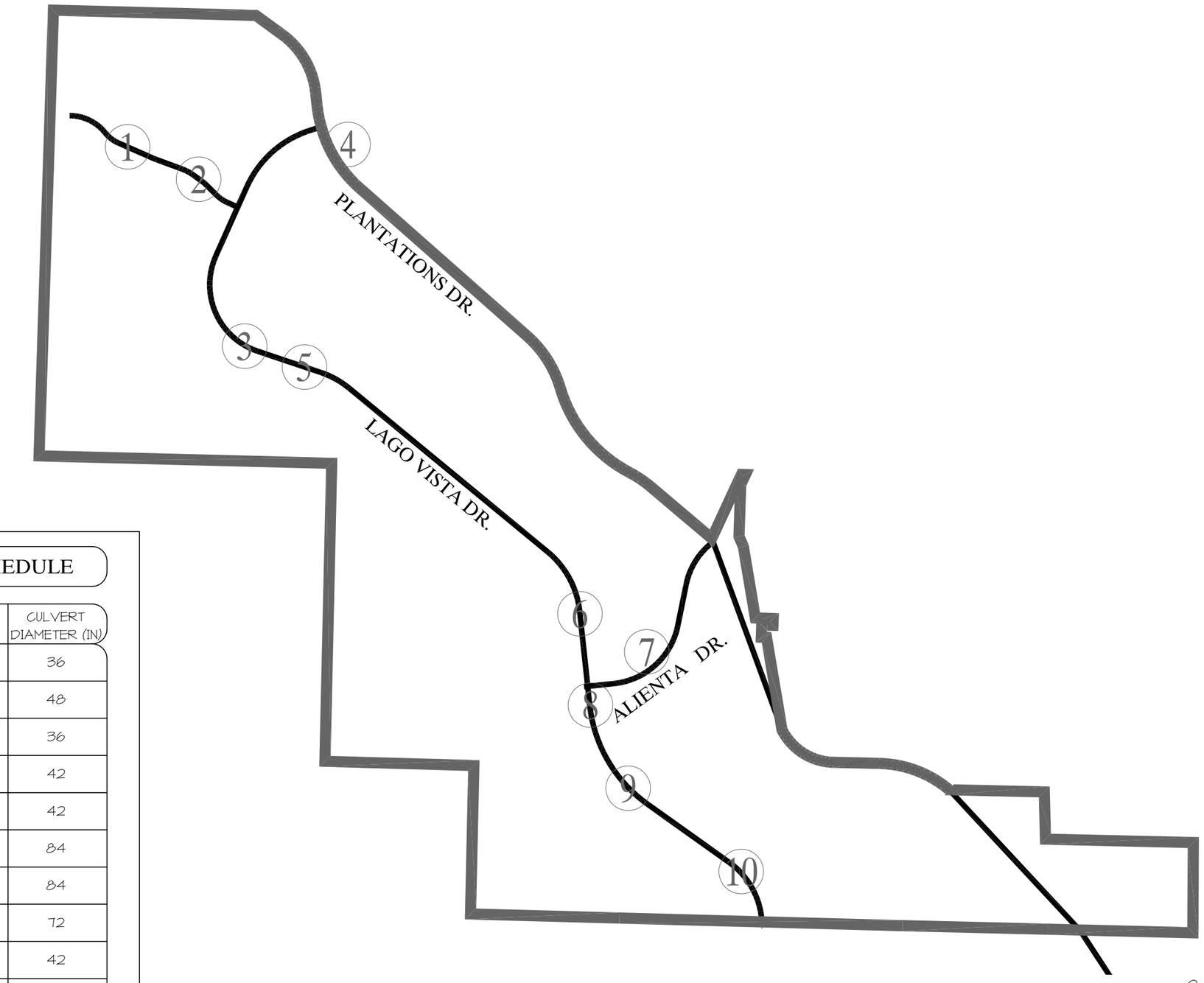
MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

DATE: 4-14-08
JOB NO.: 1286-PDA
DRAWN BY: JRH
DESIGNED BY:
DWG: WATERSHED MAP
DATE
REVISIONS


ROSENBERG ASSOCIATES
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FIGURE 3- FEMA Regulatory 100-YR Floodplain
FOR
The Lakes at St. George
St. George, Utah

SHEET
Fig. 3
1 OF 1 SHEETS




## CULVERT SCHEDULE

| CULVERT ID | 100-YR FLOW (CFS) | CULVERT DIAMETER (IN) |
|---|---|---|
| 1 | 80.7 | 36 |
| 2 | 191.9 | 48 |
| 3 | 88.1 | 36 |
| 4 | 139.9 | 42 |
| 5 | 104.5 | 42 |
| 6 | 654.3 | 84 |
| 7 | 810.0 | 84 |
| 8 | 456.7 | 72 |
| 9 | 134.7 | 42 |
| 10 | 249.4 | 60 |

NOTE
CULVERT DIAMETER CALCULATIONS ASSUME 1.0% SLOPE.

0 1000' 2000'
SCALE: 1"=1000'

DATE: 4-14-08
JOB NO.: 1286-PDA
DRAWN BY: JLN
DESIGNED BY: RMA
DWG: WATERSHED MAP

REVISIONS DATE

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# FIGURE 4 CULVERT CROSSINGS FOR THE LAKES AT ST. GEORGE

ST. GEORGE, UTAH

SHEET
Fig. 4
1 OF 1 SHEETS

United States Department of Agriculture

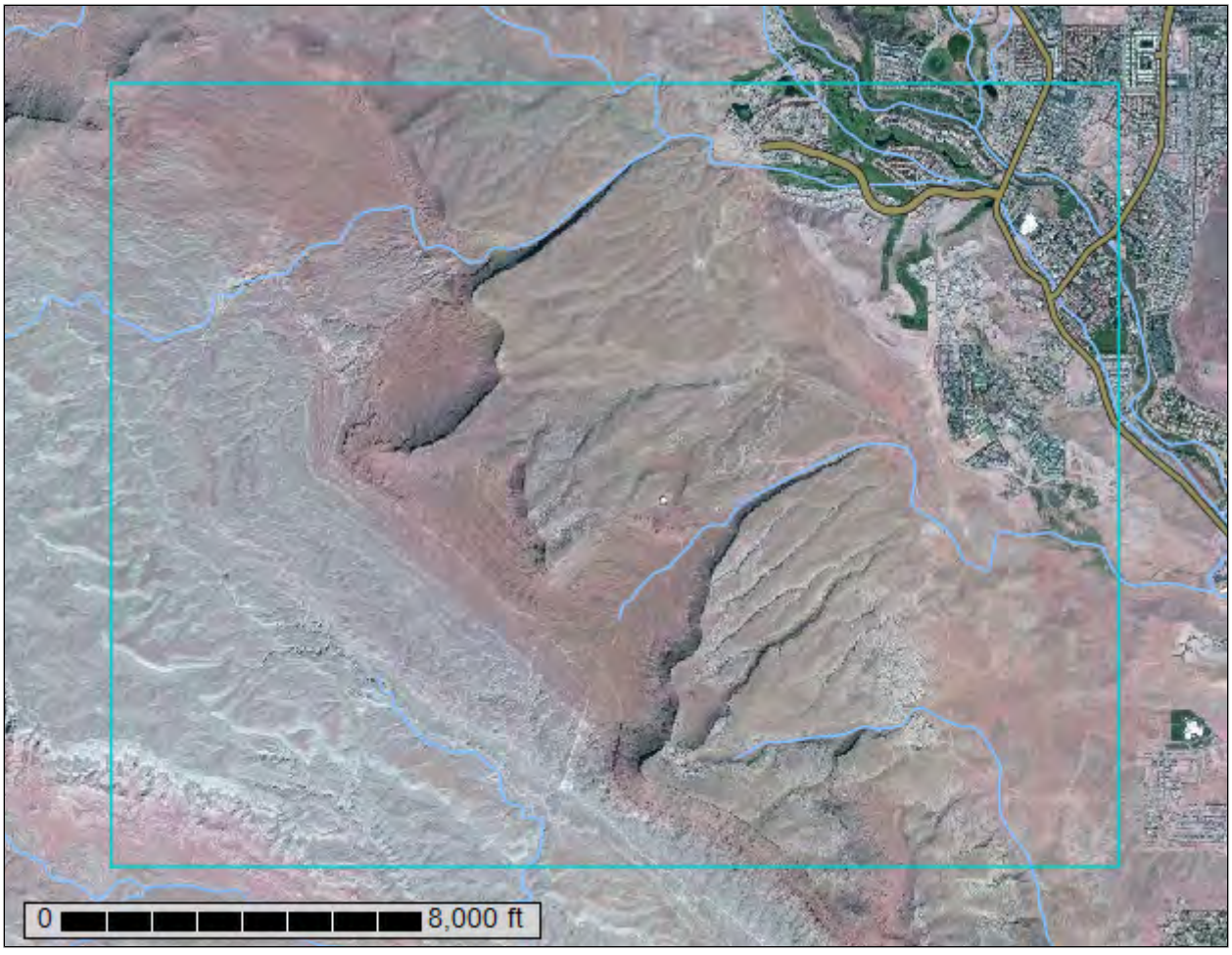
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

# Custom Soil Resource Report for Washington County Area, Utah

## The Lakes




August 19, 2016

# Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (http://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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# Contents

**Preface**.....2
**How Soil Surveys Are Made**.....5
**Soil Map**.....7
Soil Map.....8
Legend.....9
Map Unit Legend.....10
Map Unit Descriptions.....10
Washington County Area, Utah.....13
BA—Badland.....13
BB—Badland, very steep.....13
EB—Eroded land-Shalet complex, warm.....13
FA—Fluvaquents and torrifluvents, sandy.....15
GA—Gullied land.....17
GP—Gravel pits.....17
Ha—Hantz silty clay loam.....17
HG—Hobog-Rock land association.....18
IAF—Isom cobbly sandy loam, 3 to 30 percent slopes.....20
JaC—Junction fine sandy loam, 2 to 5 percent slopes.....21
LcC—Laverkin fine sandy loam, 2 to 5 percent slopes.....22
LeB—Leeds silty clay loam, 1 to 2 percent slopes.....23
NLE—Nikey sandy loam, 3 to 15 percent slopes.....24
PnC—Pintura loamy fine sand, 1 to 5 percent slopes.....26
PoD—Pintura loamy fine sand, hummocky, 1 to 10 percent slopes.....27
RE—Renbac-Rock land association.....28
RO—Rock land.....29
Tc—Tobler fine sandy loam.....30
Td—Tobler silty clay loam.....31
W—Water.....32
WBD—Winkel gravelly fine sandy loam, 1 to 8 percent slopes.....32
**Soil Information for All Uses**.....34
Soil Properties and Qualities.....34
Soil Qualities and Features.....34
Hydrologic Soil Group (The Lakes).....34
**References**.....40

# How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

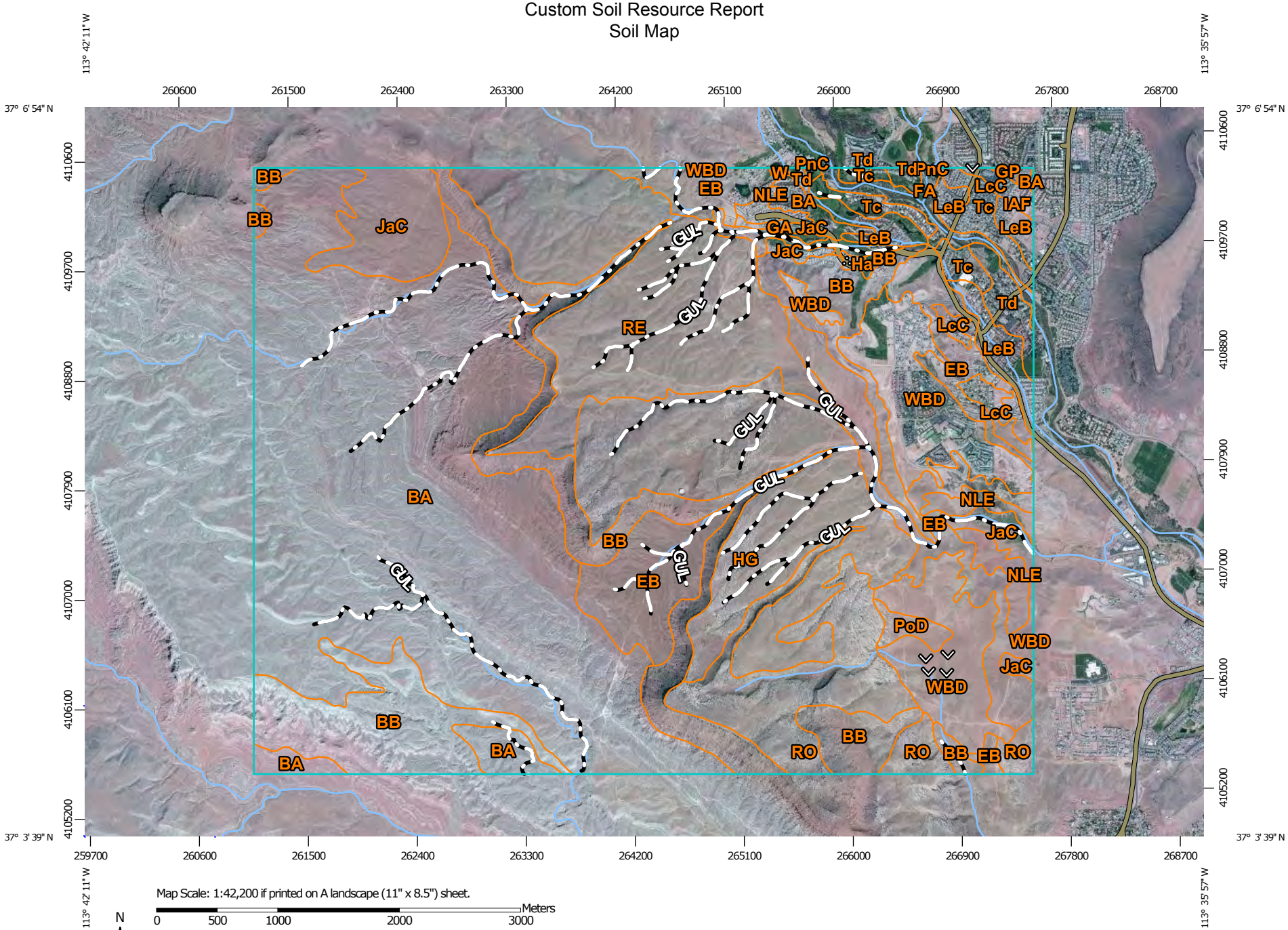
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

# Custom Soil Resource Report
## Soil Map



## MAP LEGEND

**Area of Interest (AOI)**

Area of Interest (AOI)

**Soils**

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

**Special Point Features**

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

**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.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
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 9, Sep 23, 2015

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

Date(s) aerial images were photographed: Aug 11, 2010—Nov 3, 2010

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.

# Map Unit Legend

| Washington County Area, Utah (UT641) | | | |
|---|---|---|---|
| **Map Unit Symbol** | **Map Unit Name** | **Acres in AOI** | **Percent of AOI** |
| BA | Badland | 2,583.6 | 32.5% |
| BB | Badland, very steep | 1,031.7 | 13.0% |
| EB | Eroded land-Shalet complex, warm | 727.4 | 9.1% |
| FA | Fluvaquents and torrifluvents, sandy | 63.4 | 0.8% |
| GA | Gullied land | 35.1 | 0.4% |
| GP | Gravel pits | 4.1 | 0.1% |
| Ha | Hantz silty clay loam | 9.7 | 0.1% |
| HG | Hobog-Rock land association | 870.7 | 10.9% |
| IAF | Isom cobbly sandy loam, 3 to 30 percent slopes | 15.6 | 0.2% |
| JaC | Junction fine sandy loam, 2 to 5 percent slopes | 250.5 | 3.1% |
| LcC | Laverkin fine sandy loam, 2 to 5 percent slopes | 49.5 | 0.6% |
| LeB | Leeds silty clay loam, 1 to 2 percent slopes | 142.6 | 1.8% |
| NLE | Nikey sandy loam, 3 to 15 percent slopes | 100.1 | 1.3% |
| PnC | Pintura loamy fine sand, 1 to 5 percent slopes | 3.1 | 0.0% |
| PoD | Pintura loamy fine sand, hummocky, 1 to 10 percent slopes | 30.4 | 0.4% |
| RE | Renbac-Rock land association | 893.1 | 11.2% |
| RO | Rock land | 431.7 | 5.4% |
| Tc | Tobler fine sandy loam | 129.0 | 1.6% |
| Td | Tobler silty clay loam | 71.5 | 0.9% |
| W | Water | 2.7 | 0.0% |
| WBD | Winkel gravelly fine sandy loam, 1 to 8 percent slopes | 507.9 | 6.4% |
| **Totals for Area of Interest** | | **7,953.3** | **100.0%** |

# Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

# Washington County Area, Utah

## BA—Badland

**Map Unit Composition**

*Badland:* 100 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Badland**

**Setting**

*Landform:* Escarpments, hills
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Free face, side slope
*Down-slope shape:* Convex
*Across-slope shape:* Convex

## BB—Badland, very steep

**Map Unit Composition**

*Badland:* 100 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Badland**

**Setting**

*Landform:* Escarpments, hills
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Free face, side slope
*Down-slope shape:* Convex
*Across-slope shape:* Convex

## EB—Eroded land-Shalet complex, warm

**Map Unit Setting**

*National map unit symbol:* j8ds
*Elevation:* 3,600 to 5,550 feet
*Mean annual precipitation:* 10 to 13 inches
*Mean annual air temperature:* 52 to 56 degrees F
*Frost-free period:* 165 to 170 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Eroded land:* 78 percent
*Shalet and similar soils:* 20 percent
*Minor components:* 2 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Eroded Land

#### Setting

*Landform:* Erosion remnants
*Parent material:* Residuum weathered from shale

### Description of Shalet

#### Setting

*Landform:* Swales
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Parent material:* Residuum weathered from shale

#### Typical profile

*H1 - 0 to 4 inches:* clay loam
*H2 - 4 to 12 inches:* clay loam
*H3 - 12 to 16 inches:* weathered bedrock

#### Properties and qualities

*Slope:* 2 to 20 percent
*Depth to restrictive feature:* 4 to 15 inches to paralithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* High
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately high (0.00 to 0.20 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 20 percent
*Gypsum, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* Very low (about 2.1 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* D
*Ecological site:* Desert Shallow Loam (Creosotebush) (R030XY134UT)
*Hydric soil rating:* No

### Minor Components

#### Badland

*Percent of map unit:* 2 percent

## FA—Fluvaquents and torrifluvents, sandy

### Map Unit Setting

*National map unit symbol:* j8dt
*Elevation:* 2,500 to 3,000 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 205 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Fluvaquents and similar soils:* 55 percent
*Torrifluvents and similar soils:* 35 percent
*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Fluvaquents

#### Setting

*Landform:* Swales
*Landform position (three-dimensional):* Talf
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Parent material:* Sandy alluvium derived from limestone, sandstone, and shale

#### Typical profile

*H1 - 0 to 5 inches:* fine sand
*H2 - 5 to 60 inches:* stratified fine sand to silt loam

#### Properties and qualities

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Poorly drained
*Runoff class:* Negligible
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (6.00 to 20.00 in/hr)
*Depth to water table:* About 6 to 24 inches
*Frequency of flooding:* Frequent
*Frequency of ponding:* Rare
*Calcium carbonate, maximum in profile:* 20 percent
*Salinity, maximum in profile:* Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 10.0
*Available water storage in profile:* Low (about 4.2 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7w
*Hydrologic Soil Group:* A/D
*Ecological site:* Loamy Bottom (Basin Big Sagebrush) (R035XY011UT)

*Hydric soil rating:* Yes

### Description of Torrifluvents

#### Setting

*Landform:* Flood plains
*Landform position (three-dimensional):* Talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium derived from limestone, sandstone, and shale

#### Typical profile

*H1 - 0 to 5 inches:* loamy fine sand
*H2 - 5 to 60 inches:* stratified loamy fine sand to silt loam

#### Properties and qualities

*Slope:* 0 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Very low
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (6.00 to 20.00 in/hr)
*Depth to water table:* About 42 to 72 inches
*Frequency of flooding:* Frequent
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 20 percent
*Salinity, maximum in profile:* Nonsaline to moderately saline (0.0 to 8.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* Low (about 4.8 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7w
*Hydrologic Soil Group:* A
*Ecological site:* Loamy Bottom (Basin Big Sagebrush) (R035XY011UT)
*Other vegetative classification:* Loamy Bottom (Basin Big Sagebrush) (035XY011UT)
*Hydric soil rating:* No

### Minor Components

#### Riverwash

*Percent of map unit:* 4 percent
*Landform:* Flood plains
*Landform position (three-dimensional):* Dip
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Hydric soil rating:* Yes

#### Tobler, fine sandy loam

*Percent of map unit:* 3 percent

#### Tobler, silty clay loam

*Percent of map unit:* 3 percent

## GA—Gullied land

**Map Unit Composition**

*Gullied land:* 100 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

## GP—Gravel pits

**Map Unit Composition**

*Gravel pit:* 100 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Gravel Pit**

**Interpretive groups**

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 8s

*Hydric soil rating:* No

## Ha—Hantz silty clay loam

**Map Unit Setting**

*National map unit symbol:* j8dy

*Elevation:* 2,700 to 3,300 feet

*Mean annual precipitation:* 8 to 11 inches

*Mean annual air temperature:* 57 to 65 degrees F

*Frost-free period:* 190 to 195 days

*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**

*Hantz and similar soils:* 85 percent

*Minor components:* 15 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Hantz**

**Setting**

*Landform:* Alluvial fans

*Down-slope shape:* Concave

*Across-slope shape:* Convex

*Parent material:* Mixed alluvium derived from limestone, sandstone, and shale

**Typical profile**

*H1 - 0 to 9 inches:* silty clay loam

*H2 - 9 to 19 inches:* silty clay
*H3 - 19 to 47 inches:* silty clay
*H4 - 47 to 70 inches:* silty clay

**Properties and qualities**

*Slope:* 0 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 20 percent
*Gypsum, maximum in profile:* 5 percent
*Salinity, maximum in profile:* Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* High (about 10.8 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3s
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* C
*Hydric soil rating:* No

**Minor Components**

**Leeds**

*Percent of map unit:* 5 percent

**Tobler**

*Percent of map unit:* 5 percent

**St. george, moderately saline**

*Percent of map unit:* 5 percent

## HG—Hobog-Rock land association

**Map Unit Setting**

*National map unit symbol:* j8dx
*Elevation:* 2,600 to 3,800 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Hobog and similar soils:* 50 percent
*Rock land:* 40 percent

*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Hobog

#### Setting

*Landform:* Mesas
*Down-slope shape:* Linear
*Across-slope shape:* Convex
*Parent material:* Material weathered from sandstone

#### Typical profile

*H1 - 0 to 4 inches:* very cobbly loam
*H2 - 4 to 13 inches:* very flaggy loam
*H3 - 13 to 17 inches:* unweathered bedrock

#### Properties and qualities

*Slope:* 3 to 40 percent
*Depth to restrictive feature:* 8 to 20 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Very high
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately high (0.00 to 0.20 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 25 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* Very low (about 0.6 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* D
*Ecological site:* Desert Shallow Loam (Creosotebush) (R030XY134UT)
*Hydric soil rating:* No

### Description of Rock Land

#### Setting

*Landform:* Ridges
*Down-slope shape:* Convex
*Across-slope shape:* Convex

### Minor Components

#### Rock outcrop

*Percent of map unit:* 5 percent

#### Renbac

*Percent of map unit:* 5 percent

## IAF—Isom cobbly sandy loam, 3 to 30 percent slopes

### Map Unit Setting

*National map unit symbol:* j8f0
*Elevation:* 2,700 to 3,900 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 175 to 195 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Isom and similar soils:* 90 percent
*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Isom

#### Setting

*Landform:* Alluvial fans
*Down-slope shape:* Concave
*Across-slope shape:* Convex
*Parent material:* Cobbly alluvium derived from limestone, sandstone, and shale

#### Typical profile

*H1 - 0 to 2 inches:* very cobbly sandy loam
*H2 - 2 to 10 inches:* very cobbly sandy loam
*H3 - 10 to 22 inches:* very cobbly sandy loam
*H4 - 22 to 60 inches:* extremely cobbly sandy loam

#### Properties and qualities

*Slope:* 3 to 30 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 60 percent
*Gypsum, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* Low (about 3.3 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* A

*Ecological site:* Desert Shallow Loam (Creosotebush) (R030XY134UT)
*Hydric soil rating:* No

**Minor Components**

**Shallow soils**
*Percent of map unit:* 5 percent

**Nickey**
*Percent of map unit:* 5 percent

## JaC—Junction fine sandy loam, 2 to 5 percent slopes

**Map Unit Setting**
*National map unit symbol:* j8f4
*Elevation:* 2,700 to 3,400 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**
*Junction and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Junction**

**Setting**
*Landform:* Alluvial fans, hills
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Concave, convex
*Across-slope shape:* Convex

**Typical profile**
*H1 - 0 to 2 inches:* fine sandy loam
*H2 - 2 to 9 inches:* fine sandy loam
*H3 - 9 to 21 inches:* fine sandy loam
*H4 - 21 to 32 inches:* fine sandy loam
*H5 - 32 to 60 inches:* fine sandy loam

**Properties and qualities**
*Slope:* 1 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Very low
*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None

*Calcium carbonate, maximum in profile:* 20 percent
*Gypsum, maximum in profile:* 7 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Moderate (about 7.2 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* A
*Ecological site:* Desert Loam (Creosotebush) (R030XY110UT)
*Hydric soil rating:* No

**Minor Components**

**Tobler**

*Percent of map unit:* 5 percent

**Harrisburg**

*Percent of map unit:* 5 percent

**Junction**

*Percent of map unit:* 5 percent

## LcC—Laverkin fine sandy loam, 2 to 5 percent slopes

**Map Unit Setting**

*National map unit symbol:* j8fg
*Elevation:* 2,550 to 3,300 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**

*Laverkin and similar soils:* 90 percent
*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Laverkin**

**Setting**

*Landform:* Alluvial fans, stream terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Concave, linear
*Across-slope shape:* Convex, concave
*Parent material:* Alluvium derived from limestone, sandstone, and shale

**Typical profile**

*H1 - 0 to 3 inches:* fine sandy loam
*H2 - 3 to 16 inches:* fine sandy loam
*H3 - 16 to 30 inches:* sandy clay loam
*H4 - 30 to 42 inches:* sandy clay loam

*H5 - 42 to 60 inches:* sandy clay loam

**Properties and qualities**

*Slope:* 2 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 30 percent
*Gypsum, maximum in profile:* 5 percent
*Salinity, maximum in profile:* Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
*Available water storage in profile:* High (about 9.4 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* B
*Ecological site:* Desert Loam (Creosotebush) (R030XY110UT)
*Hydric soil rating:* No

**Minor Components**

**Tobler**

*Percent of map unit:* 5 percent

**Nikey**

*Percent of map unit:* 5 percent

## LeB—Leeds silty clay loam, 1 to 2 percent slopes

**Map Unit Setting**

*National map unit symbol:* j8fk
*Elevation:* 2,550 to 3,300 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 200 days
*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**

*Leeds and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Leeds**

**Setting**

*Landform:* Flood plains

*Landform position (three-dimensional):* Talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Alluvium derived from limestone, sandstone, and shale

**Typical profile**

*H1 - 0 to 8 inches:* silty clay loam
*H2 - 8 to 15 inches:* silty clay loam
*H3 - 15 to 23 inches:* sandy loam
*H4 - 23 to 60 inches:* silt loam

**Properties and qualities**

*Slope:* 1 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 20 percent
*Salinity, maximum in profile:* Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* High (about 10.1 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3s
*Hydrologic Soil Group:* C
*Ecological site:* Desert Loam (Creosotebush) (R030XY110UT)
*Hydric soil rating:* No

**Minor Components**

**Hantz**

*Percent of map unit:* 4 percent

**St george**

*Percent of map unit:* 4 percent

**Leeds**

*Percent of map unit:* 4 percent

**Tobler**

*Percent of map unit:* 3 percent

## NLE—Nikey sandy loam, 3 to 15 percent slopes

**Map Unit Setting**

*National map unit symbol:* j8fw
*Elevation:* 2,650 to 3,350 feet
*Mean annual precipitation:* 8 to 11 inches

*Mean annual air temperature:* 59 to 62 degrees F
*Frost-free period:* 180 to 195 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Nikey and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Nikey**

**Setting**

*Landform:* Alluvial fans
*Down-slope shape:* Concave
*Across-slope shape:* Convex
*Parent material:* Gravelly alluvium derived from limestone, sandstone, and shale

**Typical profile**

*H1 - 0 to 3 inches:* sandy loam
*H2 - 3 to 26 inches:* fine sandy loam
*H3 - 26 to 38 inches:* very gravelly loam
*H4 - 38 to 46 inches:* very gravelly loam
*H5 - 46 to 60 inches:* very gravelly loam

**Properties and qualities**

*Slope:* 3 to 15 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.60 to 2.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 30 percent
*Gypsum, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Moderate (about 6.5 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* B
*Ecological site:* Desert Loam (Creosotebush) (R030XY110UT)
*Hydric soil rating:* No

**Minor Components**

**Harrisburg**

*Percent of map unit:* 5 percent

**Isom**

*Percent of map unit:* 5 percent

**Nikey**

*Percent of map unit:* 5 percent

## PnC—Pintura loamy fine sand, 1 to 5 percent slopes

### Map Unit Setting

*National map unit symbol:* j8g9
*Elevation:* 2,600 to 3,600 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Farmland of statewide importance

### Map Unit Composition

*Pintura and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Pintura

#### Setting

*Landform:* Mountain slopes
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Parent material:* Eolian sands derived from sandstone

#### Typical profile

*H1 - 0 to 3 inches:* loamy fine sand
*H2 - 3 to 65 inches:* fine sand

#### Properties and qualities

*Slope:* 1 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Somewhat excessively drained
*Runoff class:* Very low
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (6.00 to 20.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Low (about 3.1 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* A
*Ecological site:* Desert Sand (Indian ricegrass) (R030XY120UT)
*Hydric soil rating:* No

**Minor Components**

**Toquerville**
*Percent of map unit:* 4 percent

**Harrisburg**
*Percent of map unit:* 4 percent

**Tobler**
*Percent of map unit:* 4 percent

**Ivins**
*Percent of map unit:* 3 percent

## PoD—Pintura loamy fine sand, hummocky, 1 to 10 percent slopes

**Map Unit Setting**
*National map unit symbol:* j8gb
*Elevation:* 2,600 to 3,600 feet
*Mean annual precipitation:* 7 to 8 inches
*Mean annual air temperature:* 57 to 67 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**
*Pintura and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Pintura**

**Setting**
*Landform:* Mountain slopes
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Parent material:* Hummocky eolian sands derived from sandstone

**Typical profile**
*H1 - 0 to 3 inches:* loamy fine sand
*H2 - 3 to 65 inches:* fine sand

**Properties and qualities**
*Slope:* 1 to 10 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Somewhat excessively drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (6.00 to 20.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None

*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Low (about 3.1 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3s
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* A
*Ecological site:* Desert Sand (Indian ricegrass) (R030XY120UT)
*Hydric soil rating:* No

**Minor Components**

**Dune land**

*Percent of map unit:* 5 percent

**Pintura**

*Percent of map unit:* 5 percent

**Toquerville**

*Percent of map unit:* 5 percent

## RE—Renbac-Rock land association

**Map Unit Setting**

*National map unit symbol:* j8gd
*Elevation:* 2,800 to 4,000 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 61 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Renbac and similar soils:* 60 percent
*Rock land:* 25 percent
*Minor components:* 5 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Renbac**

**Setting**

*Landform:* Mountain slopes
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Convex
*Across-slope shape:* Convex
*Parent material:* Material weathered from sandstone, conglomerate, and shale

**Typical profile**

*H1 - 0 to 2 inches:* channery clay loam
*H2 - 2 to 5 inches:* very channery clay
*H3 - 5 to 9 inches:* very channery clay

*H4 - 9 to 12 inches:* very flaggy sandy loam
*H5 - 12 to 16 inches:* unweathered bedrock

**Properties and qualities**

*Slope:* 2 to 30 percent
*Depth to restrictive feature:* 8 to 17 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately high (0.00 to 0.60 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 25 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Very low (about 1.0 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* D
*Ecological site:* Semidesert Shallow Hardpan (Blackbrush) (R030XY230UT)
*Hydric soil rating:* No

**Minor Components**

**Hobog**

*Percent of map unit:* 5 percent

## RO—Rock land

**Map Unit Composition**

*Rock land:* 80 percent
*Minor components:* 20 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Rock Land**

**Setting**

*Landform:* Mountain slopes
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Convex
*Across-slope shape:* Convex

**Minor Components**

**Shallow soils**

*Percent of map unit:* 20 percent

## Tc—Tobler fine sandy loam

### Map Unit Setting

*National map unit symbol:* j8h2
*Elevation:* 2,500 to 3,500 feet
*Mean annual precipitation:* 10 to 13 inches
*Mean annual air temperature:* 48 to 57 degrees F
*Frost-free period:* 160 to 170 days
*Farmland classification:* Prime farmland if irrigated

### Map Unit Composition

*Tobler and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Tobler

#### Setting

*Landform:* Alluvial fans, hills
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Side slope
*Down-slope shape:* Concave, convex
*Across-slope shape:* Convex
*Parent material:* Alluvium derived from sandstone and shale

#### Typical profile

*H1 - 0 to 4 inches:* fine sandy loam
*H2 - 4 to 13 inches:* fine sandy loam
*H3 - 13 to 38 inches:* fine sandy loam
*H4 - 38 to 60 inches:* fine sandy loam

#### Properties and qualities

*Slope:* 1 to 5 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Very low
*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Moderate (about 7.2 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* A
*Ecological site:* Desert Loam (Creosotebush) (R030XY110UT)
*Hydric soil rating:* No

**Minor Components**

**Harrisburg**
*Percent of map unit:* 4 percent

**Ivins**
*Percent of map unit:* 4 percent

**Pintura**
*Percent of map unit:* 4 percent

**Junction**
*Percent of map unit:* 3 percent

## Td—Tobler silty clay loam

**Map Unit Setting**
*National map unit symbol:* j8h3
*Elevation:* 2,500 to 3,500 feet
*Mean annual precipitation:* 10 to 13 inches
*Mean annual air temperature:* 48 to 57 degrees F
*Frost-free period:* 160 to 170 days
*Farmland classification:* Prime farmland if irrigated

**Map Unit Composition**
*Tobler and similar soils:* 90 percent
*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Tobler**

**Setting**
*Landform:* Flood plains, valleys
*Landform position (three-dimensional):* Talf
*Down-slope shape:* Linear
*Across-slope shape:* Linear, concave
*Parent material:* Alluvium derived from sandstone and shale

**Typical profile**
*H1 - 0 to 10 inches:* silty clay loam
*H2 - 10 to 13 inches:* fine sandy loam
*H3 - 13 to 38 inches:* fine sandy loam
*H4 - 38 to 60 inches:* fine sandy loam

**Properties and qualities**
*Slope:* 1 to 2 percent
*Depth to restrictive feature:* More than 80 inches
*Natural drainage class:* Well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)

*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 10 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Available water storage in profile:* Moderate (about 7.6 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 2e
*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* C
*Ecological site:* Desert Loam (Creosotebush) (R030XY110UT)
*Hydric soil rating:* No

**Minor Components**

**Tobler**

*Percent of map unit:* 3 percent

**Leeds**

*Percent of map unit:* 3 percent

**Leeds**

*Percent of map unit:* 2 percent

**Leeds**

*Percent of map unit:* 2 percent

## W—Water

**Map Unit Composition**

*Water:* 100 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

## WBD—Winkel gravelly fine sandy loam, 1 to 8 percent slopes

**Map Unit Setting**

*National map unit symbol:* j8h9
*Elevation:* 2,800 to 4,000 feet
*Mean annual precipitation:* 8 to 11 inches
*Mean annual air temperature:* 57 to 61 degrees F
*Frost-free period:* 190 to 195 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Winkel and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

## Description of Winkel

### Setting

*Landform:* Mesas
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Calcareous material weathered from basalt, limestone, and wind-deposited sand.

### Typical profile

*H1 - 0 to 1 inches:* gravelly fine sandy loam
*H2 - 1 to 6 inches:* gravelly fine sandy loam
*H3 - 6 to 12 inches:* very gravelly fine sandy loam
*H4 - 12 to 16 inches:* extremely cobbly fine sandy loam
*H5 - 16 to 20 inches:* indurated
*H6 - 20 to 24 inches:* unweathered bedrock

### Properties and qualities

*Slope:* 1 to 8 percent
*Depth to restrictive feature:* 11 to 19 inches to petrocalcic; 14 to 24 inches to lithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately high (0.00 to 0.60 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum in profile:* 30 percent
*Salinity, maximum in profile:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
*Sodium adsorption ratio, maximum in profile:* 5.0
*Available water storage in profile:* Very low (about 1.0 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* D
*Ecological site:* Desert Shallow Loam (Creosotebush) (R030XY134UT)
*Hydric soil rating:* No

## Minor Components

### Lava flows

*Percent of map unit:* 5 percent

### Harrisburg

*Percent of map unit:* 5 percent

### Bermesa

*Percent of map unit:* 5 percent

# Soil Information for All Uses

## Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

## Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

### Hydrologic Soil Group (The Lakes)

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.

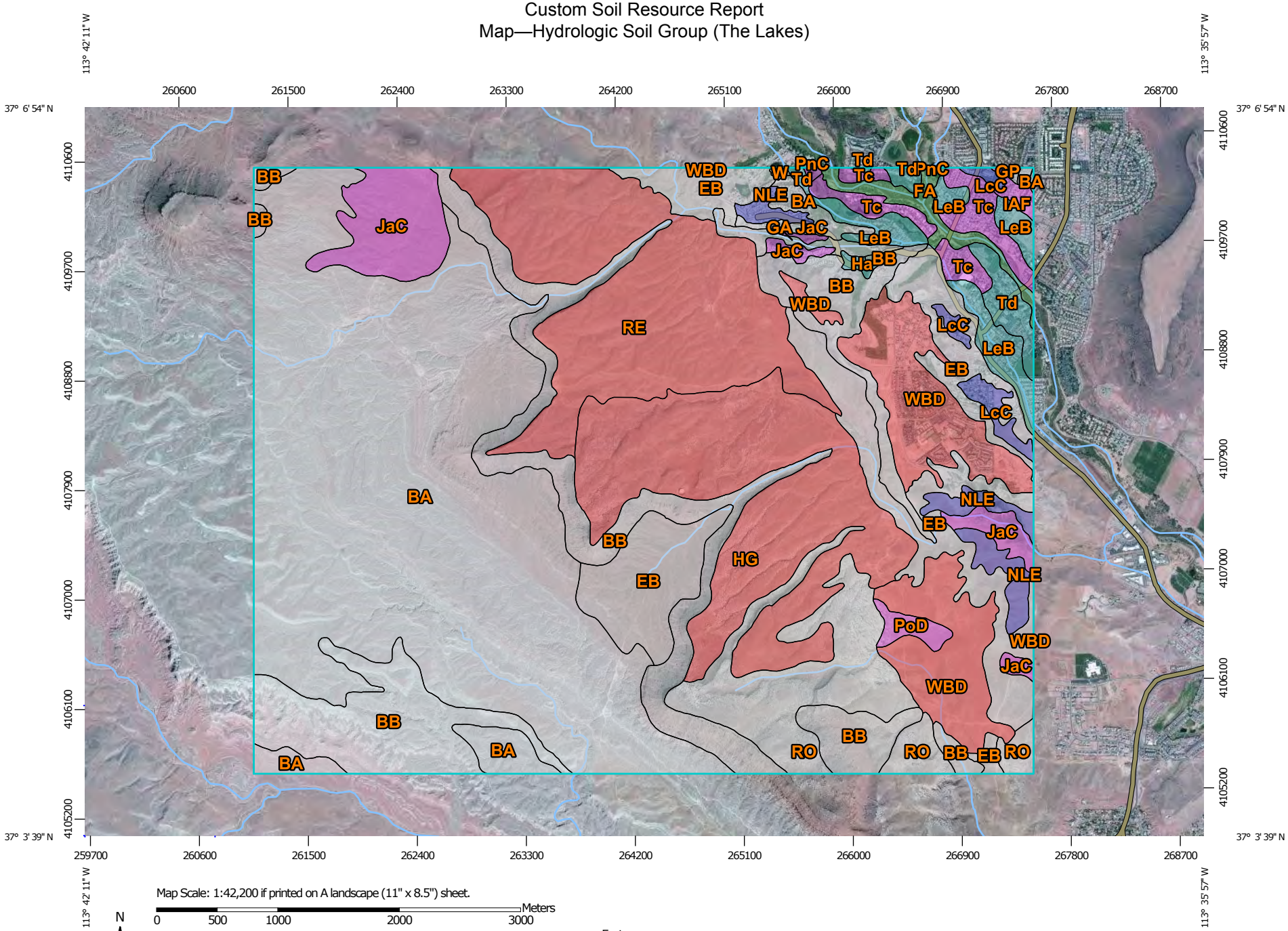
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

# Custom Soil Resource Report
## Map—Hydrologic Soil Group (The Lakes)



## 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.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
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 9, Sep 23, 2015

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

Date(s) aerial images were photographed: Aug 11, 2010—Nov 3, 2010

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.

## Table—Hydrologic Soil Group (The Lakes)

| Hydrologic Soil Group— Summary by Map Unit — Washington County Area, Utah (UT641) | | | | |
|---|---|---|---|---|
| **Map unit symbol** | **Map unit name** | **Rating** | **Acres in AOI** | **Percent of AOI** |
| BA | Badland | | 2,583.6 | 32.5% |
| BB | Badland, very steep | | 1,031.7 | 13.0% |
| EB | Eroded land-Shalet complex, warm | | 727.4 | 9.1% |
| FA | Fluvaquents and torrifluvents, sandy | A/D | 63.4 | 0.8% |
| GA | Gullied land | | 35.1 | 0.4% |
| GP | Gravel pits | | 4.1 | 0.1% |
| Ha | Hantz silty clay loam | C | 9.7 | 0.1% |
| HG | Hobog-Rock land association | D | 870.7 | 10.9% |
| IAF | Isom cobbly sandy loam, 3 to 30 percent slopes | A | 15.6 | 0.2% |
| JaC | Junction fine sandy loam, 2 to 5 percent slopes | A | 250.5 | 3.1% |
| LcC | Laverkin fine sandy loam, 2 to 5 percent slopes | B | 49.5 | 0.6% |
| LeB | Leeds silty clay loam, 1 to 2 percent slopes | C | 142.6 | 1.8% |
| NLE | Nikey sandy loam, 3 to 15 percent slopes | B | 100.1 | 1.3% |
| PnC | Pintura loamy fine sand, 1 to 5 percent slopes | A | 3.1 | 0.0% |
| PoD | Pintura loamy fine sand, hummocky, 1 to 10 percent slopes | A | 30.4 | 0.4% |
| RE | Renbac-Rock land association | D | 893.1 | 11.2% |
| RO | Rock land | | 431.7 | 5.4% |
| Tc | Tobler fine sandy loam | A | 129.0 | 1.6% |
| Td | Tobler silty clay loam | C | 71.5 | 0.9% |
| W | Water | | 2.7 | 0.0% |
| WBD | Winkel gravelly fine sandy loam, 1 to 8 percent slopes | D | 507.9 | 6.4% |
| **Totals for Area of Interest** | | | **7,953.3** | **100.0%** |

## Rating Options—Hydrologic Soil Group (The Lakes)

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule:* Higher

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ROSENBERG ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS



PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: Drainage Study Hydrology Information CHKD: RMA DATE: 30-Aug-16

**EXISTING PRE-DEVELOPMENT CONDITION**

| Hydraulic Element | | Area | | | Hydraulic Properties | |
|---|---|---|---|---|---|---|
| *(label)* | *(notes)* | *(sq ft)* | *(acre)* | *(sq mi)* | *Lo (ft)* | *S (%)* |
| X1 | Subarea X - Offiste | 625,298 | 14.35 | 0.02243 | 1,480 | 9.00 |
| X2 | Subarea X - Onsite to Plantations | 908,340 | 20.85 | 0.03258 | 1,205 | 8.00 |
| Y1 | Subarea Y - Offsite | 1,925,866 | 44.21 | 0.06908 | 3,500 | 9.00 |
| Y2 | Subarea Y - Onsite to Sentieri | 400,265 | 9.19 | 0.01436 | 802 | 8.00 |
| A1 | Subarea A - Offiste | 3,962,682 | 90.97 | 0.14214 | 3,779 | 7.00 |
| A2 | Subarea A - Onsite to Sentieri | 2,138,492 | 49.09 | 0.07671 | 2,951 | 7.00 |
| A3 | Subarea A - Onsite to Plantations | 1,627,354 | 37.36 | 0.05837 | 1,870 | 4.45 |
| B1 | Subarea B - Offsite | 476,820 | 10.95 | 0.01710 | 450 | 7.80 |
| B2 | Subarea B - Onsite to Lago Vista | 1,670,183 | 38.34 | 0.05991 | 1,495 | 7.80 |
| B3 | Subarea B - Onsite to Plantations | 2,149,110 | 49.34 | 0.07709 | 1,943 | 5.60 |
| B4 | Subarea B - Offsite to Plantations | 528,071 | 12.12 | 0.01894 | 1,880 | 2.00 |
| C1 | Subarea C - Offsite | 465,481 | 10.69 | 0.01670 | 878 | 11.67 |
| C2 | Subarea C - Onsite to Lago Vista | 1,748,993 | 40.15 | 0.06274 | 1,190 | 6.72 |
| C3 | Subarea C - Onsite to Alienta | 4,733,374 | 108.66 | 0.16979 | 4,503 | 2.67 |
| C4 | Subarea C - Offsite to Plantations | 435,932 | 10.01 | 0.01564 | 1,504 | 2.00 |
| C5 | Subarea C - Offsite to Plantations | 979,960 | 22.50 | 0.03515 | 2,040 | 3.00 |
| D1 | Sunarea D - Offsite | 16,555,867 | 380.07 | 0.59386 | 4,694 | 7.48 |
| D2 | Subarea D - Onsite to Lago Vista | 4,179,275 | 95.94 | 0.14991 | 3,297 | 7.80 |
| E1 | Subarea E - Offsite (Gap Wash) | 36,853,282 | 846.03 | 1.32193 | 14,986 | 2.25 |
| E2 | Subarea E - Onsite (Gap Wash) to Lago Vista | 894,958 | 20.55 | 0.03210 | 1,303 | 4.27 |
| E3 | Subarea E - Onsite (Gap Wash) to Plantations | 3,288,611 | 75.50 | 0.11796 | 3,501 | 4.47 |
| E4 | Subarea E - Onsite (Gap Wash) to Plantations | 2,126,723 | 48.82 | 0.07629 | 2,949 | 9.50 |
| F1 | Subarea F - Offsite | 1,869,681 | 42.92 | 0.06707 | 3,213 | 8.42 |
| F2 | Subarea F - Onsite to Lago Vista | 991,181 | 22.75 | 0.03555 | 1,764 | 8.80 |
| G1 | Subarea G - Offsite | 8,038,729 | 184.54 | 0.28835 | 7,531 | 9.56 |
| G2 | Subarea G - Onsite to Lago Vista | 1,486,884 | 34.13 | 0.05333 | 561 | 3.56 |
| H1 | Subarea H - Offsite to Plantations | 590,142 | 13.55 | 0.02117 | 1,924 | 4.20 |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: Drainage Study Hydrology Information CHKD: RMA DATE: 30-Aug-16

**PROPOSED POST-DEVELOPMENT CONDITION**

| Hydraulic Element | | Area | | | Hydraulic Properties | |
|---|---|---|---|---|---|---|
| *(label)* | *(notes)* | *(sq ft)* | *(acre)* | *(sq mi)* | *Lo (ft)* | *S (%)* |
| X1 | Subarea X - Offiste | 625,298 | 14.35 | 0.02243 | 1,480 | 9.00 |
| X2 | Subarea X - Onsite to Plantations | 908,340 | 20.85 | 0.03258 | 1,205 | 8.00 |
| Y1 | Subarea Y - Offsite | 1,925,866 | 44.21 | 0.06908 | 3,500 | 9.00 |
| Y2 | Subarea Y - Onsite to Sentieri | 400,265 | 9.19 | 0.01436 | 802 | 8.00 |
| A1 | Subarea A - Offiste | 3,962,682 | 90.97 | 0.14214 | 3,779 | 7.00 |
| A2 | Subarea A - Onsite to Sentieri | 2,138,492 | 49.09 | 0.07671 | 2,951 | 7.00 |
| A3 | Subarea A - Onsite to Plantations | 1,627,354 | 37.36 | 0.05837 | 1,870 | 4.45 |
| B1 | Subarea B - Offsite | 476,820 | 10.95 | 0.01710 | 450 | 7.80 |
| B2 | Subarea B - Onsite to Lago Vista | 1,670,183 | 38.34 | 0.05991 | 1,495 | 7.80 |
| B3 | Subarea B - Onsite to Plantations | 2,149,110 | 49.34 | 0.07709 | 1,943 | 5.60 |
| B4 | Subarea B - Offsite to Plantations | 528,071 | 12.12 | 0.01894 | 1,880 | 2.00 |
| C1 | Subarea C - Offsite | 465,481 | 10.69 | 0.01670 | 878 | 11.67 |
| C2 | Subarea C - Onsite to Lago Vista | 1,748,993 | 40.15 | 0.06274 | 1,190 | 6.72 |
| C3 | Subarea C - Onsite to Alienta | 4,733,374 | 108.66 | 0.16979 | 4,503 | 2.67 |
| C4 | Subarea C - Offsite to Plantations | 435,932 | 10.01 | 0.01564 | 1,504 | 2.00 |
| C5 | Subarea C - Offsite to Plantations | 979,960 | 22.50 | 0.03515 | 2,040 | 3.00 |
| D1 | Sunarea D - Offsite | 16,555,867 | 380.07 | 0.59386 | 4,694 | 7.48 |
| D2 | Subarea D - Onsite to Lago Vista | 4,179,275 | 95.94 | 0.14991 | 3,297 | 7.80 |
| E1 | Subarea E - Offsite (Gap Wash) | 36,853,282 | 846.03 | 1.32193 | 14,986 | 2.25 |
| E2 | Subarea E - Onsite (Gap Wash) to Lago Vista | 894,958 | 20.55 | 0.03210 | 1,303 | 4.27 |
| E3 | Subarea E - Onsite (Gap Wash) to Plantations | 3,288,611 | 75.50 | 0.11796 | 3,501 | 4.47 |
| E4 | Subarea E - Onsite (Gap Wash) to Plantations | 2,126,723 | 48.82 | 0.07629 | 2,949 | 9.50 |
| F1 | Subarea F - Offsite | 1,869,681 | 42.92 | 0.06707 | 3,213 | 8.42 |
| F2 | Subarea F - Onsite to Lago Vista | 991,181 | 22.75 | 0.03555 | 1,764 | 8.80 |
| G1 | Subarea G - Offsite | 8,038,729 | 184.54 | 0.28835 | 7,531 | 9.56 |
| G2 | Subarea G - Onsite to Lago Vista | 1,486,884 | 34.13 | 0.05333 | 561 | 3.56 |
| H1 | Subarea H - Offsite to Plantations | 590,142 | 13.55 | 0.02117 | 1,924 | 4.20 |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: Hydraulic Links and Routing CHKD: RMA DATE: 30-Aug-16

**JUNCTIONS FOR EXISTING PRE-DEVELOPMENT CONDITION**

| Hydraulic Element | |
|---|---|
| J-A | Collecting A1, A2 |
| J-Y | Collecting Y1, Y2 |
| J-AY | Collecting CulvertY, Culvert A, A3 |
| J-B | Collecting B1, B2 |
| J-B3 | Collecting J-B, B3, B4 |
| Box Canyon | Collecting J-AY, J-B3, X1, X2 |
| J-C2 | Collecting C1, C2 |
| J-C5 | Collecting C4, C5 |
| J-C3 | Collecting J-C2, J-C5 |
| J-D2 | Collecting D1, D2 |
| J-CD | Collecting J-C3, J-D2 |
| J-E2 | Collecting E1, E2 |
| J-F2 | Collecting F1, F2 |
| J-G2 | Collecting G1, G2 |
| J-E3 | Collecting J-E2, J-F2, J-G2, E3, H1 |
| Gap Wash | Collecting J-E3, E4 |

**JUNCTIONS FOR PROPOSED POST-DEVELOPMENT CONDITION**

| Hydraulic Element | |
|---|---|
| J-A | Collecting A1, A2 |
| J-Y | Collecting Y1, Y2 |
| J-AY | Collecting CulvertY, Culvert A, A3 |
| J-B | Collecting B1, B2 |
| J-B3 | Collecting J-B, B3, B4 |
| Box Canyon | Collecting J-AY, J-B3, X1, X2 |
| J-C2 | Collecting C1, C2 |
| J-C5 | Collecting C4, C5 |
| J-C3 | Collecting J-C2, J-C5 |
| J-D2 | Collecting D1, D2 |
| J-CD | Collecting J-C3, J-D2 |
| J-E2 | Collecting E1, E2 |
| J-F2 | Collecting F1, F2 |
| J-G2 | Collecting G1, G2 |
| J-E3 | Collecting J-E2, J-F2, J-G2, E3, H1 |
| Gap Wash | Collecting J-E3, E4 |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: Hydraulic Links and Routing CHKD: RMA DATE: 30-Aug-16

**ROUTING CONDUITS**

| Hydraulic Element | | Routed Length (ft) | Average Slope (%) | Manning's Roughness (n) | Culvert Diameter (in) | Bottom Width (ft) | Side Slopes (H:1V) |
|---|---|---|---|---|---|---|---|
| X to Box | Routing X1 to Box Canyon | 855 | 2.9 | 0.023 | N/A | N/A | 6.50 |
| Y1 to Y2 | Routing Y1 to J-Y | 549 | 3.1 | 0.023 | N/A | N/A | 6.50 |
| Culvert Y | Routing J-Y to J-AY | 900 | 4.5 | 0.023 | N/A | N/A | 6.50 |
| A1 to A2 | Routing A1 to J-A | 2,951 | 7.0 | 0.023 | N/A | N/A | 6.50 |
| Culvert A | Routing J-A to J-AY | 100 | 5.0 | 0.010 | 48 | N/A | N/A |
| A to Box | Routing J-AY to Box Canyon | 855 | 2.9 | 0.023 | N/A | N/A | 6.50 |
| B1 to B2 | Routing B1 to J-B | 1,495 | 7.8 | 0.023 | N/A | N/A | 6.50 |
| B to B3 | Routing J-B to J-B3 | 1,943 | 5.6 | 0.023 | N/A | N/A | 6.50 |
| Culvert B | Routing J-B3 to Box Canyon | 855 | 2.9 | 0.023 | N/A | N/A | 6.50 |
| C to C2 | Routing C1 to J-C2 | 1,189 | 6.7 | 0.023 | N/A | N/A | 6.50 |
| C2 to C3 | Routing J-C2 to J-C3 | 4,503 | 2.7 | 0.023 | N/A | N/A | 6.50 |
| C4 to C5 | Routing C4 to J-C5 | 2,043 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| C5 to C3 | Routing J-C5 to J-C3 | 1,170 | 7.0 | 0.023 | N/A | N/A | 6.50 |
| C to D | Routing J-C3 to J-CD | 3,088 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| D1 to D2 | Routing D1 to J-D2 | 2,390 | 7.8 | 0.023 | N/A | N/A | 6.50 |
| D to E3 | Routing J-D2 to J-CD | 120 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| C to E3 | Routing J-CD to J-E3 | 577 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| E1 to E2 | Routing JE1 to J-E2 | 1,303 | 4.3 | 0.023 | N/A | N/A | 6.50 |
| E2 to E3 | Routing J-E2 to J-E3 | 3,501 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| F1 to F2 | Routing F1 to J-F2 | 1,764 | 8.8 | 0.023 | N/A | N/A | 6.50 |
| F to F3 | Routing J-F2 to J-E3 | 2,651 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| G1 to G2 | Routing G1 to J-G2 | 561 | 2.3 | 0.023 | N/A | N/A | 6.50 |
| G to E3 | Routing J-G2 to J-E3 | 883 | 2.0 | 0.023 | N/A | N/A | 6.50 |
| E3 to E4 | Routing J-E3 to Gap Wash | 2,951 | 2.0 | 0.023 | N/A | N/A | 6.50 |

**TYPICAL MANNING'S n VALUES**

| | |
|---|---|
| 0.013 - Poly Pipe | 0.023 - Dirt |
| 0.017 - CM Pipe | 0.026 - Grass |
| 0.015 - Concrete | 0.035 - Gravel |
| 0.016 - Asphalt | 0.040 - Riprap |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: NRCS Curve Number CHKD: RMA DATE: 30-Aug-16

**NRCS CURVE NUMBER (CN) CHART**

| Land Use Description | SCS Curve Number (CN) Values | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Group A | | Group B | | Group C | | Group D | |
| | CN | % | CN | % | CN | % | CN | % |
| *Cultivated Land* | | | | | | | | |
| Cultivated Land; Without Conservation Treatment | 72 | | 81 | | 88 | | 91 | |
| Cultivated Land; With Conservation Treatment | 62 | | 71 | | 78 | | 81 | |
| *Pasture or Range Land* | | | | | | | | |
| Pasture or Range Land; Poor Condition | 68 | | 79 | | 86 | | 89 | |
| Pasture or Range Land; Good Condition | 39 | | 61 | | 74 | | 80 | |
| *Open Spaces (Lawns, Parks, etc.)* | | | | | | | | |
| Open Space; Poor Condition; Grass Cover < 50% | 68 | | 79 | | 86 | | 89 | |
| Open Space; Fair Condition; Grass Cover 50% to 75% | 49 | | 69 | | 79 | | 84 | |
| Open Space; Good Condition; Grass Cover > 75% | 39 | | 61 | | 74 | | 80 | |
| *Impervious Areas* | | | | | | | | |
| Impervious Areas; Paved Parking Lots, Roofs, Driveways | 98 | | 98 | | 98 | | 98 | |
| Impervious Areas; Streets and Roads; Paved; Curbs and Storm Sewers | 98 | | 98 | | 98 | | 98 | |
| Impervious Areas; Streets and Roads; Paved; Open Ditches (w/ Right-of-Way) | 83 | | 89 | | 92 | | 93 | |
| Impervious Areas; Streets and Roads; Gravel (w/ Right-of-Way) | 76 | | 85 | | 89 | | 91 | |
| Impervious Areas; Streets and Roads; Dirt (w/ Right-of-Way) | 72 | | 82 | | 87 | | 89 | |
| *Urban Commercial and Industrial Districts* | | | | | | | | |
| Urban Districts; Commercial and Business; Average 85% Impervious | 89 | | 92 | | 94 | | 95 | |
| Urban Districts; Industrial; Average 72% Impervious | 81 | | 88 | | 91 | | 93 | |
| *Residential Districts* | | | | | | | | |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | | 85 | | 90 | | 92 | |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | |
| Residential Districts; 1/3 Acre; Average 30% Impervious | 57 | | 72 | | 81 | | 86 | |
| Residential Districts; 1/2 Acre; Average 25% Impervious | 54 | | 70 | | 80 | | 85 | |
| Residential Districts; 1 Acre; Average 20% Impervious | 51 | | 68 | | 79 | | 84 | |
| Residential Districts; 2 Acre; Average 12% Impervious | 46 | | 65 | | 77 | | 82 | |
| *Western Desert Urban Areas* | | | | | | | | |
| Natural Desert Vegetation (Pervious Areas Only) | 63 | | 77 | | 85 | | 88 | |
| Artificial Desert Landscaping | 96 | | 96 | | 96 | | 96 | |
| *Developing Urban Area (No Vegetation)* | | | | | | | | |
| Newly Graded Area (Pervious Only) | 77 | | 86 | | 91 | | 94 | |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: NRCS Curve Number CHKD: RMA DATE: 30-Aug-16

**NRCS WEIGHTED AVERAGE CN VALUES** **EXISTING PRE-DEVELOPMENT CONDITION**

| Land Use Description | SCS Curve Number (CN) Values | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group A | | Group B | | Group C | | Group D | | Totals | |
| | CN | % | CN | % | CN | % | CN | % | CN | % |
| X1, X2, Y1, Y2, A1, A2, A3, B1, B2, C1, C2, D1, D2, E1, E2, F1, F2, G1, G2, H1 | | | | | | | | | 93 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 50 | 49 | 50 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 50 | 44 | 50 |
| B3, B4, C3, C4, C5 E3 | | | | | | | | | 88 | 100 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 100 | 88 | 100 |
| E4 | | | | | | | | | 79 | 100 |
| Natural Desert Vegetation | 63 | 20 | 77 | 35 | 85 | | 88 | 45 | 79.2 | 100 |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: NRCS Curve Number CHKD: RMA DATE: 30-Aug-16

**NRCS WEIGHTED AVERAGE CN VALUES** **PROPOSED POST-DEVELOPMENT CONDITION**

| Land Use Description | SCS Curve Number (CN) Values | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group A | | Group B | | Group C | | Group D | | Totals | |
| | CN | % | CN | % | CN | % | CN | % | CN | % |
| X1, Y1, A1,B1, C1, D1, E1 F1, G1, H1 | | | | | | | | | 93 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 50 | 49 | 50 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 50 | 44 | 50 |
| X2, Y2 | | | | | | | | | 89 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 13 | 12 | 13 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 75 | 65 | 75 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 12.5 | 11 | 12.5 |
| A2 | | | | | | | | | 90 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 10 | 10 | 10 |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | | 85 | | 90 | | 92 | 35 | 32 | 35 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 45 | 39 | 45 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 10 | 8.8 | 10 |
| A3 | | | | | | | | | 91 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 13 | 12 | 13 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 40 | 35 | 40 |
| Urban Districts; Commercial and Business; Average 85% Impervious | 89 | | 92 | | 94 | | 95 | 35 | 33.3 | 35 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 12.5 | 11 | 12.5 |
| B2 | | | | | | | | | 92 | 100 |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | | 85 | | 90 | | 92 | 100 | 92 | 100 |
| B3 | | | | | | | | | 88 | 100 |
| Urban Districts; Commercial and Business; Average 85% Impervious | 89 | | 92 | | 94 | | 95 | 15 | 14.3 | 15 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 55 | 48 | 55 |
| Open Space; Good Condition; Grass Cover > 75% | 39 | | 61 | | 74 | | 80 | 10 | 8 | 10 |
| Natural Desert Vegetation | 63 | | 77 | | 85 | | 88 | 20 | 17.6 | 20 |
| B4, C4. C5 | | | | | | | | | 87 | 100 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 100 | 87 | 100 |
| C2 | | | | | | | | | 94 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 10 | 10 | 10 |
| Urban Districts; Commercial and Business; Average 85% Impervious | 89 | | 92 | | 94 | | 95 | 45 | 42.8 | 45 |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | | 85 | | 90 | | 92 | 45 | 41 | 45 |
| C3 | | | | | | | | | 91 | 100 |
| Natural Desert Vegetation (NaC Naplene Silt Loam) | 63 | | 77 | | 85 | | 88 | 32 | 28 | 32 |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | | 85 | | 90 | | 92 | 68 | 63 | 68 |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: NRCS Curve Number CHKD: RMA DATE: 30-Aug-16

| Land Use Description | SCS Curve Number (CN) Values | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Group A | | Group B | | Group C | | Group D | | Totals | |
| | CN | % | CN | % | CN | % | CN | % | CN | % |
| D2 | | | | | | | | | 91 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 30 | 29 | 30 |
| Urban Districts; Commercial and Business; Average 85% Impervious | 89 | | 92 | | 94 | | 95 | 10 | 9.5 | 10 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 60 | 52 | 60 |
| E2 | | | | | | | | | 92 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 45 | 44 | 45 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 55 | 48 | 55 |
| E3 | | | | | | | | | 87 | 100 |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | | 85 | | 90 | | 92 | 32 | 29 | 32 |
| Open Space; Good Condition; Grass Cover > 75% | 39 | | 61 | | 74 | | 80 | 31 | 25 | 31 |
| Natural Desert Vegetation (NaC Naplene Silt Loam) | 63 | | 77 | | 85 | | 88 | 37 | 32.6 | 37 |
| E4 | | | | | | | | | 84 | 100 |
| Residential Districts; 1/8 Acre (Town Houses); Average 65% Impervious | 77 | 5 | 85 | 35 | 90 | | 92 | 45 | 75 | 85 |
| Natural Desert Vegetation (NaC Naplene Silt Loam) | 63 | 15 | 77 | | 85 | | 88 | | 9.45 | 15 |
| F2 | | | | | | | | | 90 | 100 |
| Natural Desert Vegetation (RO Rock Outcropping, mostly impervious) | 98 | | 98 | | 98 | | 98 | 29 | 28 | 29 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 71 | 62 | 71 |
| G2 | | | | | | | | | 87 | 100 |
| Residential Districts; 1/4 Acre; Average 38% Impervious | 61 | | 75 | | 83 | | 87 | 100 | 87 | 100 |

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PROJECT NO. 1286-14-014

PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: SCS Lag Time CHKD: RMA DATE: 30-Aug-16

**TIME OF CONCENTRATION**

$$t_c = \frac{1.67\, L_O^{\,0.8} \left( \frac{1000}{CN} - 9 \right)^{0.7}}{1900 \sqrt{S_{percent}}}$$

Where: CN = SCS runoff curve number
S = Average slope in percent
Lo = Length in ft

**SCS LAG TIME**

13.46 SCS Lag = 0.6*$t_c$

**EXISTING PRE-DEVELOPMENT CONDITION**

| Hydrologic Element | SCS CN | Longest Length Lo (ft) | Average Slope S (%) | $t_c$ (hr) | Lag Time (hr) | Lag Time (min) |
|---|---|---|---|---|---|---|
| X1 | 93 | 1,480 | 9.00 | 0.149 | 0.089 | 5.37 |
| X2 | 93 | 1,205 | 8.00 | 0.134 | 0.081 | 4.83 |
| Y1 | 93 | 3,500 | 9.00 | 0.297 | 0.178 | 10.69 |
| Y2 | 93 | 802 | 8.00 | 0.097 | 0.058 | 3.49 |
| A1 | 93 | 3,779 | 7.00 | 0.358 | 0.215 | 12.89 |
| A2 | 93 | 2,951 | 7.00 | 0.294 | 0.176 | 10.58 |
| A3 | 93 | 1,870 | 4.45 | 0.256 | 0.153 | 9.21 |
| B1 | 93 | 450 | 7.80 | 0.062 | 0.037 | 2.23 |
| B2 | 93 | 1,495 | 7.80 | 0.162 | 0.097 | 5.81 |
| B3 | 88 | 1,943 | 5.60 | 0.290 | 0.174 | 10.43 |
| B4 | 88 | 1,880 | 2.00 | 0.472 | 0.283 | 17.01 |
| C1 | 93 | 878 | 11.67 | 0.086 | 0.052 | 3.11 |
| C2 | 93 | 1,190 | 6.72 | 0.145 | 0.087 | 5.22 |
| C3 | 88 | 4,503 | 2.67 | 0.822 | 0.493 | 29.60 |
| C4 | 88 | 1,504 | 2.00 | 0.395 | 0.237 | 14.23 |
| C5 | 88 | 2,040 | 3.00 | 0.412 | 0.247 | 14.82 |
| D1 | 93 | 4,694 | 7.48 | 0.412 | 0.247 | 14.83 |
| D2 | 93 | 3,297 | 7.80 | 0.304 | 0.182 | 10.95 |
| E1 | 93 | 14,986 | 2.25 | 1.901 | 1.141 | 68.44 |
| E2 | 93 | 1,303 | 4.27 | 0.196 | 0.117 | 7.04 |
| E3 | 88 | 3,501 | 4.47 | 0.520 | 0.312 | 18.71 |
| E4 | 79 | 2,949 | 9.50 | 0.420 | 0.252 | 15.12 |
| F1 | 93 | 3,213 | 8.42 | 0.287 | 0.172 | 10.32 |
| F2 | 93 | 1,764 | 8.80 | 0.174 | 0.104 | 6.25 |
| G1 | 93 | 7,531 | 9.56 | 0.532 | 0.319 | 19.15 |
| G2 | 93 | 561 | 3.56 | 0.109 | 0.065 | 3.93 |
| H1 | 93 | 1,924 | 4.20 | 0.269 | 0.162 | 9.70 |

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PROJECT NO. 1286-14-014

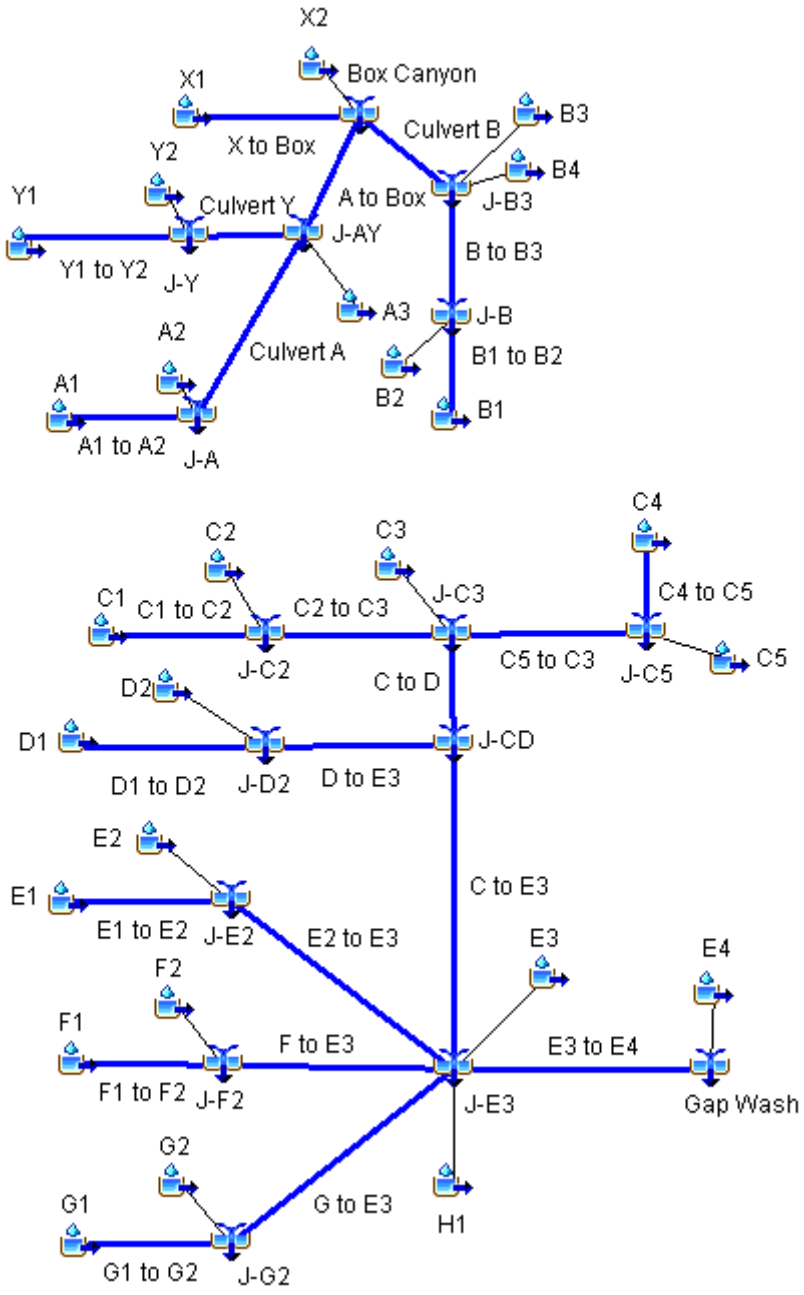
PROJECT: The Lakes - Master Plan BY: JLW DATE: 30-Aug-16

SUBJECT: SCS Lag Time CHKD: RMA DATE: 30-Aug-16

**PROPOSED POST-DEVELOPMENT CONDITION**

| Hydrologic Element | SCS CN | Longest Length Lo (ft) | Average Slope S (%) | $t_c$ (hr) | Lag Time (hr) | Lag Time (min) |
|---|---|---|---|---|---|---|
| X1 | 93 | 1,480 | 9.00 | 0.149 | 0.089 | 5.37 |
| X2 | 89 | 1,205 | 8.00 | 0.162 | 0.097 | 5.84 |
| Y1 | 93 | 3,500 | 9.00 | 0.297 | 0.178 | 10.69 |
| Y2 | 89 | 802 | 8.00 | 0.117 | 0.070 | 4.22 |
| A1 | 93 | 3,779 | 7.00 | 0.358 | 0.215 | 12.89 |
| A2 | 90 | 2,951 | 7.00 | 0.335 | 0.201 | 12.07 |
| A3 | 91 | 1,870 | 4.45 | 0.276 | 0.166 | 9.93 |
| B1 | 93 | 450 | 7.80 | 0.062 | 0.037 | 2.23 |
| B2 | 92 | 1,495 | 7.80 | 0.169 | 0.101 | 6.08 |
| B3 | 88 | 1,943 | 5.60 | 0.293 | 0.176 | 10.55 |
| B4 | 87 | 1,880 | 2.00 | 0.490 | 0.294 | 17.66 |
| C1 | 93 | 878 | 11.67 | 0.086 | 0.052 | 3.11 |
| C2 | 94 | 1,190 | 6.72 | 0.139 | 0.083 | 4.99 |
| C3 | 91 | 4,503 | 2.67 | 0.737 | 0.442 | 26.55 |
| C4 | 87 | 1,504 | 2.00 | 0.410 | 0.246 | 14.77 |
| C5 | 87 | 2,040 | 3.00 | 0.428 | 0.257 | 15.39 |
| D1 | 93 | 4,694 | 7.48 | 0.412 | 0.247 | 14.83 |
| D2 | 91 | 3,297 | 7.80 | 0.331 | 0.198 | 11.91 |
| E1 | 93 | 14,986 | 2.25 | 1.901 | 1.141 | 68.44 |
| E2 | 92 | 1,303 | 4.27 | 0.205 | 0.123 | 7.38 |
| E3 | 87 | 3,501 | 4.47 | 0.544 | 0.326 | 19.57 |
| E4 | 84 | 2,949 | 9.50 | 0.353 | 0.212 | 12.72 |
| F1 | 93 | 3,213 | 8.42 | 0.287 | 0.172 | 10.32 |
| F2 | 90 | 1,764 | 8.80 | 0.196 | 0.118 | 7.06 |
| G1 | 93 | 7,531 | 9.56 | 0.532 | 0.319 | 19.15 |
| G2 | 87 | 561 | 3.56 | 0.140 | 0.084 | 5.03 |
| H1 | 93 | 1,924 | 4.20 | 0.269 | 0.162 | 9.70 |

# HEC-HMS Model



Project: The Lakes Master Simulation Run: N Pre 10 3hr

Start of Run: 01Jan2000, 12:00 Basin Model: Pre
End of Run: 01Jan2000, 20:00 Meteorologic Model: 10-3
Compute Time: 30Aug2016, 13:54:22 Control Specifications: 10-3

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 148.6 | 01Jan2000, 13:00 | 0.45 |
| A1 | 0.14214 | 59.6 | 01Jan2000, 12:55 | 0.45 |
| A1 to A2 | 0.14214 | 59.4 | 01Jan2000, 13:00 | 0.45 |
| A2 | 0.07671 | 35.5 | 01Jan2000, 12:55 | 0.45 |
| A3 | 0.05837 | 27.7 | 01Jan2000, 12:55 | 0.45 |
| Box Canyon | 0.58871 | 223.2 | 01Jan2000, 12:55 | 0.41 |
| B to B3 | 0.07701 | 40.7 | 01Jan2000, 12:50 | 0.45 |
| B1 | 0.01710 | 10.5 | 01Jan2000, 12:45 | 0.45 |
| B1 to B2 | 0.01710 | 9.9 | 01Jan2000, 12:50 | 0.45 |
| B2 | 0.05991 | 32.5 | 01Jan2000, 12:50 | 0.45 |
| B3 | 0.07709 | 18.1 | 01Jan2000, 12:55 | 0.25 |
| B4 | 0.01894 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| Culvert A | 0.21885 | 91.0 | 01Jan2000, 13:00 | 0.45 |
| Culvert B | 0.17304 | 56.5 | 01Jan2000, 12:55 | 0.31 |
| Culvert Y | 0.08344 | 35.4 | 01Jan2000, 12:55 | 0.45 |
| C to D | 0.30002 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C to E3 | 1.04382 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C1 | 0.01670 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C1 to C2 | 0.01670 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C2 | 0.06274 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C2 to C3 | 0.07944 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C3 | 0.16979 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C4 | 0.01564 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C4 to C5 | 0.01564 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C5 | 0.03515 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| C5 to C3 | 0.05079 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| D1 | 0.59389 | 0.0 | 01Jan2000, 12:00 | 0.00 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 to D2 | 0.59389 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| D2 | 0.14991 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| D2 to C3 | 0.74380 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E1 | 1.32193 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E1 to E2 | 1.32193 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E2 | 0.03210 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E2 to E3 | 1.35403 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E3 | 0.11796 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E3 to E4 | 3.02244 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| E4 | 0.07629 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| F to E3 | 0.14378 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| F1 | 0.06707 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| F1 to F2 | 0.06707 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| F2 | 0.07671 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| Gap Wash | 3.02244 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| G to E3 | 0.34168 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| G1 | 0.28835 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| G1 to G2 | 0.28835 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| G2 | 0.05333 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| H1 | 0.02117 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-A | 0.21885 | 91.0 | 01Jan2000, 13:00 | 0.45 |
| J-AY | 0.36066 | 149.0 | 01Jan2000, 12:55 | 0.45 |
| J-B | 0.07701 | 42.4 | 01Jan2000, 12:50 | 0.45 |
| J-B3 | 0.17304 | 57.2 | 01Jan2000, 12:55 | 0.31 |
| J-CD | 1.04382 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-C2 | 0.07944 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-C3 | 0.30002 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-C5 | 0.05079 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-D2 | 0.74380 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-E2 | 1.35403 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-E4 | 3.09873 | 0.0 | 01Jan2000, 12:00 | 0.00 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-G2 | 0.34168 | 0.0 | 01Jan2000, 12:00 | 0.00 |
| J-Y | 0.08344 | 36.3 | 01Jan2000, 12:55 | 0.45 |
| X to Box | 0.02243 | 12.0 | 01Jan2000, 12:50 | 0.45 |
| X1 | 0.02243 | 12.3 | 01Jan2000, 12:50 | 0.45 |
| X2 | 0.03258 | 18.0 | 01Jan2000, 12:50 | 0.45 |
| Y1 | 0.06908 | 31.9 | 01Jan2000, 12:55 | 0.45 |
| Y1 to Y2 | 0.06908 | 30.9 | 01Jan2000, 12:55 | 0.45 |
| Y2 | 0.01436 | 8.4 | 01Jan2000, 12:45 | 0.45 |

Project: The Lakes Master Simulation Run: N Pre 10 24hr

Start of Run: 01Jan2000, 12:00 Basin Model: Pre
End of Run: 03Jan2000, 00:30 Meteorologic Model: 10-24hr
Compute Time: 30Aug2016, 13:54:14 Control Specifications: 24-Hour

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 141.2 | 02Jan2000, 00:00 | 1.03 |
| A1 | 0.14214 | 61.6 | 02Jan2000, 00:00 | 1.03 |
| A1 to A2 | 0.14214 | 54.7 | 02Jan2000, 00:00 | 1.03 |
| A2 | 0.07671 | 33.2 | 02Jan2000, 00:00 | 1.03 |
| A3 | 0.05837 | 25.3 | 02Jan2000, 00:00 | 1.03 |
| Box Canyon | 0.58871 | 218.4 | 02Jan2000, 00:00 | 0.98 |
| B to B3 | 0.07701 | 29.7 | 02Jan2000, 00:00 | 1.03 |
| B1 | 0.01710 | 7.4 | 02Jan2000, 00:00 | 1.03 |
| B1 to B2 | 0.01710 | 6.7 | 02Jan2000, 00:00 | 1.03 |
| B2 | 0.05991 | 26.0 | 02Jan2000, 00:00 | 1.03 |
| B3 | 0.07709 | 22.0 | 02Jan2000, 00:00 | 0.71 |
| B4 | 0.01894 | 5.1 | 02Jan2000, 00:00 | 0.71 |
| Culvert A | 0.21885 | 87.8 | 02Jan2000, 00:00 | 1.03 |
| Culvert B | 0.17304 | 54.1 | 02Jan2000, 00:00 | 0.86 |
| Culvert Y | 0.08344 | 33.3 | 02Jan2000, 00:00 | 1.03 |
| C to D | 0.30002 | 65.9 | 02Jan2000, 00:30 | 0.80 |
| C to E3 | 1.04382 | 350.4 | 02Jan2000, 00:00 | 0.97 |
| C1 | 0.01670 | 7.2 | 02Jan2000, 00:00 | 1.03 |
| C1 to C2 | 0.01670 | 6.7 | 02Jan2000, 00:00 | 1.03 |
| C2 | 0.06274 | 27.2 | 02Jan2000, 00:00 | 1.03 |
| C2 to C3 | 0.07944 | 23.6 | 02Jan2000, 00:00 | 1.03 |
| C3 | 0.16979 | 34.1 | 02Jan2000, 00:30 | 0.71 |
| C4 | 0.01564 | 4.5 | 02Jan2000, 00:00 | 0.71 |
| C4 to C5 | 0.01564 | 3.3 | 02Jan2000, 00:00 | 0.72 |
| C5 | 0.03515 | 10.0 | 02Jan2000, 00:00 | 0.71 |
| C5 to C3 | 0.05079 | 12.4 | 02Jan2000, 00:00 | 0.72 |
| D1 | 0.59389 | 257.3 | 02Jan2000, 00:00 | 1.03 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 to D2 | 0.59389 | 241.9 | 02Jan2000, 00:00 | 1.03 |
| D2 | 0.14991 | 65.0 | 02Jan2000, 00:00 | 1.03 |
| D2 to C3 | 0.74380 | 305.4 | 02Jan2000, 00:00 | 1.03 |
| E1 | 1.32193 | 266.6 | 02Jan2000, 01:00 | 1.03 |
| E1 to E2 | 1.32193 | 264.1 | 02Jan2000, 01:00 | 1.03 |
| E2 | 0.03210 | 13.9 | 02Jan2000, 00:00 | 1.03 |
| E2 to E3 | 1.35403 | 258.5 | 02Jan2000, 01:00 | 1.03 |
| E3 | 0.11796 | 29.7 | 02Jan2000, 00:00 | 0.71 |
| E3 to E4 | 3.02244 | 596.6 | 02Jan2000, 00:30 | 1.00 |
| E4 | 0.07629 | 7.5 | 02Jan2000, 00:00 | 0.35 |
| F to E3 | 0.14378 | 50.3 | 02Jan2000, 00:00 | 1.03 |
| F1 | 0.06707 | 29.1 | 02Jan2000, 00:00 | 1.03 |
| F1 to F2 | 0.06707 | 26.9 | 02Jan2000, 00:00 | 1.03 |
| F2 | 0.07671 | 33.2 | 02Jan2000, 00:00 | 1.03 |
| Gap Wash | 3.02244 | 644.2 | 02Jan2000, 00:00 | 0.99 |
| G to E3 | 0.34168 | 124.3 | 02Jan2000, 00:00 | 1.03 |
| G1 | 0.28835 | 109.3 | 02Jan2000, 00:00 | 1.03 |
| G1 to G2 | 0.28835 | 106.8 | 02Jan2000, 00:00 | 1.03 |
| G2 | 0.05333 | 23.1 | 02Jan2000, 00:00 | 1.03 |
| H1 | 0.02117 | 9.2 | 02Jan2000, 00:00 | 1.03 |
| J-A | 0.21885 | 88.0 | 02Jan2000, 00:00 | 1.03 |
| J-AY | 0.36066 | 146.4 | 02Jan2000, 00:00 | 1.03 |
| J-B | 0.07701 | 32.7 | 02Jan2000, 00:00 | 1.03 |
| J-B3 | 0.17304 | 56.7 | 02Jan2000, 00:00 | 0.86 |
| J-CD | 1.04382 | 358.2 | 02Jan2000, 00:00 | 0.96 |
| J-C2 | 0.07944 | 33.9 | 02Jan2000, 00:00 | 1.03 |
| J-C3 | 0.30002 | 66.6 | 02Jan2000, 00:30 | 0.80 |
| J-C5 | 0.05079 | 13.3 | 02Jan2000, 00:00 | 0.72 |
| J-D2 | 0.74380 | 306.9 | 02Jan2000, 00:00 | 1.03 |
| J-E2 | 1.35403 | 267.1 | 02Jan2000, 01:00 | 1.03 |
| J-E4 | 3.09873 | 602.2 | 02Jan2000, 00:30 | 0.98 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 60.2 | 02Jan2000, 00:00 | 1.03 |
| J-G2 | 0.34168 | 129.9 | 02Jan2000, 00:00 | 1.03 |
| J-Y | 0.08344 | 34.9 | 02Jan2000, 00:00 | 1.03 |
| X to Box | 0.02243 | 9.0 | 02Jan2000, 00:00 | 1.03 |
| X1 | 0.02243 | 9.7 | 02Jan2000, 00:00 | 1.03 |
| X2 | 0.03258 | 14.1 | 02Jan2000, 00:00 | 1.03 |
| Y1 | 0.06908 | 29.9 | 02Jan2000, 00:00 | 1.03 |
| Y1 to Y2 | 0.06908 | 28.7 | 02Jan2000, 00:00 | 1.03 |
| Y2 | 0.01436 | 6.2 | 02Jan2000, 00:00 | 1.03 |

Project: The Lakes Master Simulation Run: N Pre 100 3hr

Start of Run: 01Jan2000, 12:00 Basin Model: Pre
End of Run: 01Jan2000, 18:30 Meteorologic Model: 100-3
Compute Time: 30Aug2016, 13:54:38 Control Specifications: 100-3

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 344.2 | 01Jan2000, 12:55 | 0.99 |
| A1 | 0.14214 | 139.2 | 01Jan2000, 12:55 | 0.99 |
| A1 to A2 | 0.14214 | 135.5 | 01Jan2000, 13:00 | 0.99 |
| A2 | 0.07671 | 80.3 | 01Jan2000, 12:55 | 0.99 |
| A3 | 0.05837 | 64.4 | 01Jan2000, 12:50 | 0.99 |
| Box Canyon | 0.58871 | 541.9 | 01Jan2000, 12:55 | 0.94 |
| B to B3 | 0.07701 | 94.8 | 01Jan2000, 12:50 | 0.99 |
| B1 | 0.01710 | 23.5 | 01Jan2000, 12:40 | 0.99 |
| B1 to B2 | 0.01710 | 23.4 | 01Jan2000, 12:45 | 0.99 |
| B2 | 0.05991 | 73.1 | 01Jan2000, 12:45 | 0.99 |
| B3 | 0.07709 | 53.9 | 01Jan2000, 12:55 | 0.68 |
| B4 | 0.01894 | 10.6 | 01Jan2000, 13:05 | 0.68 |
| Culvert A | 0.21885 | 208.0 | 01Jan2000, 12:55 | 0.99 |
| Culvert B | 0.17304 | 145.8 | 01Jan2000, 12:55 | 0.82 |
| Culvert Y | 0.08344 | 82.4 | 01Jan2000, 12:55 | 0.99 |
| C to D | 0.30002 | 152.5 | 01Jan2000, 13:05 | 0.76 |
| C to E3 | 1.04382 | 815.0 | 01Jan2000, 13:00 | 0.93 |
| C1 | 0.01670 | 22.7 | 01Jan2000, 12:45 | 0.99 |
| C1 to C2 | 0.01670 | 22.1 | 01Jan2000, 12:45 | 0.99 |
| C2 | 0.06274 | 79.6 | 01Jan2000, 12:45 | 0.99 |
| C2 to C3 | 0.07944 | 98.2 | 01Jan2000, 12:55 | 0.98 |
| C3 | 0.16979 | 71.3 | 01Jan2000, 13:20 | 0.68 |
| C4 | 0.01564 | 9.6 | 01Jan2000, 13:00 | 0.68 |
| C4 to C5 | 0.01564 | 9.4 | 01Jan2000, 13:05 | 0.69 |
| C5 | 0.03515 | 21.3 | 01Jan2000, 13:00 | 0.68 |
| C5 to C3 | 0.05079 | 29.4 | 01Jan2000, 13:05 | 0.69 |
| D1 | 0.59389 | 540.9 | 01Jan2000, 13:00 | 0.99 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 to D2 | 0.59389 | 537.5 | 01Jan2000, 13:00 | 0.99 |
| D2 | 0.14991 | 156.1 | 01Jan2000, 12:55 | 0.99 |
| D2 to C3 | 0.74380 | 671.7 | 01Jan2000, 13:00 | 0.99 |
| E1 | 1.32193 | 456.4 | 01Jan2000, 14:00 | 0.99 |
| E1 to E2 | 1.32193 | 456.3 | 01Jan2000, 14:00 | 0.99 |
| E2 | 0.03210 | 38.3 | 01Jan2000, 12:50 | 0.99 |
| E2 to E3 | 1.35403 | 456.8 | 01Jan2000, 14:05 | 0.99 |
| E3 | 0.11796 | 63.8 | 01Jan2000, 13:05 | 0.68 |
| E3 to E4 | 3.02244 | 1331.1 | 01Jan2000, 13:05 | 0.95 |
| E4 | 0.07629 | 19.5 | 01Jan2000, 13:05 | 0.33 |
| F to E3 | 0.14378 | 152.6 | 01Jan2000, 12:55 | 0.99 |
| F1 | 0.06707 | 70.4 | 01Jan2000, 12:55 | 0.99 |
| F1 to F2 | 0.06707 | 69.9 | 01Jan2000, 12:55 | 0.99 |
| F2 | 0.07671 | 92.3 | 01Jan2000, 12:50 | 0.99 |
| Gap Wash | 3.02244 | 1353.9 | 01Jan2000, 13:00 | 0.96 |
| G to E3 | 0.34168 | 255.8 | 01Jan2000, 13:05 | 0.99 |
| G1 | 0.28835 | 232.1 | 01Jan2000, 13:05 | 0.99 |
| G1 to G2 | 0.28835 | 231.6 | 01Jan2000, 13:05 | 0.99 |
| G2 | 0.05333 | 71.5 | 01Jan2000, 12:45 | 0.99 |
| H1 | 0.02117 | 22.7 | 01Jan2000, 12:50 | 0.99 |
| J-A | 0.21885 | 208.4 | 01Jan2000, 12:55 | 0.99 |
| J-AY | 0.36066 | 351.9 | 01Jan2000, 12:55 | 0.99 |
| J-B | 0.07701 | 96.5 | 01Jan2000, 12:45 | 0.99 |
| J-B3 | 0.17304 | 148.6 | 01Jan2000, 12:50 | 0.82 |
| J-CD | 1.04382 | 821.0 | 01Jan2000, 13:00 | 0.92 |
| J-C2 | 0.07944 | 101.7 | 01Jan2000, 12:45 | 0.99 |
| J-C3 | 0.30002 | 153.6 | 01Jan2000, 13:00 | 0.76 |
| J-C5 | 0.05079 | 29.6 | 01Jan2000, 13:00 | 0.68 |
| J-D2 | 0.74380 | 672.3 | 01Jan2000, 13:00 | 0.99 |
| J-E2 | 1.35403 | 457.9 | 01Jan2000, 14:00 | 0.99 |
| J-E4 | 3.09873 | 1350.6 | 01Jan2000, 13:05 | 0.94 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 154.2 | 01Jan2000, 12:50 | 0.99 |
| J-G2 | 0.34168 | 256.5 | 01Jan2000, 13:05 | 0.99 |
| J-Y | 0.08344 | 82.6 | 01Jan2000, 12:55 | 0.99 |
| X to Box | 0.02243 | 27.5 | 01Jan2000, 12:50 | 0.99 |
| X1 | 0.02243 | 28.2 | 01Jan2000, 12:45 | 0.99 |
| X2 | 0.03258 | 42.3 | 01Jan2000, 12:45 | 0.99 |
| Y1 | 0.06908 | 72.2 | 01Jan2000, 12:55 | 0.99 |
| Y1 to Y2 | 0.06908 | 71.6 | 01Jan2000, 12:55 | 0.99 |
| Y2 | 0.01436 | 19.4 | 01Jan2000, 12:45 | 0.99 |

Project: The Lakes Master Simulation Run: N Pre 100 24hr

Start of Run: 01Jan2000, 12:00 Basin Model: Pre
End of Run: 03Jan2000, 00:30 Meteorologic Model: 100-24hr
Compute Time: 30Aug2016, 13:54:31 Control Specifications: 24-Hour

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 251.4 | 02Jan2000, 00:00 | 1.80 |
| A1 | 0.14214 | 107.9 | 02Jan2000, 00:00 | 1.79 |
| A1 to A2 | 0.14214 | 97.7 | 02Jan2000, 00:00 | 1.80 |
| A2 | 0.07671 | 58.2 | 02Jan2000, 00:00 | 1.79 |
| A3 | 0.05837 | 44.3 | 02Jan2000, 00:00 | 1.79 |
| Box Canyon | 0.58871 | 396.1 | 02Jan2000, 00:00 | 1.73 |
| B to B3 | 0.07701 | 52.9 | 02Jan2000, 00:00 | 1.80 |
| B1 | 0.01710 | 13.0 | 02Jan2000, 00:00 | 1.79 |
| B1 to B2 | 0.01710 | 12.0 | 02Jan2000, 00:00 | 1.80 |
| B2 | 0.05991 | 45.5 | 02Jan2000, 00:00 | 1.79 |
| B3 | 0.07709 | 44.8 | 02Jan2000, 00:00 | 1.39 |
| B4 | 0.01894 | 10.3 | 02Jan2000, 00:00 | 1.39 |
| Culvert A | 0.21885 | 155.7 | 02Jan2000, 00:00 | 1.80 |
| Culvert B | 0.17304 | 104.0 | 02Jan2000, 00:00 | 1.58 |
| Culvert Y | 0.08344 | 59.2 | 02Jan2000, 00:00 | 1.80 |
| C to D | 0.30002 | 124.8 | 02Jan2000, 00:30 | 1.51 |
| C to E3 | 1.04382 | 637.6 | 02Jan2000, 00:00 | 1.71 |
| C1 | 0.01670 | 12.7 | 02Jan2000, 00:00 | 1.79 |
| C1 to C2 | 0.01670 | 11.8 | 02Jan2000, 00:00 | 1.80 |
| C2 | 0.06274 | 47.6 | 02Jan2000, 00:00 | 1.79 |
| C2 to C3 | 0.07944 | 44.4 | 02Jan2000, 00:00 | 1.80 |
| C3 | 0.16979 | 68.0 | 02Jan2000, 00:30 | 1.39 |
| C4 | 0.01564 | 9.1 | 02Jan2000, 00:00 | 1.39 |
| C4 to C5 | 0.01564 | 7.2 | 02Jan2000, 00:00 | 1.40 |
| C5 | 0.03515 | 20.4 | 02Jan2000, 00:00 | 1.39 |
| C5 to C3 | 0.05079 | 26.2 | 02Jan2000, 00:00 | 1.40 |
| D1 | 0.59389 | 451.0 | 02Jan2000, 00:00 | 1.79 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 to D2 | 0.59389 | 428.0 | 02Jan2000, 00:00 | 1.80 |
| D2 | 0.14991 | 113.8 | 02Jan2000, 00:00 | 1.79 |
| D2 to C3 | 0.74380 | 539.6 | 02Jan2000, 00:00 | 1.79 |
| E1 | 1.32193 | 466.2 | 02Jan2000, 01:00 | 1.79 |
| E1 to E2 | 1.32193 | 462.8 | 02Jan2000, 01:00 | 1.79 |
| E2 | 0.03210 | 24.4 | 02Jan2000, 00:00 | 1.79 |
| E2 to E3 | 1.35403 | 455.8 | 02Jan2000, 01:00 | 1.79 |
| E3 | 0.11796 | 60.9 | 02Jan2000, 00:00 | 1.39 |
| E3 to E4 | 3.02244 | 1088.8 | 02Jan2000, 00:00 | 1.75 |
| E4 | 0.07629 | 23.8 | 02Jan2000, 00:00 | 0.84 |
| F to E3 | 0.14378 | 91.3 | 02Jan2000, 00:00 | 1.80 |
| F1 | 0.06707 | 50.9 | 02Jan2000, 00:00 | 1.79 |
| F1 to F2 | 0.06707 | 47.8 | 02Jan2000, 00:00 | 1.80 |
| F2 | 0.07671 | 58.2 | 02Jan2000, 00:00 | 1.79 |
| Gap Wash | 3.02244 | 1182.9 | 02Jan2000, 00:00 | 1.75 |
| G to E3 | 0.34168 | 220.4 | 02Jan2000, 00:00 | 1.79 |
| G1 | 0.28835 | 192.0 | 02Jan2000, 00:00 | 1.79 |
| G1 to G2 | 0.28835 | 188.3 | 02Jan2000, 00:00 | 1.79 |
| G2 | 0.05333 | 40.5 | 02Jan2000, 00:00 | 1.79 |
| H1 | 0.02117 | 16.1 | 02Jan2000, 00:00 | 1.79 |
| J-A | 0.21885 | 155.9 | 02Jan2000, 00:00 | 1.80 |
| J-AY | 0.36066 | 259.2 | 02Jan2000, 00:00 | 1.80 |
| J-B | 0.07701 | 57.5 | 02Jan2000, 00:00 | 1.79 |
| J-B3 | 0.17304 | 108.1 | 02Jan2000, 00:00 | 1.57 |
| J-CD | 1.04382 | 649.6 | 02Jan2000, 00:00 | 1.71 |
| J-C2 | 0.07944 | 59.5 | 02Jan2000, 00:00 | 1.79 |
| J-C3 | 0.30002 | 125.6 | 02Jan2000, 00:00 | 1.50 |
| J-C5 | 0.05079 | 27.7 | 02Jan2000, 00:00 | 1.39 |
| J-D2 | 0.74380 | 541.8 | 02Jan2000, 00:00 | 1.79 |
| J-E2 | 1.35403 | 467.8 | 02Jan2000, 01:00 | 1.79 |
| J-E4 | 3.09873 | 1112.6 | 02Jan2000, 00:00 | 1.73 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 106.0 | 02Jan2000, 00:00 | 1.79 |
| J-G2 | 0.34168 | 228.8 | 02Jan2000, 00:00 | 1.79 |
| J-Y | 0.08344 | 61.5 | 02Jan2000, 00:00 | 1.79 |
| X to Box | 0.02243 | 16.0 | 02Jan2000, 00:00 | 1.79 |
| X1 | 0.02243 | 17.0 | 02Jan2000, 00:00 | 1.79 |
| X2 | 0.03258 | 24.7 | 02Jan2000, 00:00 | 1.79 |
| Y1 | 0.06908 | 52.5 | 02Jan2000, 00:00 | 1.79 |
| Y1 to Y2 | 0.06908 | 50.6 | 02Jan2000, 00:00 | 1.79 |
| Y2 | 0.01436 | 10.9 | 02Jan2000, 00:00 | 1.79 |

Project: The Lakes Master Simulation Run: Post 10-3

Start of Run: 01Jan2000, 12:00 Basin Model: Post
End of Run: 01Jan2000, 20:00 Meteorologic Model: 10-3
Compute Time: 30Aug2016, 13:54:54 Control Specifications: 10-3

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 132.3 | 01Jan2000, 13:00 | 0.40 |
| A1 | 0.14214 | 59.6 | 01Jan2000, 12:55 | 0.45 |
| A1 to A2 | 0.14214 | 59.4 | 01Jan2000, 13:00 | 0.45 |
| A2 | 0.07671 | 22.3 | 01Jan2000, 13:00 | 0.32 |
| A3 | 0.05837 | 21.3 | 01Jan2000, 12:55 | 0.36 |
| Box Canyon | 0.58871 | 199.4 | 01Jan2000, 13:00 | 0.37 |
| B to B3 | 0.07701 | 35.9 | 01Jan2000, 12:50 | 0.41 |
| B1 | 0.01710 | 10.5 | 01Jan2000, 12:45 | 0.45 |
| B1 to B2 | 0.01710 | 9.9 | 01Jan2000, 12:50 | 0.45 |
| B2 | 0.05991 | 28.5 | 01Jan2000, 12:50 | 0.40 |
| B3 | 0.07709 | 18.0 | 01Jan2000, 12:55 | 0.25 |
| B4 | 0.01894 | 3.1 | 01Jan2000, 13:05 | 0.22 |
| Culvert A | 0.21885 | 81.6 | 01Jan2000, 13:00 | 0.40 |
| Culvert B | 0.17304 | 54.4 | 01Jan2000, 12:55 | 0.32 |
| Culvert Y | 0.08344 | 33.9 | 01Jan2000, 12:55 | 0.42 |
| C to D | 0.30002 | 76.2 | 01Jan2000, 13:10 | 0.37 |
| C to E3 | 1.04382 | 346.1 | 01Jan2000, 13:05 | 0.42 |
| C1 | 0.01670 | 10.0 | 01Jan2000, 12:45 | 0.45 |
| C1 to C2 | 0.01670 | 9.5 | 01Jan2000, 12:50 | 0.45 |
| C2 | 0.06274 | 39.0 | 01Jan2000, 12:45 | 0.50 |
| C2 to C3 | 0.07944 | 48.0 | 01Jan2000, 12:55 | 0.49 |
| C3 | 0.16979 | 39.4 | 01Jan2000, 13:15 | 0.36 |
| C4 | 0.01564 | 2.8 | 01Jan2000, 13:05 | 0.22 |
| C4 to C5 | 0.01564 | 2.8 | 01Jan2000, 13:10 | 0.22 |
| C5 | 0.03515 | 6.2 | 01Jan2000, 13:05 | 0.22 |
| C5 to C3 | 0.05079 | 8.6 | 01Jan2000, 13:10 | 0.22 |
| D to E3 | 0.74380 | 280.4 | 01Jan2000, 13:00 | 0.43 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 | 0.59389 | 238.8 | 01Jan2000, 13:00 | 0.45 |
| D1 to D2 | 0.59389 | 231.9 | 01Jan2000, 13:00 | 0.45 |
| D2 | 0.14991 | 52.7 | 01Jan2000, 12:55 | 0.36 |
| E1 | 1.32193 | 204.8 | 01Jan2000, 14:00 | 0.45 |
| E1 to E2 | 1.32193 | 204.2 | 01Jan2000, 14:00 | 0.45 |
| E2 | 0.03210 | 14.7 | 01Jan2000, 12:50 | 0.40 |
| E2 to E3 | 1.35403 | 204.7 | 01Jan2000, 14:05 | 0.45 |
| E3 | 0.11796 | 19.2 | 01Jan2000, 13:10 | 0.22 |
| E3 to E4 | 3.02244 | 551.9 | 01Jan2000, 13:10 | 0.42 |
| E4 | 0.07629 | 8.7 | 01Jan2000, 13:05 | 0.15 |
| F to E3 | 0.14378 | 55.0 | 01Jan2000, 13:00 | 0.38 |
| F1 | 0.06707 | 31.3 | 01Jan2000, 12:55 | 0.45 |
| F1 to F2 | 0.06707 | 30.0 | 01Jan2000, 12:55 | 0.45 |
| F2 | 0.07671 | 27.8 | 01Jan2000, 12:50 | 0.32 |
| Gap Wash | 3.09873 | 560.5 | 01Jan2000, 13:10 | 0.41 |
| G to E3 | 0.34168 | 107.2 | 01Jan2000, 13:05 | 0.42 |
| G1 | 0.28835 | 102.5 | 01Jan2000, 13:05 | 0.45 |
| G1 to G2 | 0.28835 | 101.5 | 01Jan2000, 13:05 | 0.45 |
| G2 | 0.05333 | 14.2 | 01Jan2000, 12:50 | 0.22 |
| H1 | 0.02117 | 10.0 | 01Jan2000, 12:55 | 0.45 |
| J-A | 0.21885 | 81.7 | 01Jan2000, 13:00 | 0.40 |
| J-AY | 0.36066 | 133.7 | 01Jan2000, 13:00 | 0.40 |
| J-B | 0.07701 | 38.4 | 01Jan2000, 12:50 | 0.41 |
| J-B3 | 0.17304 | 55.9 | 01Jan2000, 12:55 | 0.32 |
| J-CD | 1.04382 | 346.3 | 01Jan2000, 13:05 | 0.42 |
| J-C2 | 0.07944 | 48.1 | 01Jan2000, 12:50 | 0.49 |
| J-C3 | 0.30002 | 77.0 | 01Jan2000, 13:00 | 0.37 |
| J-C5 | 0.05079 | 8.6 | 01Jan2000, 13:10 | 0.22 |
| J-D2 | 0.74380 | 281.4 | 01Jan2000, 13:00 | 0.43 |
| J-E2 | 1.35403 | 205.1 | 01Jan2000, 14:00 | 0.45 |
| J-E3 | 3.02244 | 561.0 | 01Jan2000, 13:05 | 0.42 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 55.5 | 01Jan2000, 12:55 | 0.38 |
| J-G2 | 0.34168 | 109.4 | 01Jan2000, 13:05 | 0.42 |
| J-Y | 0.08344 | 35.1 | 01Jan2000, 12:55 | 0.42 |
| X to Box | 0.02243 | 12.0 | 01Jan2000, 12:50 | 0.45 |
| X1 | 0.02243 | 12.3 | 01Jan2000, 12:50 | 0.45 |
| X2 | 0.03258 | 10.5 | 01Jan2000, 12:50 | 0.28 |
| Y1 | 0.06908 | 31.9 | 01Jan2000, 12:55 | 0.45 |
| Y1 to Y2 | 0.06908 | 31.1 | 01Jan2000, 12:55 | 0.45 |
| Y2 | 0.01436 | 5.0 | 01Jan2000, 12:50 | 0.28 |

Project: The Lakes Master Simulation Run: Post 10-24

Start of Run: 01Jan2000, 12:00 Basin Model: Post
End of Run: 02Jan2000, 12:00 Meteorologic Model: 10-24hr
Compute Time: 30Aug2016, 13:54:45 Control Specifications: 24hr

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 129.3 | 02Jan2000, 00:00 | 0.95 |
| A1 | 0.14214 | 61.6 | 02Jan2000, 00:00 | 1.02 |
| A1 to A2 | 0.14214 | 54.7 | 02Jan2000, 00:00 | 1.02 |
| A2 | 0.07671 | 26.1 | 02Jan2000, 00:00 | 0.82 |
| A3 | 0.05837 | 21.6 | 02Jan2000, 00:00 | 0.88 |
| Box Canyon | 0.58871 | 200.2 | 02Jan2000, 00:00 | 0.90 |
| B to B3 | 0.07701 | 27.8 | 02Jan2000, 00:00 | 0.97 |
| B1 | 0.01710 | 7.4 | 02Jan2000, 00:00 | 1.02 |
| B1 to B2 | 0.01710 | 6.7 | 02Jan2000, 00:00 | 1.02 |
| B2 | 0.05991 | 24.0 | 02Jan2000, 00:00 | 0.95 |
| B3 | 0.07709 | 22.0 | 02Jan2000, 00:00 | 0.71 |
| B4 | 0.01894 | 4.5 | 02Jan2000, 00:00 | 0.65 |
| Culvert A | 0.21885 | 80.7 | 02Jan2000, 00:00 | 0.95 |
| Culvert B | 0.17304 | 51.8 | 02Jan2000, 00:00 | 0.82 |
| Culvert Y | 0.08344 | 31.9 | 02Jan2000, 00:00 | 0.98 |
| C to D | 0.30002 | 75.9 | 02Jan2000, 00:30 | 0.90 |
| C to E3 | 1.04382 | 350.7 | 02Jan2000, 00:00 | 0.96 |
| C1 | 0.01670 | 7.2 | 02Jan2000, 00:00 | 1.02 |
| C1 to C2 | 0.01670 | 6.7 | 02Jan2000, 00:00 | 1.02 |
| C2 | 0.06274 | 29.3 | 02Jan2000, 00:00 | 1.09 |
| C2 to C3 | 0.07944 | 25.4 | 02Jan2000, 00:00 | 1.08 |
| C3 | 0.16979 | 42.8 | 02Jan2000, 00:30 | 0.88 |
| C4 | 0.01564 | 4.1 | 02Jan2000, 00:00 | 0.66 |
| C4 to C5 | 0.01564 | 3.0 | 02Jan2000, 00:00 | 0.66 |
| C5 | 0.03515 | 9.0 | 02Jan2000, 00:00 | 0.66 |
| C5 to C3 | 0.05079 | 11.2 | 02Jan2000, 00:00 | 0.66 |
| D to E3 | 0.74380 | 295.9 | 02Jan2000, 00:00 | 0.99 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 | 0.59389 | 257.3 | 02Jan2000, 00:00 | 1.02 |
| D1 to D2 | 0.59389 | 241.9 | 02Jan2000, 00:00 | 1.02 |
| D2 | 0.14991 | 55.4 | 02Jan2000, 00:00 | 0.88 |
| E1 | 1.32193 | 266.6 | 02Jan2000, 01:00 | 1.00 |
| E1 to E2 | 1.32193 | 264.1 | 02Jan2000, 01:00 | 1.00 |
| E2 | 0.03210 | 12.9 | 02Jan2000, 00:00 | 0.95 |
| E2 to E3 | 1.35403 | 258.3 | 02Jan2000, 01:00 | 1.00 |
| E3 | 0.11796 | 27.0 | 02Jan2000, 00:00 | 0.65 |
| E3 to E4 | 3.02244 | 590.6 | 02Jan2000, 00:30 | 0.97 |
| E4 | 0.07629 | 14.5 | 02Jan2000, 00:00 | 0.52 |
| F to E3 | 0.14378 | 44.0 | 02Jan2000, 00:00 | 0.92 |
| F1 | 0.06707 | 29.1 | 02Jan2000, 00:00 | 1.02 |
| F1 to F2 | 0.06707 | 26.9 | 02Jan2000, 00:00 | 1.02 |
| F2 | 0.07671 | 26.1 | 02Jan2000, 00:00 | 0.82 |
| Gap Wash | 3.09873 | 599.6 | 02Jan2000, 00:30 | 0.95 |
| G to E3 | 0.34168 | 115.3 | 02Jan2000, 00:00 | 0.96 |
| G1 | 0.28835 | 109.3 | 02Jan2000, 00:00 | 1.01 |
| G1 to G2 | 0.28835 | 106.8 | 02Jan2000, 00:00 | 1.02 |
| G2 | 0.05333 | 13.8 | 02Jan2000, 00:00 | 0.66 |
| H1 | 0.02117 | 9.2 | 02Jan2000, 00:00 | 1.02 |
| J-A | 0.21885 | 80.8 | 02Jan2000, 00:00 | 0.95 |
| J-AY | 0.36066 | 134.2 | 02Jan2000, 00:00 | 0.94 |
| J-B | 0.07701 | 30.7 | 02Jan2000, 00:00 | 0.96 |
| J-B3 | 0.17304 | 54.3 | 02Jan2000, 00:00 | 0.82 |
| J-CD | 1.04382 | 358.5 | 02Jan2000, 00:00 | 0.96 |
| J-C2 | 0.07944 | 36.0 | 02Jan2000, 00:00 | 1.08 |
| J-C3 | 0.30002 | 76.1 | 02Jan2000, 00:00 | 0.89 |
| J-C5 | 0.05079 | 12.0 | 02Jan2000, 00:00 | 0.66 |
| J-D2 | 0.74380 | 297.4 | 02Jan2000, 00:00 | 0.99 |
| J-E2 | 1.35403 | 267.0 | 02Jan2000, 01:00 | 1.00 |
| J-E3 | 3.02244 | 625.5 | 02Jan2000, 00:00 | 0.96 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 53.0 | 02Jan2000, 00:00 | 0.91 |
| J-G2 | 0.34168 | 120.6 | 02Jan2000, 00:00 | 0.96 |
| J-Y | 0.08344 | 33.4 | 02Jan2000, 00:00 | 0.97 |
| X to Box | 0.02243 | 9.0 | 02Jan2000, 00:00 | 1.02 |
| X1 | 0.02243 | 9.7 | 02Jan2000, 00:00 | 1.02 |
| X2 | 0.03258 | 10.2 | 02Jan2000, 00:00 | 0.76 |
| Y1 | 0.06908 | 29.9 | 02Jan2000, 00:00 | 1.02 |
| Y1 to Y2 | 0.06908 | 28.9 | 02Jan2000, 00:00 | 1.02 |
| Y2 | 0.01436 | 4.5 | 02Jan2000, 00:00 | 0.76 |

Project: The Lakes Master Simulation Run: Post 100-3

Start of Run: 01Jan2000, 12:00 Basin Model: Post
End of Run: 01Jan2000, 18:30 Meteorologic Model: 100-3
Compute Time: 30Aug2016, 13:55:09 Control Specifications: 100-3

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 311.8 | 01Jan2000, 13:00 | 0.92 |
| A1 | 0.14214 | 139.2 | 01Jan2000, 12:55 | 0.99 |
| A1 to A2 | 0.14214 | 135.5 | 01Jan2000, 13:00 | 0.99 |
| A2 | 0.07671 | 60.1 | 01Jan2000, 12:55 | 0.79 |
| A3 | 0.05837 | 52.7 | 01Jan2000, 12:55 | 0.86 |
| Box Canyon | 0.58871 | 498.1 | 01Jan2000, 12:55 | 0.87 |
| B to B3 | 0.07701 | 88.1 | 01Jan2000, 12:50 | 0.93 |
| B1 | 0.01710 | 23.5 | 01Jan2000, 12:40 | 0.99 |
| B1 to B2 | 0.01710 | 23.4 | 01Jan2000, 12:45 | 0.99 |
| B2 | 0.05991 | 67.0 | 01Jan2000, 12:50 | 0.92 |
| B3 | 0.07709 | 53.8 | 01Jan2000, 12:55 | 0.68 |
| B4 | 0.01894 | 9.6 | 01Jan2000, 13:05 | 0.63 |
| Culvert A | 0.21885 | 191.9 | 01Jan2000, 13:00 | 0.92 |
| Culvert B | 0.17304 | 139.9 | 01Jan2000, 12:55 | 0.79 |
| Culvert Y | 0.08344 | 80.7 | 01Jan2000, 12:55 | 0.95 |
| C to D | 0.30002 | 182.0 | 01Jan2000, 13:05 | 0.87 |
| C to E3 | 1.04382 | 820.9 | 01Jan2000, 13:00 | 0.94 |
| C1 | 0.01670 | 22.7 | 01Jan2000, 12:45 | 0.99 |
| C1 to C2 | 0.01670 | 22.1 | 01Jan2000, 12:45 | 0.99 |
| C2 | 0.06274 | 88.4 | 01Jan2000, 12:45 | 1.06 |
| C2 to C3 | 0.07944 | 104.5 | 01Jan2000, 12:55 | 1.04 |
| C3 | 0.16979 | 97.0 | 01Jan2000, 13:15 | 0.86 |
| C4 | 0.01564 | 8.7 | 01Jan2000, 13:00 | 0.63 |
| C4 to C5 | 0.01564 | 8.4 | 01Jan2000, 13:05 | 0.63 |
| C5 | 0.03515 | 19.1 | 01Jan2000, 13:00 | 0.63 |
| C5 to C3 | 0.05079 | 26.6 | 01Jan2000, 13:05 | 0.63 |
| D to E3 | 0.74380 | 654.3 | 01Jan2000, 13:00 | 0.96 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 | 0.59389 | 540.9 | 01Jan2000, 13:00 | 0.99 |
| D1 to D2 | 0.59389 | 537.5 | 01Jan2000, 13:00 | 0.99 |
| D2 | 0.14991 | 132.9 | 01Jan2000, 12:55 | 0.86 |
| E1 | 1.32193 | 456.4 | 01Jan2000, 14:00 | 0.99 |
| E1 to E2 | 1.32193 | 456.3 | 01Jan2000, 14:00 | 0.99 |
| E2 | 0.03210 | 35.4 | 01Jan2000, 12:50 | 0.92 |
| E2 to E3 | 1.35403 | 456.7 | 01Jan2000, 14:05 | 0.99 |
| E3 | 0.11796 | 58.6 | 01Jan2000, 13:05 | 0.63 |
| E3 to E4 | 3.02244 | 1317.2 | 01Jan2000, 13:05 | 0.94 |
| E4 | 0.07629 | 31.7 | 01Jan2000, 13:00 | 0.50 |
| F to E3 | 0.14378 | 134.7 | 01Jan2000, 12:55 | 0.89 |
| F1 | 0.06707 | 70.4 | 01Jan2000, 12:55 | 0.99 |
| F1 to F2 | 0.06707 | 69.9 | 01Jan2000, 12:55 | 0.99 |
| F2 | 0.07671 | 73.2 | 01Jan2000, 12:50 | 0.79 |
| Gap Wash | 3.09873 | 1348.4 | 01Jan2000, 13:05 | 0.93 |
| G to E3 | 0.34168 | 249.4 | 01Jan2000, 13:05 | 0.94 |
| G1 | 0.28835 | 232.1 | 01Jan2000, 13:05 | 0.99 |
| G1 to G2 | 0.28835 | 231.6 | 01Jan2000, 13:05 | 0.99 |
| G2 | 0.05333 | 41.6 | 01Jan2000, 12:50 | 0.63 |
| H1 | 0.02117 | 22.7 | 01Jan2000, 12:50 | 0.99 |
| J-A | 0.21885 | 191.9 | 01Jan2000, 13:00 | 0.92 |
| J-AY | 0.36066 | 321.4 | 01Jan2000, 12:55 | 0.92 |
| J-B | 0.07701 | 88.1 | 01Jan2000, 12:45 | 0.94 |
| J-B3 | 0.17304 | 140.3 | 01Jan2000, 12:50 | 0.79 |
| J-CD | 1.04382 | 828.6 | 01Jan2000, 13:00 | 0.94 |
| J-C2 | 0.07944 | 110.5 | 01Jan2000, 12:45 | 1.05 |
| J-C3 | 0.30002 | 182.6 | 01Jan2000, 13:00 | 0.87 |
| J-C5 | 0.05079 | 26.8 | 01Jan2000, 13:05 | 0.63 |
| J-D2 | 0.74380 | 655.1 | 01Jan2000, 13:00 | 0.96 |
| J-E2 | 1.35403 | 457.8 | 01Jan2000, 14:00 | 0.99 |
| J-E3 | 3.02244 | 1331.5 | 01Jan2000, 13:00 | 0.95 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 135.0 | 01Jan2000, 12:50 | 0.89 |
| J-G2 | 0.34168 | 250.6 | 01Jan2000, 13:05 | 0.93 |
| J-Y | 0.08344 | 81.3 | 01Jan2000, 12:55 | 0.95 |
| X to Box | 0.02243 | 27.5 | 01Jan2000, 12:50 | 0.99 |
| X1 | 0.02243 | 28.2 | 01Jan2000, 12:45 | 0.99 |
| X2 | 0.03258 | 29.0 | 01Jan2000, 12:50 | 0.74 |
| Y1 | 0.06908 | 72.2 | 01Jan2000, 12:55 | 0.99 |
| Y1 to Y2 | 0.06908 | 71.7 | 01Jan2000, 12:55 | 0.99 |
| Y2 | 0.01436 | 13.3 | 01Jan2000, 12:45 | 0.74 |

Project: The Lakes Master Simulation Run: Post 100-24

Start of Run: 01Jan2000, 12:00 Basin Model: Post
End of Run: 03Jan2000, 00:30 Meteorologic Model: 100-24hr
Compute Time: 30Aug2016, 13:55:01 Control Specifications: 24-Hour

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| A to Box | 0.36066 | 237.5 | 02Jan2000, 00:00 | 1.70 |
| A1 | 0.14214 | 107.9 | 02Jan2000, 00:00 | 1.79 |
| A1 to A2 | 0.14214 | 97.7 | 02Jan2000, 00:00 | 1.80 |
| A2 | 0.07671 | 50.0 | 02Jan2000, 00:00 | 1.54 |
| A3 | 0.05837 | 40.1 | 02Jan2000, 00:00 | 1.62 |
| Box Canyon | 0.58871 | 374.8 | 02Jan2000, 00:00 | 1.65 |
| B to B3 | 0.07701 | 50.9 | 02Jan2000, 00:00 | 1.73 |
| B1 | 0.01710 | 13.0 | 02Jan2000, 00:00 | 1.79 |
| B1 to B2 | 0.01710 | 12.0 | 02Jan2000, 00:00 | 1.80 |
| B2 | 0.05991 | 43.3 | 02Jan2000, 00:00 | 1.70 |
| B3 | 0.07709 | 44.8 | 02Jan2000, 00:00 | 1.39 |
| B4 | 0.01894 | 9.5 | 02Jan2000, 00:00 | 1.32 |
| Culvert A | 0.21885 | 147.5 | 02Jan2000, 00:00 | 1.71 |
| Culvert B | 0.17304 | 101.2 | 02Jan2000, 00:00 | 1.54 |
| Culvert Y | 0.08344 | 57.5 | 02Jan2000, 00:00 | 1.74 |
| C to D | 0.30002 | 136.8 | 02Jan2000, 00:30 | 1.65 |
| C to E3 | 1.04382 | 640.6 | 02Jan2000, 00:00 | 1.73 |
| C1 | 0.01670 | 12.7 | 02Jan2000, 00:00 | 1.79 |
| C1 to C2 | 0.01670 | 11.8 | 02Jan2000, 00:00 | 1.80 |
| C2 | 0.06274 | 49.9 | 02Jan2000, 00:00 | 1.88 |
| C2 to C3 | 0.07944 | 46.4 | 02Jan2000, 00:00 | 1.88 |
| C3 | 0.16979 | 78.0 | 02Jan2000, 00:30 | 1.62 |
| C4 | 0.01564 | 8.6 | 02Jan2000, 00:00 | 1.32 |
| C4 to C5 | 0.01564 | 6.8 | 02Jan2000, 00:00 | 1.33 |
| C5 | 0.03515 | 19.0 | 02Jan2000, 00:00 | 1.32 |
| C5 to C3 | 0.05079 | 24.4 | 02Jan2000, 00:00 | 1.33 |
| D to E3 | 0.74380 | 528.7 | 02Jan2000, 00:00 | 1.76 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| D1 | 0.59389 | 451.0 | 02Jan2000, 00:00 | 1.79 |
| D1 to D2 | 0.59389 | 428.0 | 02Jan2000, 00:00 | 1.80 |
| D2 | 0.14991 | 103.0 | 02Jan2000, 00:00 | 1.62 |
| E1 | 1.32193 | 466.2 | 02Jan2000, 01:00 | 1.79 |
| E1 to E2 | 1.32193 | 462.8 | 02Jan2000, 01:00 | 1.79 |
| E2 | 0.03210 | 23.2 | 02Jan2000, 00:00 | 1.70 |
| E2 to E3 | 1.35403 | 455.6 | 02Jan2000, 01:00 | 1.79 |
| E3 | 0.11796 | 57.3 | 02Jan2000, 00:00 | 1.32 |
| E3 to E4 | 3.02244 | 1069.7 | 02Jan2000, 00:00 | 1.74 |
| E4 | 0.07629 | 34.5 | 02Jan2000, 00:00 | 1.12 |
| F to E3 | 0.14378 | 83.8 | 02Jan2000, 00:00 | 1.67 |
| F1 | 0.06707 | 50.9 | 02Jan2000, 00:00 | 1.79 |
| F1 to F2 | 0.06707 | 47.8 | 02Jan2000, 00:00 | 1.80 |
| F2 | 0.07671 | 50.0 | 02Jan2000, 00:00 | 1.54 |
| Gap Wash | 3.09873 | 1104.2 | 02Jan2000, 00:00 | 1.73 |
| G to E3 | 0.34168 | 209.4 | 02Jan2000, 00:00 | 1.72 |
| G1 | 0.28835 | 192.0 | 02Jan2000, 00:00 | 1.79 |
| G1 to G2 | 0.28835 | 188.3 | 02Jan2000, 00:00 | 1.79 |
| G2 | 0.05333 | 29.2 | 02Jan2000, 00:00 | 1.32 |
| H1 | 0.02117 | 16.1 | 02Jan2000, 00:00 | 1.79 |
| J-A | 0.21885 | 147.6 | 02Jan2000, 00:00 | 1.71 |
| J-AY | 0.36066 | 245.0 | 02Jan2000, 00:00 | 1.70 |
| J-B | 0.07701 | 55.3 | 02Jan2000, 00:00 | 1.72 |
| J-B3 | 0.17304 | 105.2 | 02Jan2000, 00:00 | 1.53 |
| J-CD | 1.04382 | 652.6 | 02Jan2000, 00:00 | 1.73 |
| J-C2 | 0.07944 | 61.8 | 02Jan2000, 00:00 | 1.86 |
| J-C3 | 0.30002 | 145.1 | 02Jan2000, 00:00 | 1.64 |
| J-C5 | 0.05079 | 25.8 | 02Jan2000, 00:00 | 1.32 |
| J-D2 | 0.74380 | 530.9 | 02Jan2000, 00:00 | 1.76 |
| J-E2 | 1.35403 | 467.6 | 02Jan2000, 01:00 | 1.79 |
| J-E3 | 3.02244 | 1162.8 | 02Jan2000, 00:00 | 1.74 |

| Hydrologic Element | Drainage Area (MI2) | Peak Discharge (CFS) | Time of Peak | Volume (IN) |
|---|---|---|---|---|
| J-F2 | 0.14378 | 97.7 | 02Jan2000, 00:00 | 1.66 |
| J-G2 | 0.34168 | 217.5 | 02Jan2000, 00:00 | 1.72 |
| J-Y | 0.08344 | 59.8 | 02Jan2000, 00:00 | 1.74 |
| X to Box | 0.02243 | 16.0 | 02Jan2000, 00:00 | 1.79 |
| X1 | 0.02243 | 17.0 | 02Jan2000, 00:00 | 1.79 |
| X2 | 0.03258 | 20.1 | 02Jan2000, 00:00 | 1.46 |
| Y1 | 0.06908 | 52.5 | 02Jan2000, 00:00 | 1.79 |
| Y1 to Y2 | 0.06908 | 51.0 | 02Jan2000, 00:00 | 1.79 |
| Y2 | 0.01436 | 8.8 | 02Jan2000, 00:00 | 1.46 |

# Worksheet for Culvert 1

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 36 | in |
| Discharge | 80.70 | $ft^3/s$ |

## Results

| | | |
|---|---|---|
| Normal Depth | 2.29 | ft |
| Flow Area | 5.79 | $ft^2$ |
| Wetted Perimeter | 6.38 | ft |
| Hydraulic Radius | 0.91 | ft |
| Top Width | 2.55 | ft |
| Critical Depth | 2.78 | ft |
| Percent Full | 76.4 | % |
| Critical Slope | 0.00750 | ft/ft |
| Velocity | 13.93 | ft/s |
| Velocity Head | 3.02 | ft |
| Specific Energy | 5.31 | ft |
| Froude Number | 1.63 | |
| Maximum Discharge | 93.27 | $ft^3/s$ |
| Discharge Full | 86.70 | $ft^3/s$ |
| Slope Full | 0.00866 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 76.36 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 1

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 2.29 | ft |
| Critical Depth | 2.78 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00750 | ft/ft |

# Worksheet for Culvert 2

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 48 | in |
| Discharge | 191.90 | ft³/s |

## Results

| | | |
|---|---|---|
| Normal Depth | 3.39 | ft |
| Flow Area | 11.35 | ft² |
| Wetted Perimeter | 9.35 | ft |
| Hydraulic Radius | 1.21 | ft |
| Top Width | 2.88 | ft |
| Critical Depth | 3.82 | ft |
| Percent Full | 84.7 | % |
| Critical Slope | 0.00917 | ft/ft |
| Velocity | 16.91 | ft/s |
| Velocity Head | 4.44 | ft |
| Specific Energy | 7.83 | ft |
| Froude Number | 1.50 | |
| Maximum Discharge | 200.86 | ft³/s |
| Discharge Full | 186.73 | ft³/s |
| Slope Full | 0.01056 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 84.70 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 2

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 3.39 | ft |
| Critical Depth | 3.82 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00917 | ft/ft |

# Worksheet for Culvert 3

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 36 | in |
| Discharge | 88.10 | $ft^3/s$ |

## Results

| | | |
|---|---|---|
| Normal Depth | 2.50 | ft |
| Flow Area | 6.31 | $ft^2$ |
| Wetted Perimeter | 6.91 | ft |
| Hydraulic Radius | 0.91 | ft |
| Top Width | 2.23 | ft |
| Critical Depth | 2.83 | ft |
| Percent Full | 83.5 | % |
| Critical Slope | 0.00893 | ft/ft |
| Velocity | 13.97 | ft/s |
| Velocity Head | 3.03 | ft |
| Specific Energy | 5.54 | ft |
| Froude Number | 1.46 | |
| Maximum Discharge | 93.27 | $ft^3/s$ |
| Discharge Full | 86.70 | $ft^3/s$ |
| Slope Full | 0.01032 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 83.50 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 3

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 2.50 | ft |
| Critical Depth | 2.83 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00893 | ft/ft |

# Worksheet for Culvert 4

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 42 | in |
| Discharge | 139.90 | ft³/s |

## Results

| | | |
|---|---|---|
| Normal Depth | 3.18 | ft |
| Flow Area | 9.18 | ft² |
| Wetted Perimeter | 8.85 | ft |
| Hydraulic Radius | 1.04 | ft |
| Top Width | 2.01 | ft |
| Critical Depth | 3.35 | ft |
| Percent Full | 90.9 | % |
| Critical Slope | 0.00995 | ft/ft |
| Velocity | 15.23 | ft/s |
| Velocity Head | 3.61 | ft |
| Specific Energy | 6.79 | ft |
| Froude Number | 1.26 | |
| Maximum Discharge | 140.69 | ft³/s |
| Discharge Full | 130.79 | ft³/s |
| Slope Full | 0.01144 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 90.89 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 4

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 3.18 | ft |
| Critical Depth | 3.35 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00995 | ft/ft |

# Worksheet for Culvert 5

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 42 | in |
| Discharge | 104.50 | ft³/s |

## Results

| | | |
|---|---|---|
| Normal Depth | 2.37 | ft |
| Flow Area | 6.92 | ft² |
| Wetted Perimeter | 6.76 | ft |
| Hydraulic Radius | 1.02 | ft |
| Top Width | 3.28 | ft |
| Critical Depth | 3.12 | ft |
| Percent Full | 67.6 | % |
| Critical Slope | 0.00567 | ft/ft |
| Velocity | 15.10 | ft/s |
| Velocity Head | 3.54 | ft |
| Specific Energy | 5.91 | ft |
| Froude Number | 1.83 | |
| Maximum Discharge | 140.69 | ft³/s |
| Discharge Full | 130.79 | ft³/s |
| Slope Full | 0.00638 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 67.60 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 5

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 2.37 | ft |
| Critical Depth | 3.12 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00567 | ft/ft |

# Worksheet for Culvert 6

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 84 | in |
| Discharge | 654.30 | ft³/s |

## Results

| | | |
|---|---|---|
| Normal Depth | 4.68 | ft |
| Flow Area | 27.37 | ft² |
| Wetted Perimeter | 13.41 | ft |
| Hydraulic Radius | 2.04 | ft |
| Top Width | 6.59 | ft |
| Critical Depth | 6.43 | ft |
| Percent Full | 66.9 | % |
| Critical Slope | 0.00539 | ft/ft |
| Velocity | 23.91 | ft/s |
| Velocity Head | 8.88 | ft |
| Specific Energy | 13.57 | ft |
| Froude Number | 2.07 | |
| Maximum Discharge | 893.31 | ft³/s |
| Discharge Full | 830.44 | ft³/s |
| Slope Full | 0.00621 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 66.91 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 6

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 4.68 | ft |
| Critical Depth | 6.43 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00539 | ft/ft |

# Worksheet for Culvert 7

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 84 | in |
| Discharge | 810.00 | ft³/s |

## Results

| | | |
|---|---|---|
| Normal Depth | 5.59 | ft |
| Flow Area | 32.94 | ft² |
| Wetted Perimeter | 15.47 | ft |
| Hydraulic Radius | 2.13 | ft |
| Top Width | 5.62 | ft |
| Critical Depth | 6.73 | ft |
| Percent Full | 79.8 | % |
| Critical Slope | 0.00830 | ft/ft |
| Velocity | 24.59 | ft/s |
| Velocity Head | 9.40 | ft |
| Specific Energy | 14.99 | ft |
| Froude Number | 1.79 | |
| Maximum Discharge | 893.31 | ft³/s |
| Discharge Full | 830.44 | ft³/s |
| Slope Full | 0.00951 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 79.83 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 7

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 5.59 | ft |
| Critical Depth | 6.73 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00830 | ft/ft |

# Worksheet for Culvert 8

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 72 | in |
| Discharge | 456.70 | ft³/s |

## Results

| | | |
|---|---|---|
| Normal Depth | 4.17 | ft |
| Flow Area | 20.98 | ft² |
| Wetted Perimeter | 11.83 | ft |
| Hydraulic Radius | 1.77 | ft |
| Top Width | 5.52 | ft |
| Critical Depth | 5.55 | ft |
| Percent Full | 69.5 | % |
| Critical Slope | 0.00596 | ft/ft |
| Velocity | 21.77 | ft/s |
| Velocity Head | 7.37 | ft |
| Specific Energy | 11.54 | ft |
| Froude Number | 1.97 | |
| Maximum Discharge | 592.21 | ft³/s |
| Discharge Full | 550.53 | ft³/s |
| Slope Full | 0.00688 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 69.51 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 8

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 4.17 | ft |
| Critical Depth | 5.55 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00596 | ft/ft |

# Worksheet for Culvert 9

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 42 | in |
| Discharge | 134.70 | $ft^3/s$ |

## Results

| | | |
|---|---|---|
| Normal Depth | 2.97 | ft |
| Flow Area | 8.71 | $ft^2$ |
| Wetted Perimeter | 8.21 | ft |
| Hydraulic Radius | 1.06 | ft |
| Top Width | 2.50 | ft |
| Critical Depth | 3.33 | ft |
| Percent Full | 84.9 | % |
| Critical Slope | 0.00919 | ft/ft |
| Velocity | 15.46 | ft/s |
| Velocity Head | 3.72 | ft |
| Specific Energy | 6.69 | ft |
| Froude Number | 1.46 | |
| Maximum Discharge | 140.69 | $ft^3/s$ |
| Discharge Full | 130.79 | $ft^3/s$ |
| Slope Full | 0.01061 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 84.95 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 9

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 2.97 | ft |
| Critical Depth | 3.33 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00919 | ft/ft |

# Worksheet for Culvert 10

## Project Description

| | |
|---|---|
| Friction Method | Manning Formula |
| Solve For | Normal Depth |

## Input Data

| | | |
|---|---|---|
| Roughness Coefficient | 0.010 | |
| Channel Slope | 0.01000 | ft/ft |
| Diameter | 60 | in |
| Discharge | 249.40 | $ft^3/s$ |

## Results

| | | |
|---|---|---|
| Normal Depth | 3.19 | ft |
| Flow Area | 13.23 | $ft^2$ |
| Wetted Perimeter | 9.25 | ft |
| Hydraulic Radius | 1.43 | ft |
| Top Width | 4.81 | ft |
| Critical Depth | 4.42 | ft |
| Percent Full | 63.8 | % |
| Critical Slope | 0.00486 | ft/ft |
| Velocity | 18.85 | ft/s |
| Velocity Head | 5.52 | ft |
| Specific Energy | 8.72 | ft |
| Froude Number | 2.00 | |
| Maximum Discharge | 364.19 | $ft^3/s$ |
| Discharge Full | 338.56 | $ft^3/s$ |
| Slope Full | 0.00543 | ft/ft |
| Flow Type | SuperCritical | |

## GVF Input Data

| | | |
|---|---|---|
| Downstream Depth | 0.00 | ft |
| Length | 0.00 | ft |
| Number Of Steps | 0 | |

## GVF Output Data

| | | |
|---|---|---|
| Upstream Depth | 0.00 | ft |
| Profile Description | | |
| Profile Headloss | 0.00 | ft |
| Average End Depth Over Rise | 0.00 | % |
| Normal Depth Over Rise | 63.82 | % |
| Downstream Velocity | Infinity | ft/s |

# Worksheet for Culvert 10

## GVF Output Data

| | | |
|---|---|---|
| Upstream Velocity | Infinity | ft/s |
| Normal Depth | 3.19 | ft |
| Critical Depth | 4.42 | ft |
| Channel Slope | 0.01000 | ft/ft |
| Critical Slope | 0.00486 | ft/ft |

# Exhibit D

Executive Geotechnical Summary

July 5, 2005 1286-04-ZC

City of St. George
175 East 200 North
St. George, Utah 84790

Attn: Hillside Review Committee

Subject: Executive Summary
Geotechnical Site Evaluation
Lakes At St. George Development

Gentlemen:

**Introduction**

The purpose of this letter is to provide a summary of the general geologic and soil conditions at the subject site, and general geotechnical requirements for development. The project site (previously known as the Plantations Development site), is approximately 730 acres in area and is located within and along a relatively small valley west of the Green Valley and Sunbrook developments in St. George, Utah. Development of the site will be in phases and will consist of a 9-hole golf course, three to four lakes, and residential construction.

Previous geotechnical investigations conducted on the project site were referenced for this summary. The following geotechnical reports were reviewed.

2001 Geotechnical Investigation
Plantations at St. George, Phase 1
Residential Pods 12A, 12B & 15
Rosenberg Associates Project No. 95-1198-01

1995 Geotechnical Investigation
The Plantations, Phase 1
Black, Miller & Associates Project No. 95-1198-01

1992 Preliminary Geotechnical Site Assessment
730-Acre Plantations Project
Kleinfelder Project No. 31-800570

## General Geologic Conditions

The majority of the site consists of a northwest trending valley flanked by a broad, shallow dip slope to the west and a plateau to the east. The southern-most portion of the site occupies a smaller, east-west trending valley separated from the remaining portion of the site by a south trending spur. The northern third of the site drains to the northeast through a series of subparallel tributary washes that join and exit the site in the northeast corner. The southern two-thirds of the site drains to the southwest from the west through a major tributary wash which enters the site through a feature known as "The Gap". The main wash flows to the south and then to the east, meandering back and forth across the southern site boundary.

Geologic deposits ranging in age from Triassic to Recent are found at the site (see Drawing No. 1 enclosed at the end of this letter). Bedrock consists chiefly of the Triassic Chinle Formation. The lower Shinarump Member consisting of sandstones and conglomerates outcrops extensively on the western portion of the site. The upper Petrified Forest Member (locally known as "Blue Clay"), underlies most of the central alluvial basin deposits and which outcrops on the eastern side of the site. Quaternary deposits consisting of Older gravels, Recent alluvial deposits, and possible landslide deposits are also present on the site as shown on Drawing No. 1 (Christenson and Deen, 1983).

## General Subsurface Soil Conditions

For the purpose of this letter, we have separated the subject site into the four (4) general areas based on soil type (see Drawing No. 1). The subsurface conditions encountered on the western portion of the site (see orange colored area on Drawing No. 1), generally consisted of ½ to 1½ feet of loose, surficial silty sand or soft sandy clay soils overlying moderately hard to hard sandstone bedrock. Although generally jointed and fractured, the sandstones have a high shear strength, are relatively incompressible, and provide favorable foundation support characteristics.

The subsurface conditions at the base of the western slopes in the central and along the low ridges of the eastern portion of the site generally consist of varying thicknesses of alluvial soils (soft to stiff clayey soils, or loose to medium dense gravelly soils) overlying red-brown and green-gray highly plastic clays and mudstone bedrock associated with the Petrified Forest Member of the Chinle Formation (see the purple areas on Drawing No. 1). The Petrified Forest Member, or clay soils derived from erosion of this unit, generally have a high to critical swell potential with changes in moisture content, are of relatively low strength, and experience considerable reductions in strength when exposed to moisture.

In the northern portion of the site (see gray colored area on Drawing No. 1), the subsurface conditions generally consist predominantly of green-gray shales. The red-brown and purple mudstones, locally known as "Blue Clay" were not encountered within this area.. Clayey soils derived from the green-gray shales generally have low to moderate swell potentials.

On the plateau area to the east, the subsurface conditions are expected to consist of slightly to very well indurated (naturally cemented) sands, gravels, and cobbles associated with an Older Quaternary gravel formation. The sand and gravel deposits (see the green area on Drawing No. 2) generally provide favorable subgrade characteristics.

Groundwater was encountered during the 1992 preliminary assessment performed by Kleinfelder in the southeastern portion of the property at depths of about 4 to 12½ feet below the existing ground surface.

**General Geotechnical Requirements**

Based on the subsurface conditions encountered during at the site, and our experience with similar soil conditions, it is our opinion (from a geotechnical view point) that with proper preparation and design the subject site can be utilized for the proposed developments.

In the northern and western portions of the site (see orange and gray colored areas on Drawing No. 1), site grading will generally consist of reworking the existing surficial soils. The proposed structures should receive adequate support from conventional spread footings founded on competent undisturbed medium dense to dense native soils, on properly placed and compacted structural fill, or entirely on undisturbed non-expansive bedrock. The main geotechnical constraint within this area is the presence of moderately hard to hard bedrock. Rock excavating techniques should be anticipated where these materials are encountered during site grading and utility trench excavation. Steel reinforcing is recommended for footings and floor slabs constructed within the gray area due to the localized presence of low to moderately expansive soils.

Where the Petrified Forest Member of the Chinle Formation is present (see purple colored areas on Drawing No. 1), the most significant constraints to the development are related to the overall instability and generally poor foundation support characteristics this formation. Where this formation is present within slopes, the integrity of the slopes can be impaired by grading activities as well as loading and the introduction of water. Special grading and foundation considerations will be required where the Petrified Forest Member will be present within 15 feet of the planned rough pad elevations. We recommend that the structures be supported by a deep foundation systems with grade beams to support wall loads, and a raised structural floor system. Where conventional foundation systems are desired within expansive clay areas, any expansive clay soils or bedrock located within 15 feet of the final building pad elevations would require overexcavation and replacement with approved structural fill materials. Within exterior flatwork and street improvement areas, expansive native materials present within 3 feet of the planned subgrade elevation should be overexcavated and replaced with structural fill.

Older Quaternary gravels at the site (see green colored areas in the southeast portion of the site) occur primarily as a cap overlying the Petrified Forest Member in the plateau areas to the east. These materials consist of slightly to very well cemented sands, gravels, and cobbles. The sand and gravel deposits are generally anticipated to provide favorable foundation support

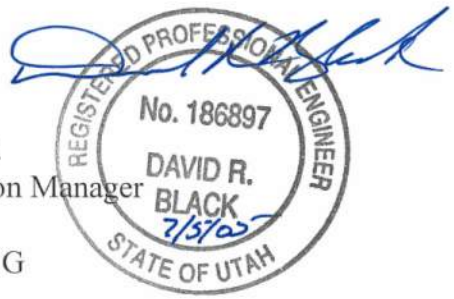
characteristics. However, in the vicinity of slopes, overall stability anticipated to be a consideration for portions of the development within this area due to the underlying presence of the Petrified Forest Member.

**Closure**

It is our pleasure to be of continued service on this project. If you have any questions concerning the information contained in this letter, please contact us at your convenience.

Sincerely,

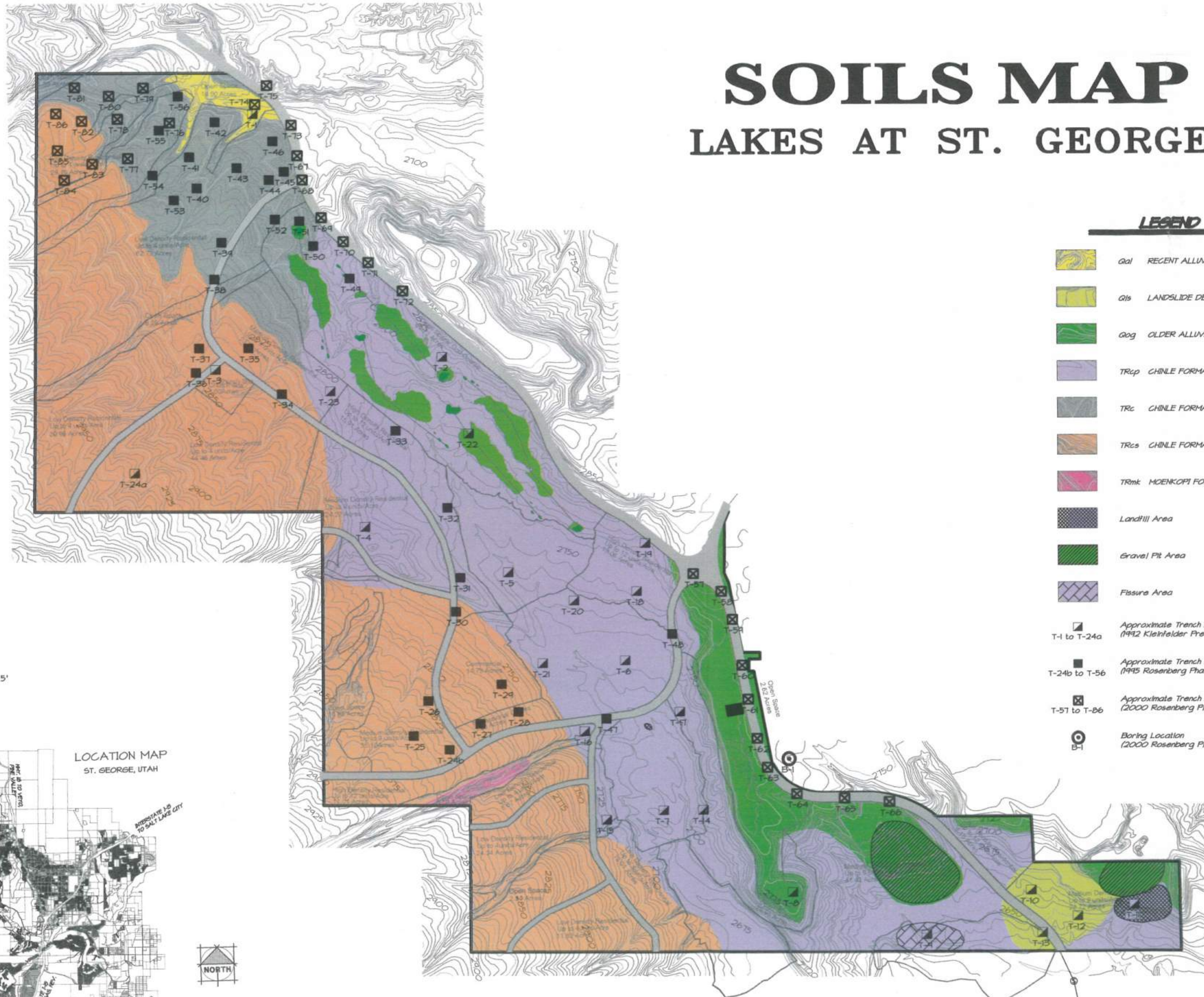
ROSENBERG ASSOCIATES




David R. Black, P.E.
Geotechnical Division Manager

DRB/RTR/05R-137.G

# SOILS MAP
## LAKES AT ST. GEORGE







CONTOUR INTERVAL = 5'

LOCATION MAP
ST. GEORGE, UTAH
SANTA CLARA
HWY. 18 TO VEYO, PINE VALLEY
INTERSTATE I-15 TO SALT LAKE CITY
INTERSTATE I-15 TO LAS VEGAS NEV.
Lakes at St. George
NORTH

### LEGEND

| | | |
|---|---|---|
| Qal | RECENT ALLUVIAL SANDS AND GRAVELS | |
| Qls | LANDSLIDE DEBRIS | |
| Qog | OLDER ALLUVIAL GRAVEL | |
| TRcp | CHINLE FORMATION, PETRIFIED FOREST MEMBER (WITHIN 12 FEET) | |
| TRc | CHINLE FORMATION, GREEN/GRAY SHALE BEDS | |
| TRcs | CHINLE FORMATION, SHINARUMP MEMBER | |
| TRmk | MOENKOPI FORMATION, UPPER RED MEMBER | |
| | Landfill Area | |
| | Gravel Pit Area | |
| | Fissure Area | |
| T-1 to T-24a | Approximate Trench Locations (1992 Kleinfelder Preliminary Site Assessment) | |
| T-24b to T-56 | Approximate Trench Locations (1995 Rosenberg Phase I Geotechnical Investigation) | |
| T-57 to T-86 | Approximate Trench Locations (2000 Rosenberg Plantations Drive Investigation) | |
| B-1 | Boring Location (2000 Rosenberg Plantations Drive Investigation) | |

DATE: 09-24-04
JOB NUMBER: 1286-04
SCALE: 1" = 500'
DRAWN BY: T.J.F.
CHECKED BY:
REVISIONS DATE


ROSENBERG ASSOCIATES
CONSULTING ENGINEERS AND LAND SURVEYORS
352 East Riverside Drive, Suite A2 St. George, Utah 84790 - (435) 673-8586


SOILS MAP
PLANTATIONS AT ST. GEORGE
CITY OF ST. GEORGE
WASHINGTON COUNTY, UTAH

DRAWING NAME: 1286SoilTyp
SHEET 1 OF 1 SHEETS

St.George
Community Development

**ITEM 3**
Hillside Permit

# HILLSIDE REVIEW BOARD AGENDA REPORT: **02/23/2022**

| **South Rim at Foremaster Ridge Phase 4 – Lot 85**<br>Hillside Development Permit (Case No. 2022-HS-007) | | |
|---|---|---|
| **Request:** | A Hillside Development Permit to allow structures in the 30' ridgeline setback in anticipation of the construction of a residential home on lot 85. | |
| **Applicant:** | Robert and Rhonda Marshall | |
| **Representative:** | Robert and Rhonda Marshall | |
| **Location:** | 1709 E. Ridgeline Circle | |
| **General Plan:** | Low Density Residential (LDR), Open Space (OS) | |
| **Existing Zoning:** | Single Family Residential, minimum lot size 10,000 sf (R-1-10) | |
| **Surrounding Zoning:** | North | R-1-10 |
| | South | R-1-10 |
| | East | R-1-10 |
| | West | R-1-10 |
| **Land Area:** | Approximately 0.29 acres | |



## BACKGROUND

This is a request to obtain a hillside permit for the property located at 1687 E. Ridgeline Circle (Lot 85, South Rim at Foremaster Ridge Phase 4). (See Exhibit A, South Rim at Foremaster Ridge Phase 4 final plat.) This location is a residential neighborhood and the applicant would like to build a house on this lot. The rear of the applicant's property abuts the ridge line of Foremaster Ridge. The plat identifies this ridge line as having a 30' ridge line setback area and states, "*No structures, walls, or solid fences are allowed within the 30' foot ridge line setback area*."

There is an existing retaining wall in the rear of the property that falls within the 30' ridge line setback area. The applicant would like to remove this existing retaining wall and build a new retaining wall on the rear and side property lines which falls within this 30' setback, and therefore, is asking to amend the plat to allow a retaining wall within this 30' setback. The purpose of this request is to extend the usable area in the rear yard. Since this request will alter the view from below the ridge, the applicant was asked to return to the Hillside Review Board.

On January 26, 2022, this Hillside Board met and recommended approval to allow lots 82-84 to build a retaining wall within the 30' ridgeline setback with the following conditions:

1. No privacy wall will be permitted on top of the rock retaining wall.
2. A black rod iron fence is acceptable to go on top of the rock retaining wall.
3. Rocks used for the rock retaining wall must be stained black.
4. No exposed fill slopes are allowed.

**APPLICABLE ORDINANCE(S)** *(Selected portions)*

10-13A-6: Building Setbacks and Additional Design Standards:

A. *Front Setback along Streets:* Along streets where the slope of the adjacent property to the street is over fifteen percent (15%), the minimum setback is twenty feet (20').

B. *Setbacks:* All setbacks shall conform to the underlying zone criteria except as provided herein. No structure or accessory structure shall be constructed within the setback area as defined below. However, a see-through wrought iron fence with at least fifty percent (50%) of the fence open, landscaping, and a nonvertical swimming pool are permitted in the setback area.

   1. *Ridgelines:* All ridgelines as shown on the ridgeline map shall be subject to the setback provisions contained herein. Setbacks from ridgelines not identified on the ridgeline map shall be a minimum of thirty feet (30'), or greater if recommended in the geotechnical reports.

   2. *Plateaus:* On plateaus, the setback from the ridgeline shall be a minimum of fifty feet (50') unless a greater setback is recommended in the geotechnical reports.

C. *Cuesta:* Where a ridgeline occurs on a cuesta, the minimum setback shall be one hundred feet (100') measured normal (perpendicular) to the closest point of the ridge, unless a greater setback is recommended in the geotechnical report.

D. *Additional Design Standards:*

1. Retaining walls shall be colored to blend into the surrounding natural geology.

2. Retaining wall height is limited to the heights set forth in chapter 18 of this title and the standards for rock wall construction.

3. Building exterior colors shall be earth tone and blend with the surrounding natural landscape.

4. In residential zones, "no disturbance" areas shall be held as the "common area" of a project. Common areas shall be owned and maintained by the homeowners' association or may be deeded to the city when accepted by the city.

5. In nonresidential zones, any "no disturbance" area shall be identified on the final site plan or final plat.

6. Any required no disturbance area shall be identified on the ground with temporary fencing or other approved means to prevent accidental disturbance of the area during construction and such fencing shall be installed prior to issuance of a grading permit.

7. The building site shall be located on the flattest portion of the parcel.

8. No structure shall extend over any natural ridgeline. The structure shall be in contact with the ground at all edges. (Ord. 2019-10-002, 10-10-2019)

**EXHIBITS PROVIDED**

1. Exhibit A – South Rim at Foremaster Ridge Phase 4 Final Plat
   "Exhibit A" in the packet shows the final plat of Foremaster Ridge Phase 4.

2. Exhibit B – Topographic Map
   "Exhibit B" is a topographic map showing the property and surrounding area.

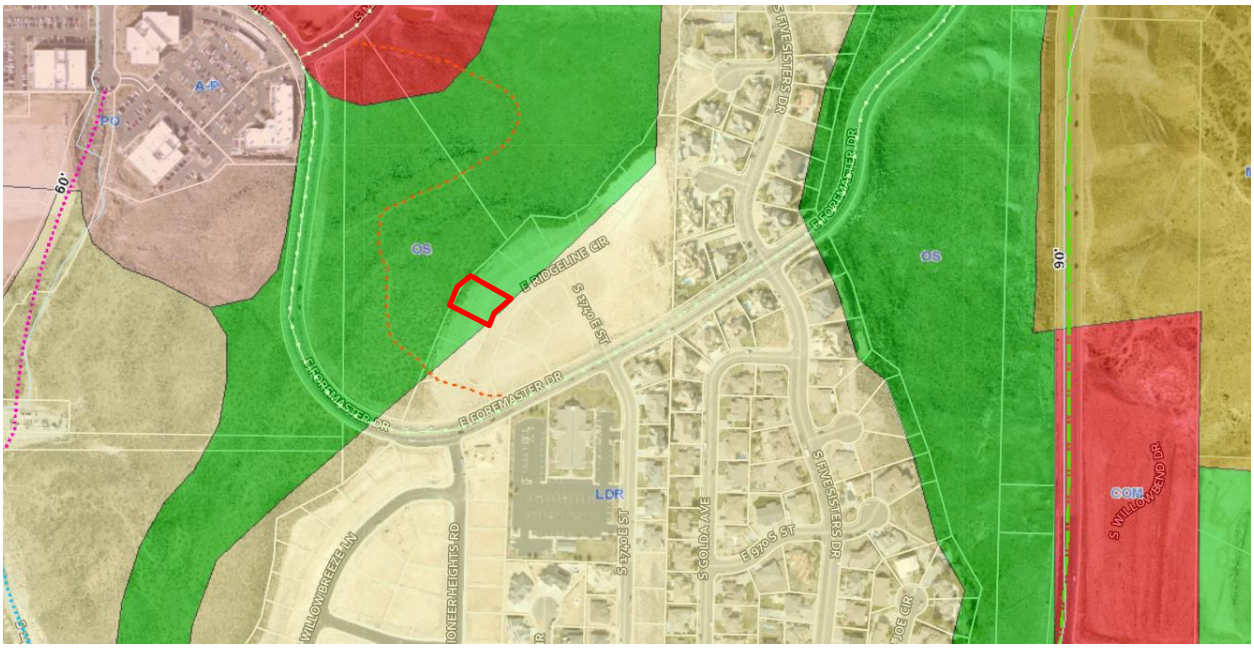
3. Exhibit C – Site Plan
   "Exhibit C" is a drawing of lot 85 with dimensions.

4. Exhibit D – Photographs
   "Exhibit C" is some photos of the property and surrounding subdivision.

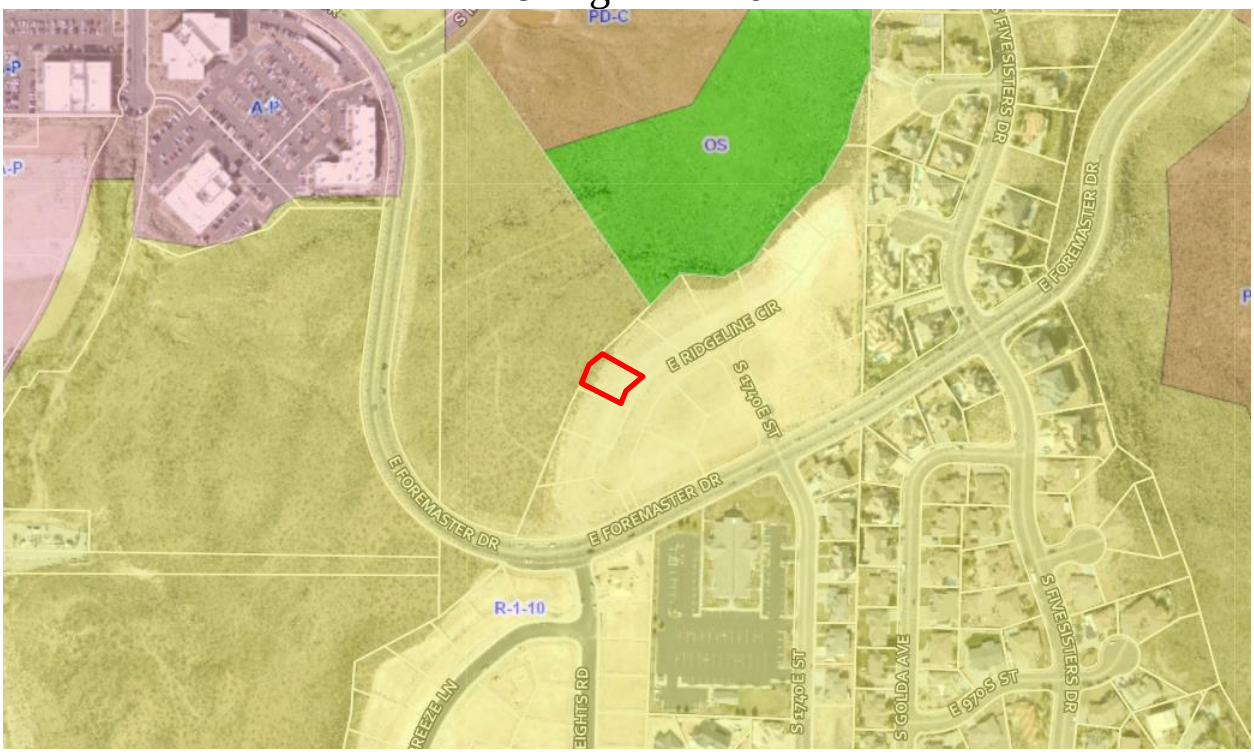
**RECOMMENDATION**

The applicant is requesting that Lot 85 of the South Rim at Foremaster Ridge final plat have the 30’ ridge line setback removed.

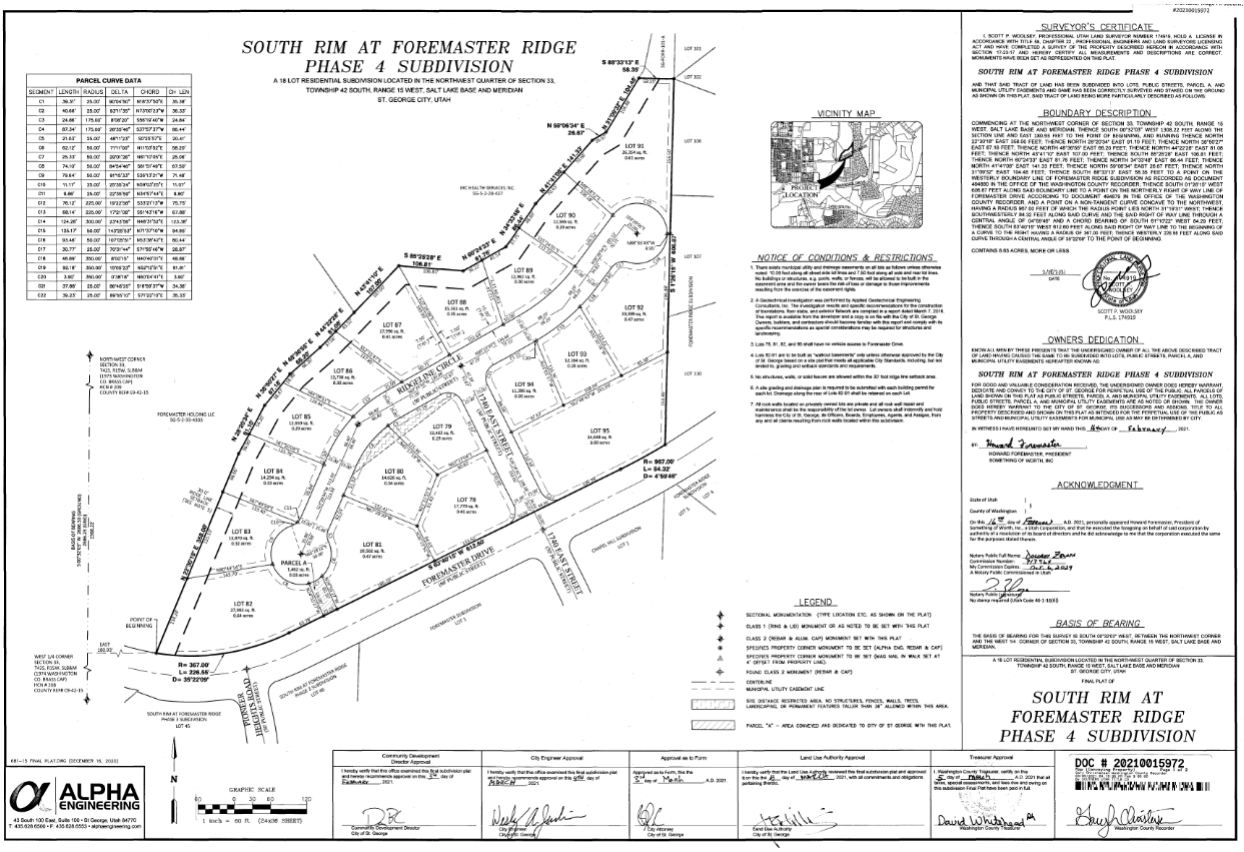
## General Plan - COM




## Zoning - R-1-10

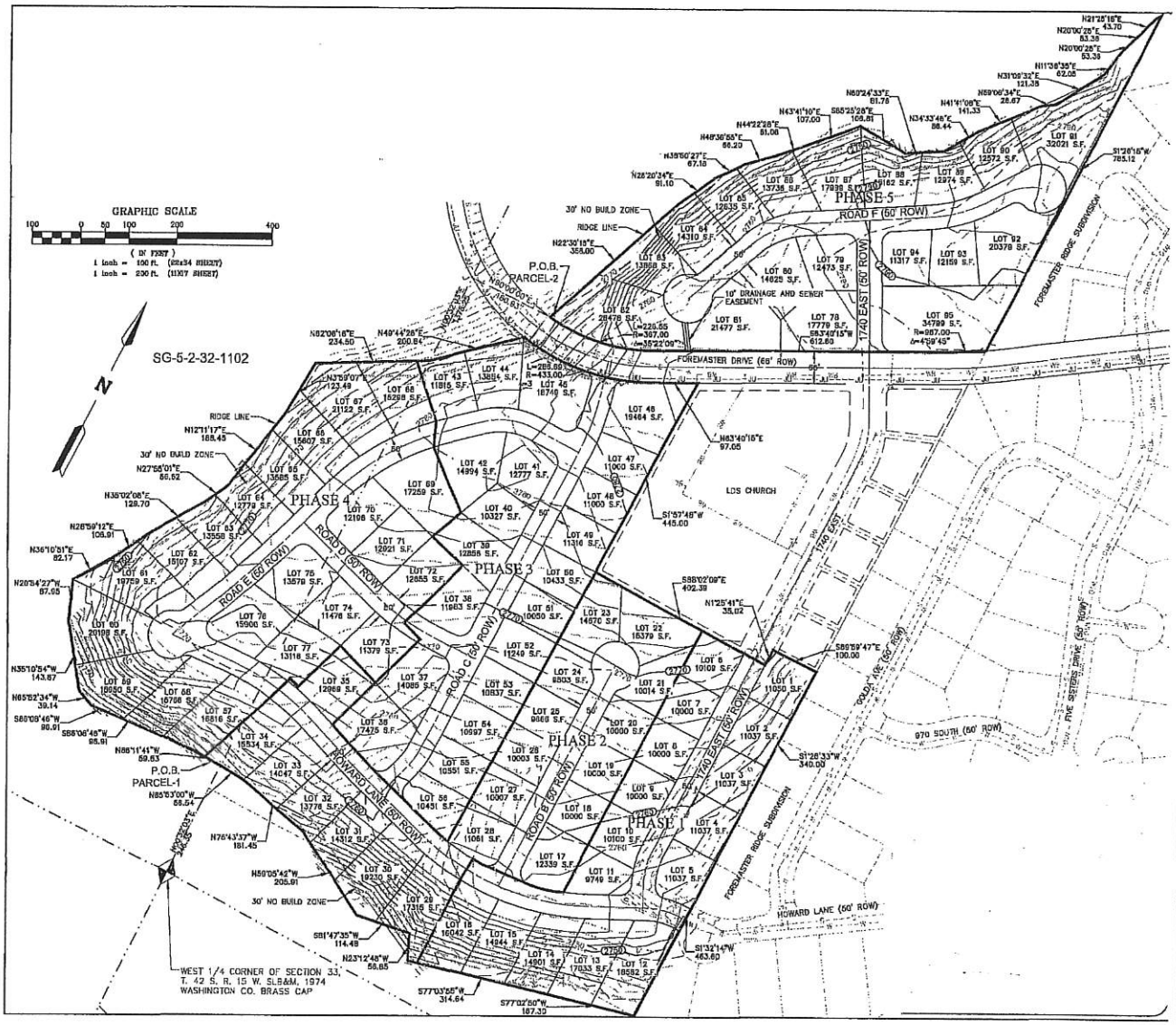


# Exhibit A
# SOUTH RIM AT FOREMASTER RIDGE PHASE 4



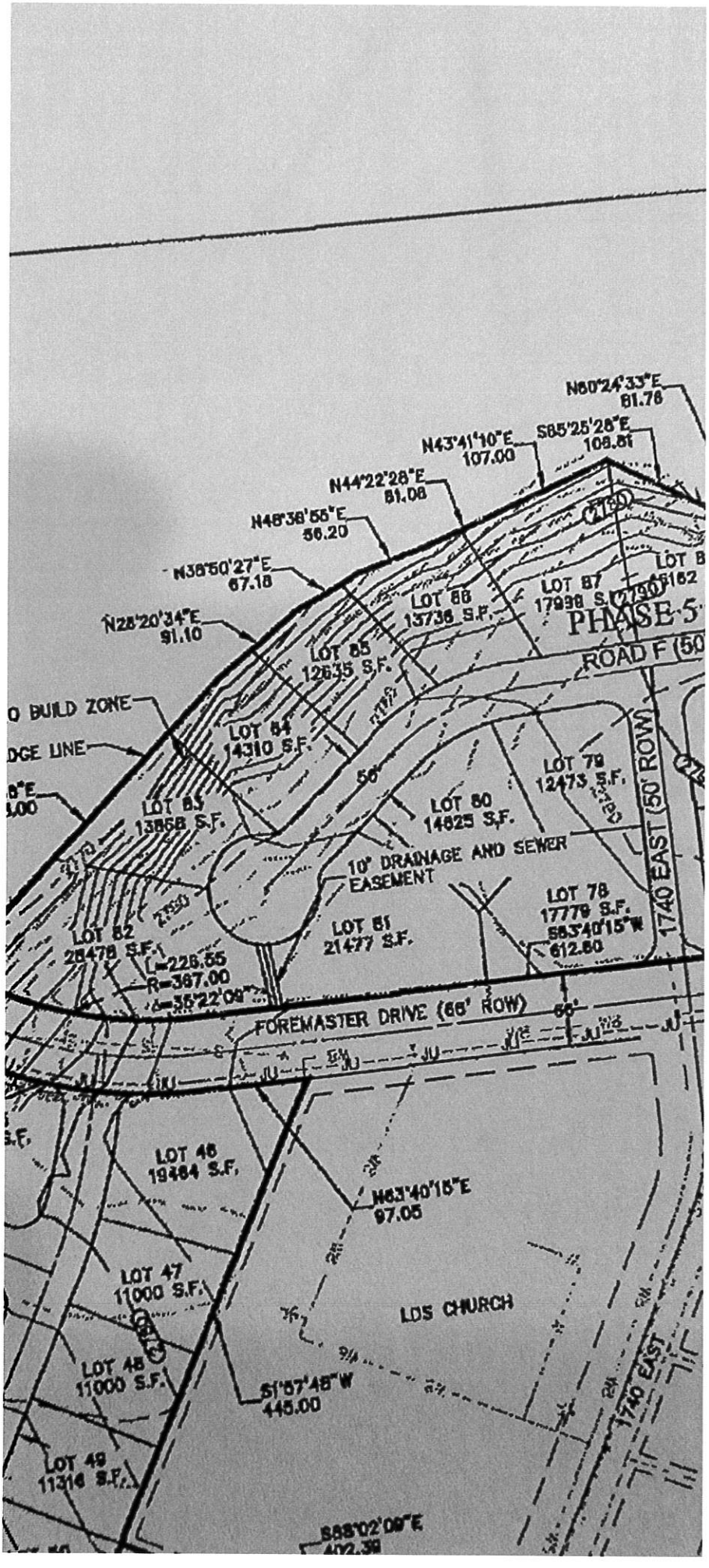
# Exhibit B
# TOPOGRAPHIC MAP

SG-SRFR-4-85

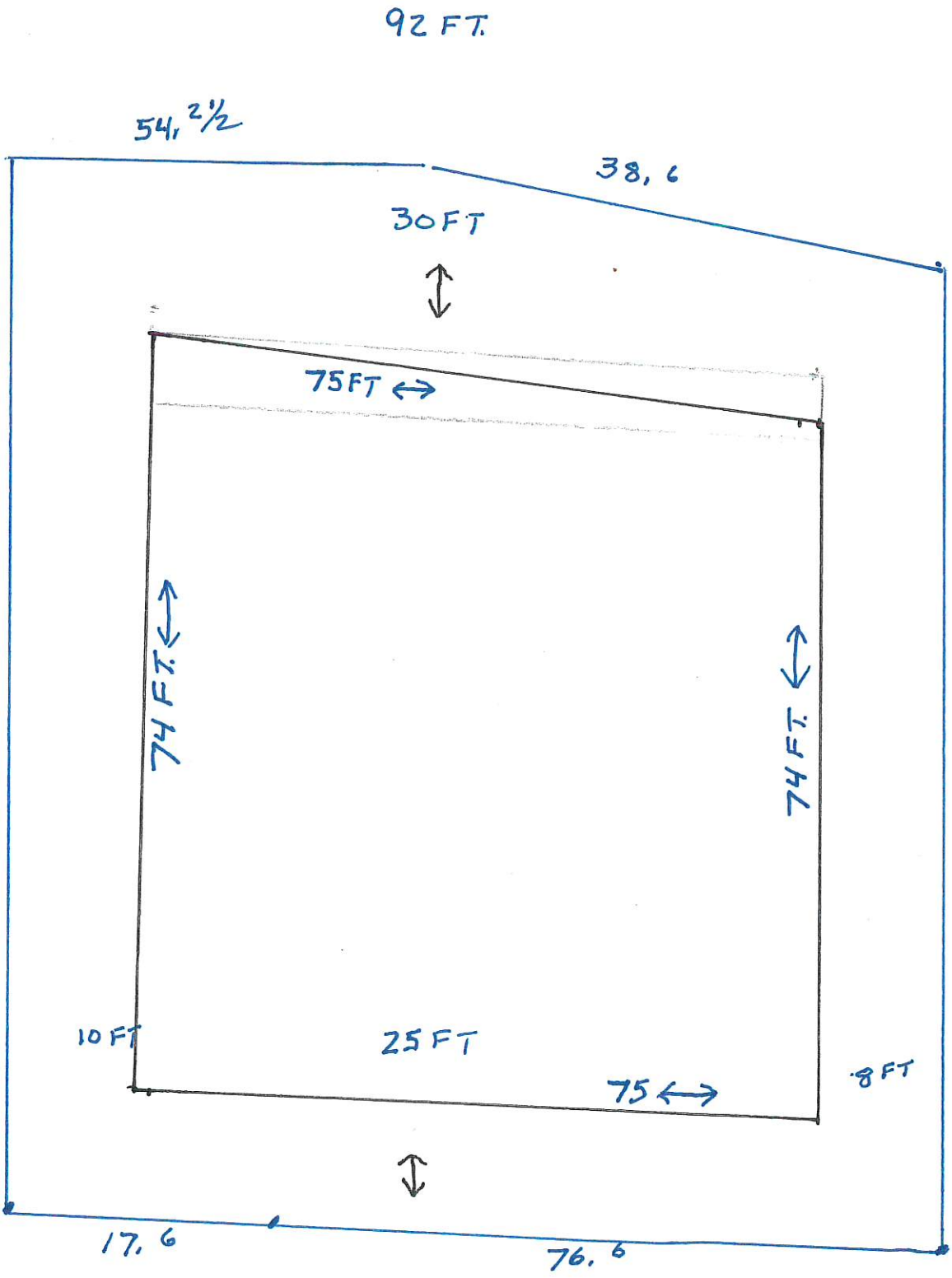



Adapted from Alpha Engineering, Preliminary Plat, dated June 30, 2015

| | | |
|---|---|---|
| LANDMARK TESTING & ENGINEERING | SITE PLAN<br>LANDMARK PROJECT 16079 | Figure 2 |


N60°24'33"E
81.78
N43°41'10"E
107.00
S85°25'28"E
108.81
N44°22'28"E
81.08
N48°38'55"E
56.20
N38°50'27"E
67.18
N28°20'34"E
91.10
LOT 88
13736 S.F.
LOT 87
17938 S.F.
PHASE 5
ROAD F (50'
LOT 85
12635 S.F.
LOT 84
14310 S.F.
LOT 79
12473 S.F.
LOT 80
14625 S.F.
LOT 83
13858 S.F.
10' DRAINAGE AND SEWER
EASEMENT
LOT 78
17779 S.F.
S83°40'15"W
612.80
1740 EAST (50' ROW)
LOT 82
28478 S.F.
L=226.55
R=367.00
Δ=35°22'09"
LOT 81
21477 S.F.
FOREMASTER DRIVE (66' ROW)
LOT 46
19484 S.F.
N83°40'15"E
97.05
LOT 47
11000 S.F.
LDS CHURCH
LOT 48
11000 S.F.
S1°57'48"W
445.00
LOT 49
11314 S.F.
1740 EAST
S88°02'09"E

# Exhibit C
# SITE PLAN LOT 85




93 FT wide

LOT 85

# Exhibit D
## PHOTOGRAPHS

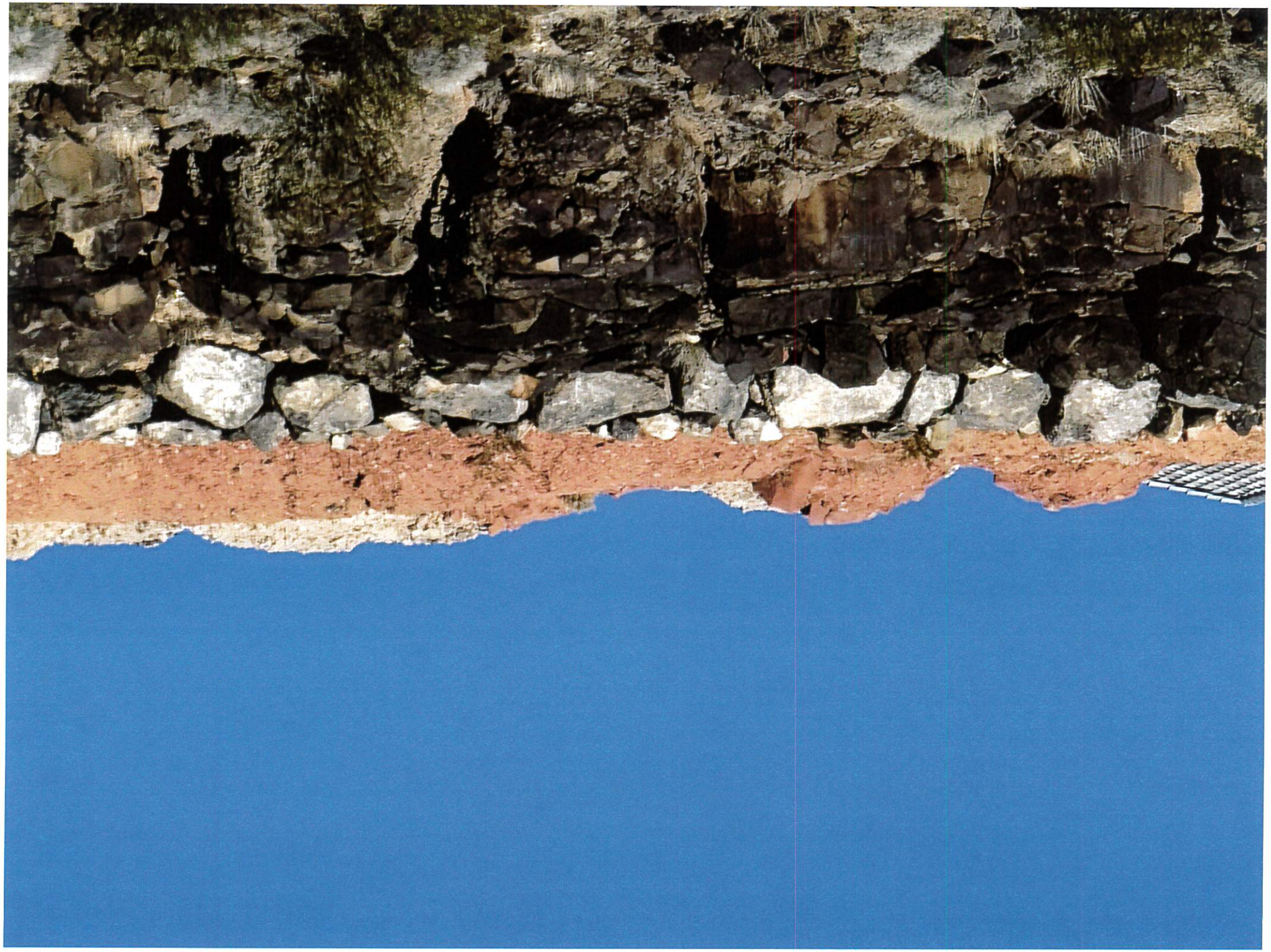

CAT
CAT

















St.George
Community Development

**ITEM 4**
Hillside Permit

# HILLSIDE REVIEW BOARD AGENDA REPORT: **02/23/2022**

| **South Rim at Foremaster Ridge Phase 4 – Lot 86**<br>Hillside Development Permit (Case No. 2022-HS-006) | | |
|---|---|---|
| **Request:** | A Hillside Development Permit to allow structures in the 30' ridgeline setback in anticipation of the construction of a residential home on lot 86. | |
| **Applicant:** | Joshua Ballantyne | |
| **Representative:** | Joshua Ballantyne | |
| **Location:** | 1721 E. Ridgeline Circle | |
| **General Plan:** | Low Density Residential (LDR), Open Space (OS) | |
| **Existing Zoning:** | Single Family Residential, minimum lot size 10,000 sf (R-1-10) | |
| **Surrounding Zoning:** | North | R-1-10 |
| | South | R-1-10 |
| | East | R-1-10 |
| | West | R-1-10 |
| **Land Area:** | Approximately 0.32 acres | |



## BACKGROUND

This is a request to obtain a hillside permit for the property located at 1687 E. Ridgeline Circle (Lot 86, South Rim at Foremaster Ridge Phase 4). (See Exhibit A, South Rim at Foremaster Ridge Phase 4 final plat.) This location is a residential neighborhood and the applicant would like to build a house on this lot. The rear of the applicant's property abuts the ridge line of Foremaster Ridge. The plat identifies this ridge line as having a 30' ridge line setback area and states, "*No structures, walls, or solid fences are allowed within the 30' foot ridge line setback area*."

There is an existing retaining wall in the rear of the property that falls within the 30' ridge line setback area. The applicant would like to remove this existing retaining wall and build a new retaining wall on the rear and side property lines which falls within this 30' setback, and therefore, is asking to amend the plat to allow a retaining wall within this 30' setback. The purpose of this request is to extend the usable area in the rear yard. Since this request will alter the view from below the ridge, the applicant was asked to return to the Hillside Review Board.

On January 26, 2022, this Hillside Board met and recommended approval to allow lots 82-84 to build a retaining wall within the 30' ridgeline setback with the following conditions:

1. No privacy wall will be permitted on top of the rock retaining wall.
2. A black rod iron fence is acceptable to go on top of the rock retaining wall.
3. Rocks used for the rock retaining wall must be stained black.
4. No exposed fill slopes are allowed.

**APPLICABLE ORDINANCE(S)** *(Selected portions)*

10-13A-6: Building Setbacks and Additional Design Standards:

A. *Front Setback along Streets:* Along streets where the slope of the adjacent property to the street is over fifteen percent (15%), the minimum setback is twenty feet (20').

B. *Setbacks:* All setbacks shall conform to the underlying zone criteria except as provided herein. No structure or accessory structure shall be constructed within the setback area as defined below. However, a see-through wrought iron fence with at least fifty percent (50%) of the fence open, landscaping, and a nonvertical swimming pool are permitted in the setback area.

   1. *Ridgelines:* All ridgelines as shown on the ridgeline map shall be subject to the setback provisions contained herein. Setbacks from ridgelines not identified on the ridgeline map shall be a minimum of thirty feet (30'), or greater if recommended in the geotechnical reports.

   2. *Plateaus:* On plateaus, the setback from the ridgeline shall be a minimum of fifty feet (50') unless a greater setback is recommended in the geotechnical reports.

C. *Cuesta:* Where a ridgeline occurs on a cuesta, the minimum setback shall be one hundred feet (100') measured normal (perpendicular) to the closest point of the ridge, unless a greater setback is recommended in the geotechnical report.

D. *Additional Design Standards:*

1. Retaining walls shall be colored to blend into the surrounding natural geology.

2. Retaining wall height is limited to the heights set forth in chapter 18 of this title and the standards for rock wall construction.

3. Building exterior colors shall be earth tone and blend with the surrounding natural landscape.

4. In residential zones, “no disturbance” areas shall be held as the “common area” of a project. Common areas shall be owned and maintained by the homeowners’ association or may be deeded to the city when accepted by the city.

5. In nonresidential zones, any “no disturbance” area shall be identified on the final site plan or final plat.

6. Any required no disturbance area shall be identified on the ground with temporary fencing or other approved means to prevent accidental disturbance of the area during construction and such fencing shall be installed prior to issuance of a grading permit.

7. The building site shall be located on the flattest portion of the parcel.

8. No structure shall extend over any natural ridgeline. The structure shall be in contact with the ground at all edges. (Ord. 2019-10-002, 10-10-2019)

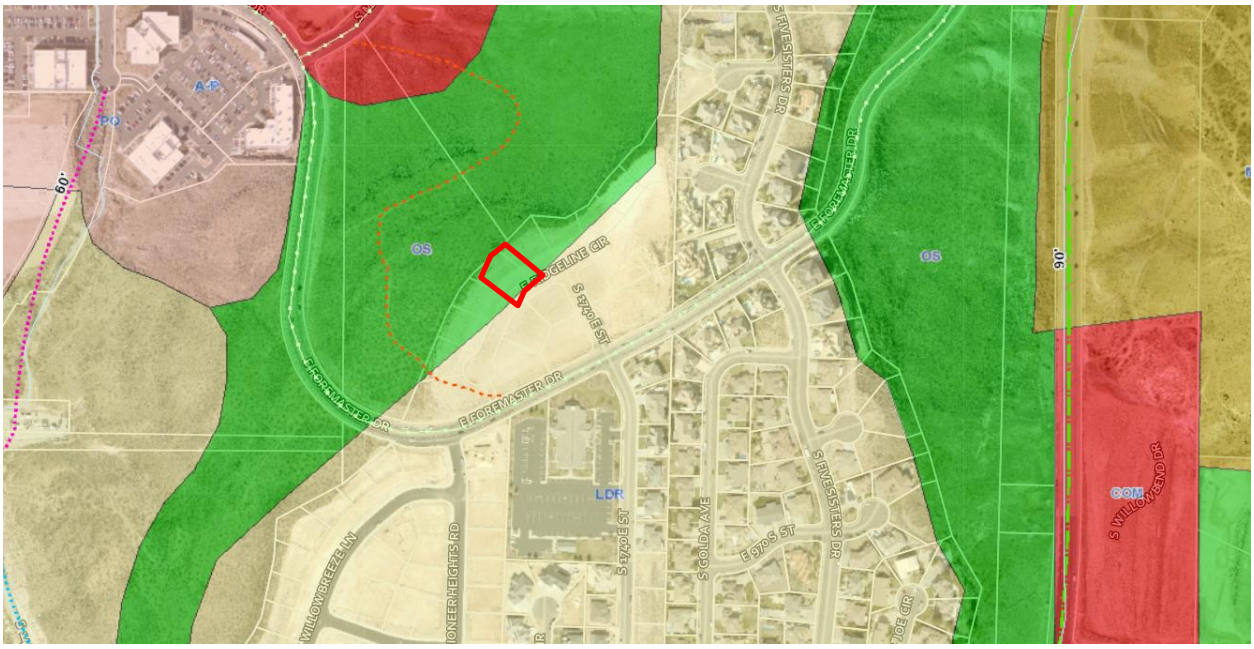
**EXHIBITS PROVIDED**

1. Exhibit A – South Rim at Foremaster Ridge Phase 4 Final Plat
   “Exhibit A” in the packet shows the final plat of Foremaster Ridge Phase 4.

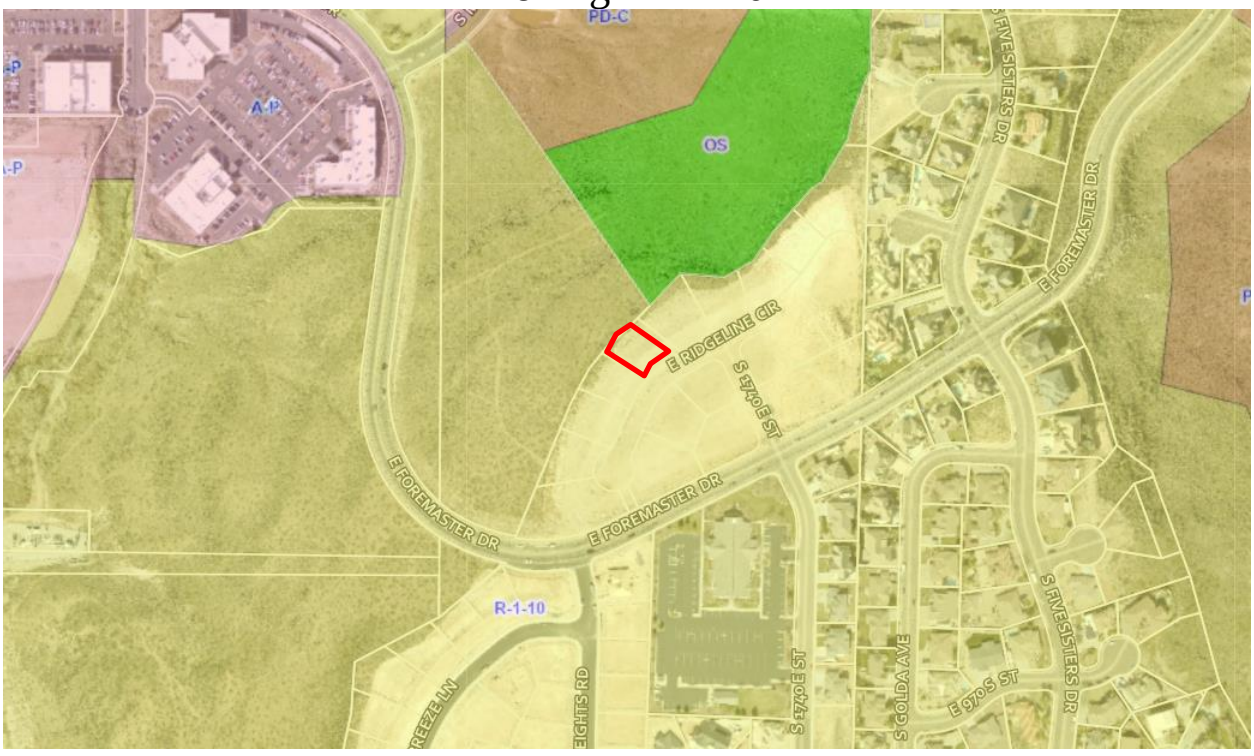
**RECOMMENDATION**

The applicant is requesting that Lot 86 of the South Rim at Foremaster Ridge final plat have the 30’ ridge line setback removed.

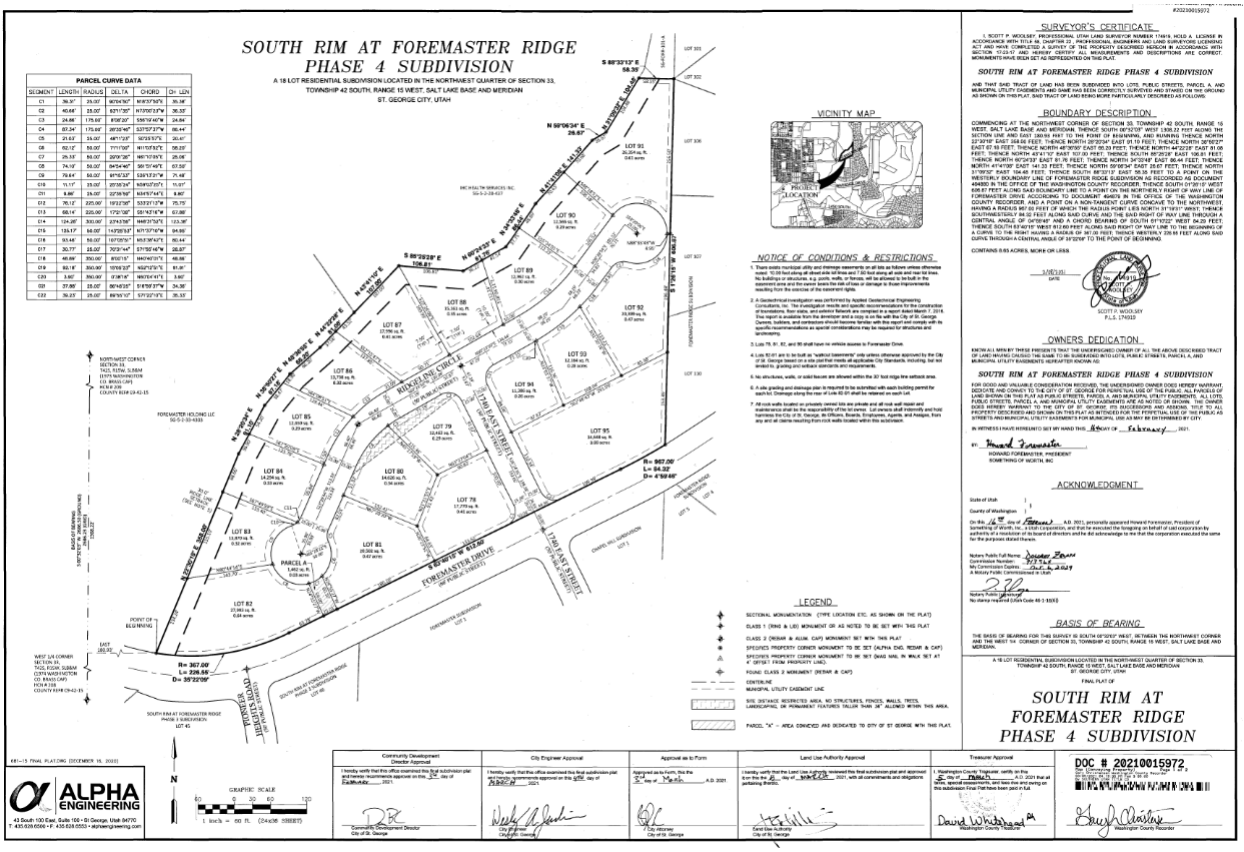
## General Plan - COM




## Zoning - R-1-10



# Exhibit A
# SOUTH RIM AT FOREMASTER RIDGE PHASE 4



St.George
Community Development

**ITEM 5**
Hillside Permit

# HILLSIDE REVIEW BOARD AGENDA REPORT: **02/23/2022**

| **Foremaster Ridge – Lot 120**<br>Hillside Development Permit (Case No. 2022-HS-008) | | |
|---|---|---|
| **Request:** | A Hillside Development Permit to determine the ridge line on lot 120 of Foremaster Ridge for the construction of a residential home. | |
| **Applicant:** | John Wilson | |
| **Representative:** | John Wilson | |
| **Location:** | Foremaster Ridge, Lot 120 (Approximately 445 S. Five Sisters Dr.) | |
| **General Plan:** | Low Density Residential (LDR) | |
| **Existing Zoning:** | Single Family Residential, minimum lot size 10,000 sf (R-1-10) | |
| **Surrounding Zoning:** | North | R-1-10 |
| | South | R-1-10 |
| | East | R-1-10 |
| | West | R-1-10 |
| **Land Area:** | Approximately 0.28 acres | |



## BACKGROUND

This is a request from the property owner's of lot 120 in the Foremaster Ridge subdivision for the Hillside Review Board to determine the location of the ridgeline. In addition, the owner would like to have a reduced front setback on their property – reduced from 25' to 20'. The owner is coming before the Hillside Review Board for the purpose of determining where he can place their proposed home on this vacant lot.

## APPLICABLE ORDINANCE(S) *(Selected portions)*

10-13A-6: Building Setbacks and Additional Design Standards:

A. *Front Setback along Streets:* Along streets where the slope of the adjacent property to the street is over fifteen percent (15%), the minimum setback is twenty feet (20').

B. *Setbacks:* All setbacks shall conform to the underlying zone criteria except as provided herein. No structure or accessory structure shall be constructed within the setback area as defined below. However, a see-through wrought iron fence with at least fifty percent (50%) of the fence open, landscaping, and a nonvertical swimming pool are permitted in the setback area.

1. *Ridgelines:* All ridgelines as shown on the ridgeline map shall be subject to the setback provisions contained herein. Setbacks from ridgelines not identified on the ridgeline map shall be a minimum of thirty feet (30'), or greater if recommended in the geotechnical reports.

2. *Plateaus:* On plateaus, the setback from the ridgeline shall be a minimum of fifty feet (50') unless a greater setback is recommended in the geotechnical reports.

C. *Cuesta:* Where a ridgeline occurs on a cuesta, the minimum setback shall be one hundred feet (100') measured normal (perpendicular) to the closest point of the ridge, unless a greater setback is recommended in the geotechnical report.

D. *Additional Design Standards:*

1. Retaining walls shall be colored to blend into the surrounding natural geology.

2. Retaining wall height is limited to the heights set forth in chapter 18 of this title and the standards for rock wall construction.

3. Building exterior colors shall be earth tone and blend with the surrounding natural landscape.

4. In residential zones, "no disturbance" areas shall be held as the "common area" of a project. Common areas shall be owned and maintained by the

homeowners' association or may be deeded to the city when accepted by the city.

5. In nonresidential zones, any "no disturbance" area shall be identified on the final site plan or final plat.

6. Any required no disturbance area shall be identified on the ground with temporary fencing or other approved means to prevent accidental disturbance of the area during construction and such fencing shall be installed prior to issuance of a grading permit.

7. The building site shall be located on the flattest portion of the parcel.

8. No structure shall extend over any natural ridgeline. The structure shall be in contact with the ground at all edges. (Ord. 2019-10-002, 10-10-2019)

**EXHIBITS PROVIDED**

1. Exhibit A – Foremaster Ridge Subdivision
   "Exhibit A" in the packet shows the final plat of Foremaster Ridge

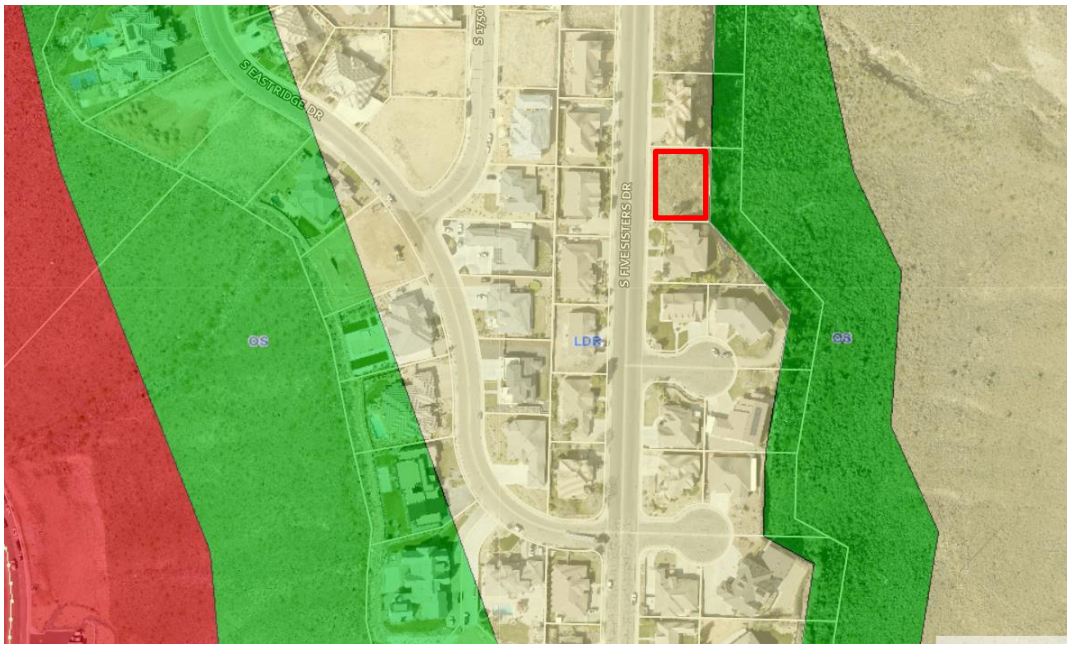
2. Exhibit B – Topographic Survey
   "Exhibit B" is the topographic survey of lot 120 of Foremaster Ridge

3. Exhibit C – 30' Setback examples
   "Exhibit C" shows examples of other homes in the neighborhood that have not followed the 30' ridgeline setback

**RECOMMENDATION**

The applicant is requesting that Lot 120 of the Foremaster Ridge final plat have the ridge line determined, and the applicant is requesting to receive a front setback yard reduction from 25' to 20' (10-13A-6A).

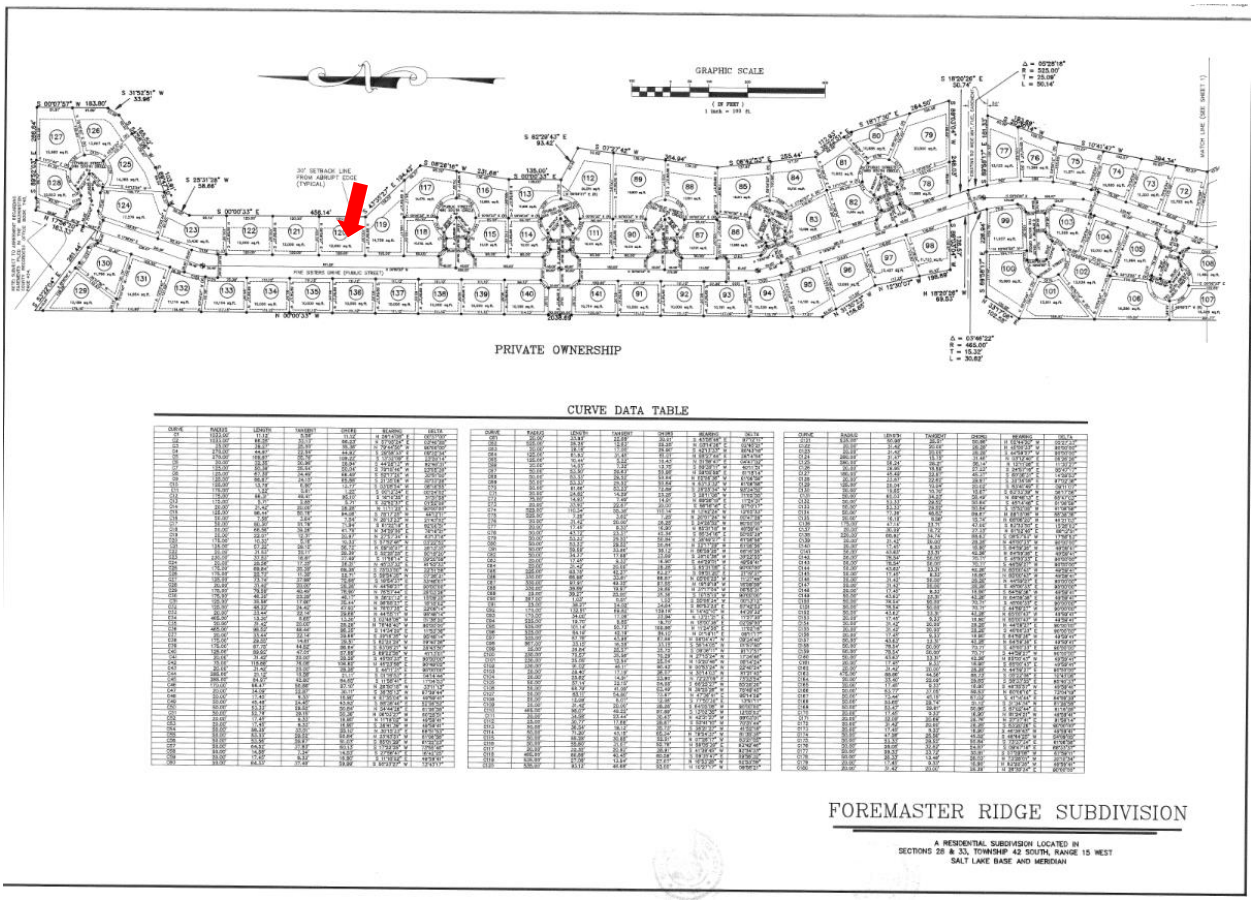
## General Plan - COM



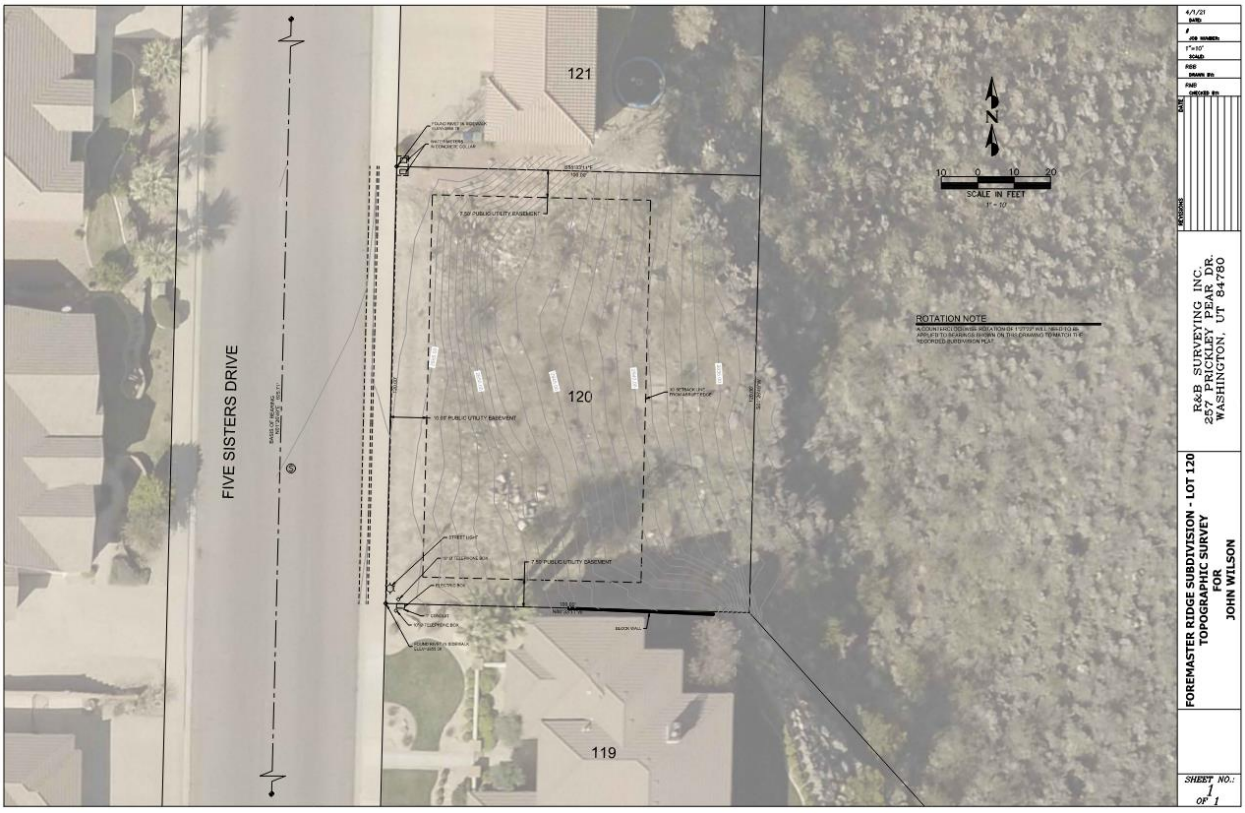

## Zoning - R-1-10



# Exhibit A
# FOREMASTER RIDGE Final Plat

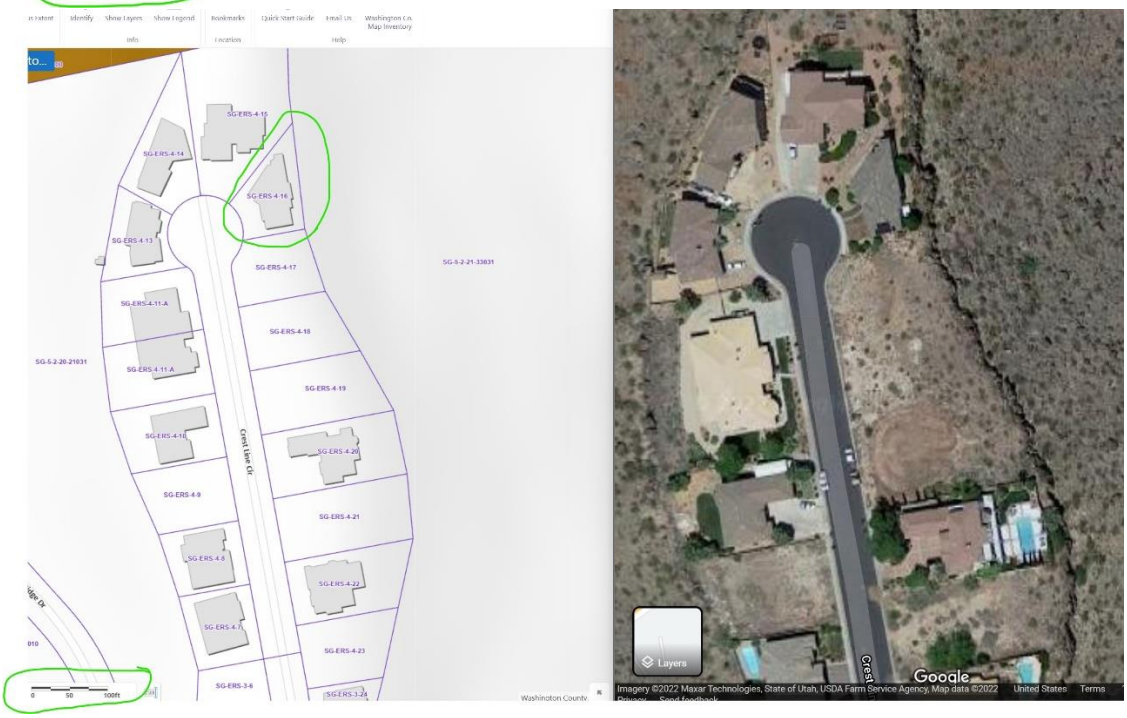


# Exhibit B
# TOPOGRAPHICAL SURVEY



# Exhibit C
# SETBACK EXAMPLES



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, January 26, 2022,** commencing on-site at approximately 8:30 a.m.

**PRESENT:**
James Sullivan
Dave Black
Jeff Mathis
James Dotson

**EXCUSED:**
Russ Owens

**CITY STAFF:**
Assistant Public Works Director, Wes Jenkins
Planner III, Dan Boles
Planner III, Carol Davidson
Development Office Supervisor, Brenda Hatch

The agenda for the meeting is as follows:

Chair James Sullivan called the meeting to order at 8:52 am.

1. Consider a request for a hillside development permit at the Divario Subdivision. The applicant is proposing to construct in the area shown on the slope map labeled 20-29% and 30-39%. This is specifically in the PA-4 area which is situated in the far south west corner of the Divario development. The property is currently zoned Single-Family Residential, minimum lot size 8,000 square feet (R-1-8). The applicant is 730 St George, LLC. Case No. 2022-HS-003.

   Wes Jenkins – As you remember, the whole Divario Development, called The Lakes at that time, went through the hillside approval process. In certain planning areas they said if these areas that are highlighted in pink are going to be disturbed then you need to bring the Hillside Review Board back out and have them look at it and see if they are comfortable with it or if portions of that need to be saved. Like in PA-14 where you asked to save those waterfall areas. This one was highlighted on the wash here. We need to walk it and make sure there isn't some aesthetic value to the wash.

   Dave Black – It seems like these washes in these corridors were preserved for trails, is there anything planned, master planned for the trail on this wash where we would lose connectivity to something else.

Wes Jenkins – Not that I know of.

Jeff Mathis – I think there are probably steep slopes on either side of this wash, right? But they were saying they were non-contiguous, so it doesn't fit that requirement?

Wes Jenkins – They must have said that. Obviously they thought that if this was going to be disturbed that it would need a second look through Hillside.

Dave Black – It kind of fell into the aesthetics and trying to preserve some of the natural features. There is not a lot of natural rock outcrops except within the drainages and so if there was something significant then we probably check it and if there's not then we would be ok to disturb it.

Jeff Mathis – And that's what would happen if we say ok, then it will be gone, there won't be a wash here?

Wes Jenkins – They piped that down, you can see on the map there is a little developable area here that was included as part of PA-14 and the wash divided the 2 parcels. Their hope is to fill this wash in and bring them both together. I suggest we walk up there a little bit and see what you think.

Dave Black – Is this BLM or private?

Wes Jenkins – I think it's BLM, it is on the north side.

Discussion continued on the property boundaries and what might be surrounding it.

James Dotson – See the contours on the map, they would probably lose 10 lots.

Discussion on how they could change the access so that the wash could be kept.

Jeff Mathis – I think it is pretty significant here.

James Sullivan – I think it is pretty significant.

Dave Black – If we look at what don't want to lose maybe this lath would be acceptable, we say this would be the limit.

Wes Jenkins – This boring marker right here?

Dave Black – Yes, that's just an idea. It may take us down further or to those other rocks we were standing on.

James Dotson – I think that point right there on that rock is a good spot because it's kind of insignificant and there is no cliff face.

Dave Black – Alright, let's walk down to that one. We are about 175 feet east of that lath.

Jeff Mathis – What's the limits on the top of the wash? Is it where it crest over?

Dave Black – Yes.

James Sullivan - If we are preserving this wash, what's our limit?

Wes Jenkins – You could have them come out and put in some stakes to give us an idea of where it would be.

James Sullivan – We would like to see this wash preserved from here up. Our next question is how do we know where the rims are? Where do we stop, do we get a slope map?

Mark Teepen – We have a slope map; it doesn't define the whole wash. We did this years and years ago.

Jeff Mathis – You understand the challenge of what we are trying to preserve. Could you guys propose your disturbing line, and then we come and look at it from that point? If you give us an idea based on our design, this point and this will be a fill of 5 ft will be a cut of a foot. Roughly, right.

James Dotson – Yes, stakes on the edges so we can make out where.

Jeff Mathis – The rim gets more defined the higher up you go, but with this one the rim is undefined.

Mark Teepen – Yes that is the hard part. You really have to come out and get a feel for it. Maybe we will just do that, stake what I think will be the rim and then have you guys come and look at it.

Dave Black – If this was a 5 foot or a 10-foot cut right here, and that cut might come over a certain distance and then everything past that is a no disturb line. But if it's a 10-foot fill that's encroaching on the wash then that is a different scenario.

Mark Teepen – The rock walls we build, no matter where it's at, it's going to really look good.

Jeff Mathis – I think the general guidance would be the top of the wash. So that is fuzzy there. Generally, it goes up and then starts to level out.

Dave Black – Within the wash we have these natural rock outcrops and they've got the desert varnish and stuff like that; I think that's kind of the intent is to preserve those. Above those it probably is not as critical.

Mark Teepen – Let's do that, we'll stake it. I just walked this last week. We were questioning what we were doing. If I can get the value off the lots the loss of lots won't matter. Can we leave it up to staff or do you guys want to come back out again?

James Dotson – My concern has always been fill slopes and that we don't push dirt and it ends up here all disturbed.

Mark Teepen – So we find a non-disturbance line.

James Sullivan – Do you think we have seen enough, or do we need to come back out?

Dave Black – Somebody needs to come out and look at it. Does the City want to do it or do they want us to?

Wes Jenkins – It's up to you, like Mark said if you want them to stake it we can come out and walk it, take some pictures and send them to you, with an aerial like you suggested or you can come back out here and convene if you want.

Mark Teepen – As long as we can get on the next agenda, I don't want to push it 2 months.

Dan Boles – I think we will be out here next month looking at PA-18.

Dave Black – We can look at it then.

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| MOTION: Jeff Mathis made a motion to table the item to the next meeting.<br>SECOND: Dave Black<br>AYES (4)<br>James Sullivan<br>Dave Black<br>Jeff Mathis<br>James Dotson<br>NAYS (0)<br>Motion carries. |

2. Consider a request for a hillside development permit at the Tech Ridge development. The applicant is proposing to put in a storm drain with a concrete trail above it and a pedestrian bridge all within the Hillside Overlay. The property is generally located southwest of 475 Donlee Drive and is zoned Planned Development Mixed Use (PD-MU) and Open Space (OS). The applicant is Isaac Barlow and the representative is Mike Bradshaw. Case No. 2022-HS-002.

   James Sullivan – Basically we are looking at the storm drain coming off the hill with the stair, pedestrian trail coming down.

   Craig Coats – Let's start with the location, the location of the stair and the storm drain, if you see the shadow of the crest, the old over fill there just to the right, a low point? The stairs run right up that edge. That's where the stairs are coming off. With the Tech Ride development, we have to get the storm drain down to this detention pond and originally our plan was to bring just the pipe down and have it above surface and not have any disturbance. Working with Isaac, it makes sense with the amenity to bring the stairs, cover that pipe down the hillside, and make it blend it with the current hillside there.

   Isaac Barlow – And connect it to the trails on both sides.

   Craig Coats – You can see this is kind of where the trail is going to be, right where we are standing along this edge, and it ties into a future City trail that is the old cut that goes all the way to the top and then there will be the trail on the west rim of Tech Ridge. And so there will be a connection between the two trail systems. To give you a bearing on where

the bridge is located, it's located directly east of us. There are stakes up there, you can barely see them in orange, right where the shadow is overcasting, it's in between that ridge. It's a 100-foot span bridge and it would be the same span bridge that is all around the City trails.

James Sullivan – What about ADA compliance?

Mike Bradshaw – Trails aren't necessarily ADA compliant.

Jeff Mathis – I think they have to provide certain things at the trail heads, but not the entire trail.

Dave Black – I like it.

James Dotson – I think the video was great.

Dave Black – The only comment that I had was when we met out here on the development, I think you guys have done an excellent job of tying things in and blending. You have established a really good track record. It's exactly what we'd hoped for. And what you are doing here, I think follows that.

Jeff Mathis – What is the finish of the concrete? Will it be natural concrete, just gray?

Isaac Barlow – Our goal is to try to do what the City recommended, to try to have some sort of color to darken it a bit to try and blend in.

Mike Bradshaw – I don't think it will be black, but we would probably go with a darker color.

Dave Black – It looked like you had some disturbed areas and I have seen that you used a mulch that blends in.

Mike Bradshaw – Either that or you can see where we've mulched the rock on the entrance here, maybe we'd mulch it like that, and probably put some native plants back in there.

Isaac Barlow – I think the disturbance area would be as much as 24 or 25 feet, we want to build the steps 12 feet wide to make sure there is enough room on each side for someone to pass someone if they are running. We want to get 6 feet on each side of the rail. That should make where the disturbance on each side is only 6 feet.

Jeff Mathis – Does the natural drain stay in place?

Mike Bradshaw – We are above the natural drainage because it would cause erosion.

| |
|---|
| MOTION: Dave Black made a motion to recommend this project for approval as presented.<br>SECOND: James Dotson<br>AYES (4)<br>James Sullivan |

| |
|---|
| Dave Black<br>Jeff Mathis<br>James Dotson<br>NAYS (0)<br>Motion carries. |

3. Consider a request for a hillside development permit at the South Rim at Foremaster Ridge Phase 4 development. The applicant is proposing to allow structures in the 30' ridgeline setback in anticipation of the construction of a residential home on lot 83. The property is generally located at 1687 Ridgeline Circle and is currently zoned Single Family Residential, minimum lot size 10,000 sf (R-1-10). The applicant is Jordan Wood. Case No. 2022-HS-001.

James Sullivan – We are reconvening on lot 83 at Foremaster Ridge.

Wes Jenkins – I think we were going to look at these 3 lots.

James Sullivan – The drawing we've got is for this lot, the one lot.

Wes Jenkins – Yes, but we were going to look at these 3.

James Sullivan – So for the hillside overlay was it 30 feet back from the property line, or was it from some other point?

Wes Jenkins – To give you some background, the one on the south didn't come to hillside. Basically, Alpha drew a ridgeline and said this is where your ridgeline is both here and on the north side and on the south side. We're going to hold everything back 30 feet, everything that is going to be developed is going to be less than 20%. They established a ridgeline and a setback, nothing on top was above the 20% that was going to be disturbed. That's why we didn't take it to hillside. Jordan is now coming back; I have printed out maps so you can see what it looked like in 2017 before it was disturbed. Jordan's question is he felt like there really is no ridgeline setback here that Alpha disturbed, so he is requesting to go back to the property line and not have the 30-foot ridgeline setback. The question is, is there a ridgeline, do they need to have a 30-foot setback? That's why I had them stake the 3 lots. It didn't make any sense to look at 1 lot individually and then have the others come in. The question is are we comfortable with him creating a ridgeline? What are you going to build here? Two walls?

Jordan Wood – We are just pushing the retainer wall that is existing right there onto the property line. I talked to the lot next to us and they are planning on doing the same thing.

Dave Black – Is that elevation on top of that fill slope where those stakes are?

Jordan Wood – Yes.

Dave Black – What happens between the elevation of that wall and the pad elevation?

Jordan Wood – This is being built up and we'll have a basement portion on that higher tier, it's a walk out basement.

Wes Jenkins – So is the plan to move the 8-foot rock wall right here to the property line?

Jordan Wood – Yes.

Jeff Mathis – So we end up with an 8-foot wall on the property line.

Wes Jenkins – So in essence the question was they are kind of creating a ridgeline based on building a rock wall. The ordinance has changed, it used to be that we didn't allow any disturbance within that 30-foot ridgeline set back. Needless to say, we got a lot of pushback. People were saying, we want to put a pool, we want to landscape it, so the ordinance was changed in 2019 to allow disturbance within that 30-foot set back but no structure. You could build a pool with a wrought iron fencing and things like that, but we never anticipated rock walls. In essence that would be creating what we would consider a ridgeline by allowing them to fill this in and put a rock wall there.

Jeff Mathis – So the approved Alpha plan was to build this little, shorter wall here on the edge and then go back the 30 feet and build another wall?

Wes Jenkins – No because when they came in it was before the ordinance had changed so it was supposed to be a non-disturb area. That was the ordinance back then.

James Dotson – So the wall that was built with the pads, with the infrastructure, is the one that is back, and now they have come and pushed this out, they'll get another 30 foot. So that wall ties into that ridgeline like they show on that plan, but the lower wall is going to bend back around.

James Sullivan – It's happened all the way along that ridge.

Wes Jenkins – Just so you are aware, when Foremaster came in and developed, I think they stuck with it. They were required to paint their walls, they had a less of a set back then. I don't remember what the setbacks were then. We may have an application from an individual on the east side of Foremaster also, it is similar to this, it's establishing the ridgeline setback.

James Dotson – At this point it is disturbed. It has been pretty consistent across there; they've done those walls. As long as we don't have fill slopes that are left without a wall, I think we are better off.

James Sullivan – Yes, I'd rather see a rock wall than a dirt slope.

Jordan Wood – When they built the original development this was already disturbed as well.

Dave Black – So on top of the 8-foot wall is there another privacy wall?

Jordan Wood – We we're planning on it; we would just do wrought iron. So, it doesn't disturb the view or anything.

Jeff Mathis – I think that's a good idea, it's what these guys have done over there. So, you don't end up with a 14-foot face.

Dave Black – That could be part of the motion, that they keep it wrought iron, so we are not putting a direct fence on top of a block wall.

Jeff Mathis – Can you dictate the color, so it matches the wall?

James Dotson – What about the face of the wall, the rock wall, does it need to be stained or painted?

Dave Black – It looks pretty good over there.

James Dotson – It's not natural, they sprayed an emulsion on those.

Discussion continued on coloring the rock wall.

MOTION: James Dotson made a motion to recommend for approval this project, building out to the property line with an 8-foot rock wall with the contingency that there is no solid privacy wall above the rock wall, it has to be view fencing also the 8-foot rock wall be stained or painted to match the ridgeline rock and that there be no exposed fill slopes. It applies to lots 82, 83 and 84.
SECOND: Dave Black
AYES (4)
James Sullivan
Dave Black
Jeff Mathis
James Dotson
NAYS (0)
Motion carries.

4. Consider approval of the meeting minutes from September 29, 2021.

MOTION: Dave Black made a motion to approve the minutes from September 29, 2021.
SECOND: James Dotson
AYES (4)
James Sullivan
Dave Black
Jeff Mathis
James Dotson
NAYS (0)
Motion carries.