Newlin Gulch Major Drainageway Plan

Draft Baseline Hydrology

January 2015

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

DOUGLAS COUNTY
COLORADO

Town of Parker COLORADO

MULLER

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Muller Engineering Company, Inc.
Consulting Engineers

January 20, 2015

Ms. Shea Thomas, P.E.
Senior Project Engineer, Master Planning
Urban Drainage and Flood Control District
2480 West 26th Avenue, Suite 156 B
Denver, Colorado 80211-5301

RE: Newlin Gulch MDP & FHAD
Draft Baseline Hydrology Report
Agreement No. 12-09.02

Dear Ms. Thomas:

Muller Engineering Company is pleased to submit this draft of the Baseline Hydrology Report for the Newlin Gulch Major Drainageway Plan for your review and comment. This study has updated the hydrology of the 15 square mile Newlin Gulch watershed to recognize the flood detention benefits of the recently constructed Rueter-Hess Reservoir. Since the reservoir has substantially altered the hydrology of the watershed, this study is well-timed to guide future development and serve as a foundation for subsequent evaluations of flooding and stream stability improvements along Newlin Gulch.

This report updates the hydrology from the 1993 OSP completed by Kiowa Engineering Corporation. The update redefines subwatershed boundaries according to UDFCD guidelines and according to existing and future development flow patterns, updates existing development and future development projections, and incorporates publically maintained regional detention facilities. It is our understanding that this submittal will be distributed to and reviewed by the project sponsors; comments received from this review will be incorporated in subsequent revisions of this report.

We appreciate the opportunity to work with you on this report, and look forward to our continuing collaboration.

Sincerely,

MULLER ENGINEERING COMPANY, INC.

Derek D. Johns

Derek D. Johns, P.E.

Project Manager

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1 INTRODUCTION

1.1 AUTHORIZATION

The Urban Drainage and Flood Control District (UDFCD), in agreement with Douglas County and the Town of Parker, contracted with Muller Engineering Company, Inc. to conduct a Major Drainageway Plan (MDP) for Newlin Gulch. The work is authorized under UDFCD Agreement No. 12-09.02, dated November 13, 2012.

1.2 PURPOSE AND SCOPE

The Newlin Gulch watershed was last studied in the Newlin and Baldwin Gulches and Basin 4600-09 Outfall Systems Planning Study (OSP), published in August 1993 by Kiowa Engineering Corporation. The Newlin Gulch regulatory floodplain was established in a 1977 Flood Hazard Area Delineation (FHAD) prepared by Howard, Needles, Tammen & Bergendoff along with Happy Canyon Creek, Baldwin, Sulphur, and Tallman Gulches. Several Letter of Map Revision (LOMR) updates to the floodplain have been incorporated since the 1977 FHAD.

UDFCD typically updates master plans every 20-30 years based on requests and support from local governments. In the case of the Newlin Gulch watershed, significant development in the lower portion of the watershed within the Town of Parker has occurred since the 1993 OSP. More development is expected in the near future, in particular in the City of Castle Pines in the upper portion of the watershed as construction begins on the Canyons Development. The most dramatic change to the watershed has been the recent construction of the Rueter-Hess Reservoir, a large water storage reservoir. The large normal pool (1.7 square miles) impacts the hydrology of the lower two-thirds of the watershed. This update is therefore well-timed to help guide channel improvements, address flooding concerns in conjunction with development, and reflect the impact of Rueter-Hess Reservoir on hydrology and channel stability.

The overall scope of work for the MDP includes the following main tasks:

1. Meet periodically with the project sponsors and other stakeholders to exchange information and to solicit input and direction.
2. Set up and maintain a project web site to present information and receive input from interested parties.
3. Collect and review available reports and studies related to existing and proposed stormwater facilities, local hydrology, floodplains, current and future land use, and water quality.
4. Review the 1993 hydrologic model and create new historic, existing, and future land-use hydrologic models using the latest versions of CUHP and SWMM. Include current publicly-maintained regional detention facilities, account for the increased imperviousness and inadvertent flood storage of Reuter-Hess Reservoir, and reflect other watershed conditions that currently exist.
5. Perform hydraulic calculations necessary to assess the adequacy of existing stormwater facilities and to size alternative improvement plans.
6. Identify existing and potential future drainage, erosion, water quality, and flooding problems in the project area, including a general identification of wetland and riparian zones and potential detention sites.
7. Formulate and evaluate conceptual alternative plans to address drainage, erosion, water quality, and flood hazard problems associated with the drainageway, considering probable costs, water quality effects, and maintenance aspects.
8. Prepare a draft alternatives analysis report to document the formulation and evaluation of alternative plans and to recommend a preferred alternative, review with project sponsors and stakeholders, and revise to address the comments received.
9. Undertake a conceptual design of the selected alternative and prepare drawings and probable cost information for the plan, documenting in a draft, then final conceptual design report.

A FHAD was also authorized under the same agreement, and will be presented in a separate document.

1.3 PLANNING PROCESS

Based on input from the project sponsors and on observations of the current condition of various reaches of Newlin Gulch, the following main objectives for this master plan were identified:

- Determine the impact of the Reuter-Hess Reservoir on existing and future peak flow rates. Use the hydrologic models as the basis for an agreement with the reservoir concerning flood storage and discharge.
- Estimate the existing and future floodplain downstream of Reuter-Hess using the updated hydrology.
- Identify floodplain and channel stability concerns associated with the new development and develop appropriate alternatives to address the issues.
- Develop conceptual design improvements to be implemented with adjacent development.
- Achieve the objectives of project sponsors and stakeholders while preserving a natural channel character and supporting riparian vegetation communities and resident wildlife habitat

Periodic meetings were held to gather input from project sponsors and stakeholders. A summary of project meetings is shown in **Table 1-1**; meeting minutes are included in **Appendix A**.

Table 1-1: Project Meetings

Meeting	Date	Purpose
Kickoff Meeting	November 19, 2012	Review project scope and project approach, identify information needs
Progress Meeting #2	March 18, 2013	Hydrology status update, review land use assumptions, review SWMM and CUHP model assumptions
Progress Meeting #3	May 15, 2013	Discuss course of action relative to Rueter-Hess Reservoir Routing and Adequate Assurances Agreement with PWSD
Progress Meeting #4	December 17, 2014	Restart project following hiatus while Rueter-Hess Adequate Assurances Agreement was being coordinated and approved

1.4 MAPPING AND SURVEYS

Mapping data sources used for the Newlin Gulch MDP included the following:

- Color aerial photography was provided by UDFCD. The photography was part of an aerial imagery project by the Town of Parker. Photographs are from early 2012.
- 2-foot interval topography within the northern project area (north of Lincoln Avenue) was obtained from the Denver Democratic National Convention (DNC) LIDAR Survey compiled by Sanborn Geospatial on July 25, 2008.
- 2-foot interval topography along the main stem of Newlin Gulch was provided by UDFCD. The topography was prepared by Merrick & Company GeoSpatial and was based on LiDAR imaging taken in October of 2012.
- 5-foot interval topography in Douglas County was provided by the County and was used to delineate watershed boundaries and define subwatershed and channel properties south of Lincoln Avenue. The source of the mapping was Merrick & Company's 1996 Digital Elevation Model (DEM) "Mass Points."
- Supplemental ground survey of the Hess Road Bridge, Bradbury Ranch Pond IV, and the Newlin Gulch channel at Challenger Regional Park was provided by UDFCD. Survey was conducted by Accurate EngiSurv, LLC in April 2013.

All mapping is on the Colorado State Plane Central Zone (0502) projection, horizontal datum NAD83, and vertical datum NAVD 1988.

Existing parcel boundaries, zoning, jurisdictional boundaries, and Digital Flood Insurance Rate Map (DFIRM) data were provided by Douglas County in Geographic Information System (GIS) format.

1.5 DATA COLLECTION

Numerous reports, studies, and design plans were reviewed and utilized in the preparation of this report. A listing of the primary references is as follows; a full listing is included in the References section at the end of this report.

- 1977 Flood Hazard Area Delineation, Happy Canyon Creek, Badger Gulch, Newlin Gulch, Baldwin Gulch, Sulphur Gulch, Tallman Gulch (Howard, Needles, Tammen & Bergendoff)
- 1993 Newlin and Baldwin Gulches and Basin 4600-09 Outfall Systems Planning Study (Kiowa Engineering Corporation)

1.6 ACKNOWLEDGEMENTS

This report could not have been prepared without the participation and support of the following project sponsors and stakeholders. We are grateful for their contributions.

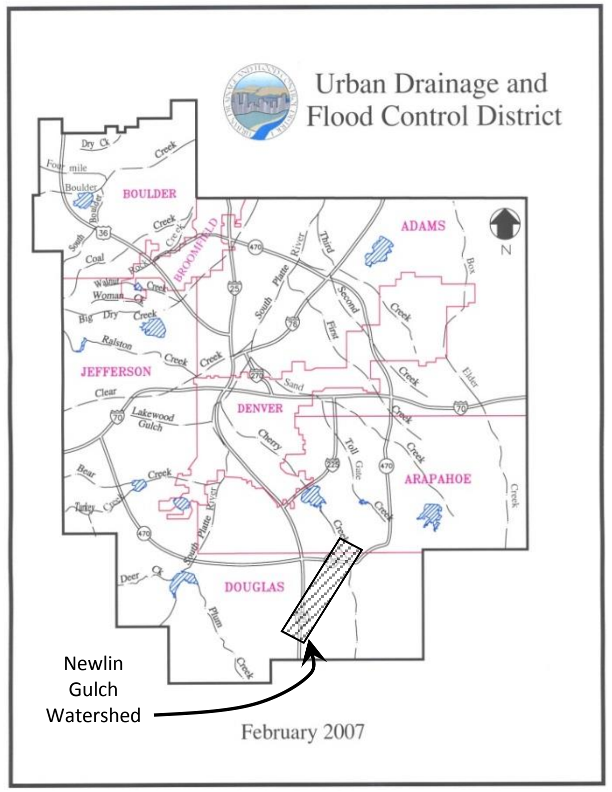
Table 1-2: Project Participants

Project Sponsors	Agency
Shea Thomas	Urban Drainage and Flood Control District
Brad Robenstein	Douglas County
Tom Williams	Town of Parker
Jacob James	Town of Parker
Project Stakeholders	**Agency**
Brad Meyering	City of Castle Pines
Pieter Van Ry	Parker Water and Sanitation District
	Cherry Creek Basin Water Quality Authority
	Stonegate Village Metro District

2 STUDY AREA DESCRIPTION

2.1 PROJECT AREA

Figure 2-1: Vicinity Map



Newlin Gulch originates in the City of Castle Pines, located along I-25 about 3 1/2-miles north of Castle Rock. The creek and its tributaries flow northeast through areas of Castle Pines, unincorporated Douglas County, and the Town of Parker before emptying into Cherry Creek near Challenger Park in the Town of Parker. The Newlin Gulch watershed area is approximately 15 square miles.

The upper third of the watershed is primarily within the City of Castle Pines. West of I-25, recently annexed areas are slated for residential and commercial development. East of I-25, the watershed includes the majority of the planned Canyons development, also in Castle Pines. The middle third of the watershed starts upstream of the new Rueter-Hess Reservoir and ends at Mainstreet in the Town of Parker. A portion of the Parker Homestead development is located in the watershed just north of Rueter-Hess. The lower third of the watershed, located north of Mainstreet, is nearly fully developed by the Stonegate Village and Challenger Park Estates developments, among others.

The Newlin Gulch watershed is approximately 8.8 miles in length and has an average width of 1.8 miles for most of its length, tapering to 0.5 miles wide at the north end. The total area is 15.0 square miles or 9,600 acres. Approximately 20% of the watershed area is developed. Another 12% of the watershed is within the projected maximum normal pool of Rueter-Hess Reservoir, which encompasses 1.8 square miles. The highest and lowest points of the watershed are 6680 and 5768 feet above mean sea level, respectively, and the average watershed slope is 1.8%. Underlying soils include hydrologic group A along the mainstem downstream of Hess Road and in some areas within the normal pool of Rueter-Hess, surrounded by areas of group B soils. The majority of the tributary area is underlain by hydrologic group C soils. A map of soil classifications is included as **Figure B-1** in **Appendix B**.

Newlin Gulch is UDFCD Project Reuse watershed #4612.

The Major Drainageway Plan project area includes approximately 4 miles of mainstem Newlin Gulch downstream of the Reuter-Hess Reservoir, from Hess Road to the Newlin Gulch confluence with Cherry Creek. The scope of this project does not include master planning of improvements upstream of Reuter-Hess Reservoir; however, the entire watershed has been modeled for the baseline hydrology.

2.2 LAND USE

Land use within the Newlin Gulch watershed varies from rangeland and open space to high density city center. Existing development conditions were generally based on visual assessment of the aerial photography provided by UDFCD, and future development conditions were based on information provided by project sponsors and stakeholders, including planning documents, zoning, master drainage plans, and direct input. In a few cases, roads were identified separately in land use analysis: the I-25 corridor is reflected as 50% impervious to reflect separation between travel lanes and additional right-of-way, while Hess Road, Chambers Road and Lincoln Avenue are assumed 100% impervious. All other existing or planned roads are assumed to be accounted for in the impervious values of adjacent development. The projected maximum normal pool of Rueter-Hess Reservoir is treated as 100% impervious under both existing and future development conditions.

The overall existing weighted impervious value for the Newlin Gulch watershed is 22.5%. Future development is projected to increase watershed imperviousness to 34.7%. The interactive hydrology map in Appendix B shows existing and future land use boundaries and impervious values (Figures B-2 and B-3).

Upper Watershed: Castle Pines Town Center to Rueter-Hess Reservoir

The upper watershed extends from approximately two miles south of the I-25 and Castle Pines Parkway Interchange north to the boundary of the Rueter-Hess Reservoir normal pool. The mainstem channel length is slightly less than three miles. A small portion of the watershed west of I-25 includes existing medium-density residential and commercial lots which are part of the City of Castle Pines. The extreme south end of the watershed includes existing large-lot residential from the Sapphire Pointe development. Undeveloped parcels cover the remainder of the upper watershed in the existing condition. Future development includes The Canyons, Castle Pine Town Center, and LaGae Ranch. The Canyons is the largest of the three and extends from the edge of Rueter-Hess Reservoir to beyond the southern boundary of the watershed. Future land-use and impervious values for the future developments were based on the most current drainage plans available. The weighted impervious value for the upper watershed is 21% (future development condition).

The upper watershed includes numerous tributary “fingers” to the mainstem: the Spring Tributary, the Roundtop Tributary, the Mesa Tributary, South Newlin Gulch, and the Big Windmill Tributary. The majority of these tributaries (with the exception of the Spring Tributary) are currently undeveloped.

Lower Watershed: Rueter-Hess Reservoir to Cherry Creek Confluence

Rueter-Hess Reservoir is a water supply reservoir owned by Parker Water and Sanitation District (PWSD). It is located on the mainstem of Newlin Gulch in the central portion of the watershed. The construction of the reservoir was completed in 2012 and consists of a 170-foot tall earthen dam that is designed to store 72,000 acre-feet of water. Though the reservoir will not be full for several years, the planned normal pool will have a surface area of approximately 1.8 square miles (1,150 acres), which is approximately 12% of the entire watershed. Downstream of the reservoir, the recent Hess Road extension to I-25 provides a boundary between the reservoir and existing and future residential development. Existing medium to dense residential lots cover a large portion of the lower watershed. These lots are part of a number of subdivisions, including (from north to south): Challenger Park Estates, Stonegate Village, Bradbury Ranch, New Horizon, The Regency, and Newlin Meadows. Additionally, construction is currently underway for the Parker Homestead development just north of Hess Road. The remaining undeveloped areas are centered on the intersection of Chambers and Mainstreet. West of Chambers, commercial and residential development is currently in the planning stages as part of Meridian Village. The weighted impervious value for the lower watershed is 37% (future development condition, excluding the Rueter-Hess normal pool).

The Sandpit Tributary passes through the northern edge of the Parker Homestead development and empties into the mainstem just east of Chambers Road. West of Parker Homestead, construction is currently underway for the new Parker Water and Sanitation District water treatment plant. The upper portion of the Sandpit Tributary remains undeveloped with no plans for future development.

The Jordan Road tributary, which empties into the mainstem just west of Jordan Road, is fully developed with portions of Stonegate Village and Bradbury Ranch.

2.3 REACH DESCRIPTION

Reach descriptions will be included in subsequent reports.

2.4 FLOOD HISTORY

The 1993 OSP does not include a record of flooding for the watershed, in part because the majority of development in the lower watershed (downstream of Rueter-Hess Reservoir) occurred after the 1993 OSP study. The floodplain was effectively managed during development to leave sufficient capacity for major storms flows while preventing damage to adjacent structures. The addition of Rueter-Hess Reservoir will reduce the peak flows in the developed portions of the watershed, further reducing the flooding impacts.

In Challenger Park, Newlin Gulch crosses Recreation Drive with an on-grade crossing which has caused recent flooding problems. The crossing is signed with flood warnings including flashing hazard lights. Despite these warnings, vehicles have been documented using the crossing during flood events. In one recent case, a vehicle stalled in the moving water. Alternatives to an on-grade crossing will be analyzed in subsequent reports.

2.5 ENVIRONMENTAL ASSESSMENT

An environmental assessment will be included in subsequent reports.

3 HYDROLOGIC ANALYSIS

3.1 OVERVIEW

In watersheds where hydrologic models exist, master planning efforts generally utilize the existing models as a starting point for baseline hydrology, with revisions made as necessary to reflect changes in the watershed and to update the models to current software. For Newlin Gulch, hydrologic models from the 1993 OSP were provided by UDFCD. Electronic AutoCAD or GIS files were not available for the OSP subwatershed delineation. A number of challenges arose while reviewing and attempting to recreate the boundaries based on the Hydrological Basin Map from the 1993 report. Most evident was the impact of Rueter-Hess Reservoir on the watershed: the maximum normal pool of the Reservoir covers about 12% of the total watershed area. As a result, the Big Windmill, Canal, and Parkway Tributaries have been significantly shortened, and the Benchmark Tributary has been completed eliminated by the Reservoir permanent pool. Accordingly, the subwatershed delineations, design points, and routing elements necessary to model the Reservoir are different from the 1993 OSP. In addition, significant development in the lower watershed necessitated numerous changes to subwatershed boundaries, design points, and routing elements. As a result, though the 1993 boundaries were used as a guide, a new subwatershed delineation was performed.

These watersheds were evaluated using UDFCD's Colorado Urban Hydrograph Procedure (CUHP) 2005, version 1.3.3 (release date January 2010). Hydrographs generated in CUHP were then routed through the Environmental Protection Agency's (EPA) Storm Water Management Model (SWMM), version 5.0.020. Due to the numerous changes that would have been needed to reflect the updated delineation, the design team elected to create a new SWMM model as well rather than update the previous model. This facilitated numerous improvements to the model to make it more user-friendly with the current software, including a revised naming scheme for subwatersheds, conveyance elements, and design points; layout of the SWMM model elements in the graphical user interface (GUI) over a background image of the watershed; and updating SWMM node elevations to match the project mapping.

3.2 DESIGN RAINFALL

One-hour point rainfall depths for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events were obtained from UDFCD rainfall maps for the project area and compared with the values used in the 1993 OSP. Current values are slightly lower than those used in 1993 for all but the 50-year storm, as shown in **Table 3-1.**

Table 3-1: Point Rainfall Depths

Storm Event	One-Hour Rainfall Depth (in)	
	1993 OSP	**Current Study**
2-year	1.06	0.95
5-year	1.43	1.41
10-year	1.66	1.66
25-year	N/A	1.97
50-year	2.26	2.28
100-year	2.6	2.57

UDFCD is currently in the process of updating the criteria presented in the USDCM. Updates include changes to the design storm duration and adjustments based on watershed size. The September 2012 draft version of Chapter 4 – Rainfall of the USDCM was used to develop the design rainfall distributions for this study. While the 1993 OSP used a 3-hour design storm for the Newlin Gulch watershed, the updated criteria eliminates 3-hour design storms and extends the use of a 2-hour storm duration to watersheds up to 15 square miles. Because the Newlin Gulch watershed is almost exactly 15 square miles, only a 2-hour storm distribution was used.

Adjustments to the incremental rainfall point values based on watershed area have also changed with the September 2012 draft criteria. Depth Reduction Factors (DRFs) are only applied to watershed areas greater than 15 square miles for the 25-, 50-, and 100-year storm events; therefore no adjustment for these design storms was made. For the smaller 2-, 5-, and 10-year storm events, DRFs are applied when watershed areas exceed 2 square miles. In order to apply a DRF, adjustment values are interpolated from tables provided in the draft criteria based on the applicable contributing area. CHUP and SWMM are then run with the adjusted incremental rainfall values, and design peak flow rates from the DRF-adjusted models are used for design points where the cumulative area exceeds the limits given. Several DRF-adjusted runs may be required as the cumulative watershed area increases down the mainstem. For design points in the upper watershed or off the mainstem, where the cumulative area is below the DRF threshold, the unadjusted models are used to generate design peak flow rates.

In this case, Rueter-Hess Reservoir effectively disconnects the upper watershed from the lower watershed by drastically minimizing the contributions of the upper watershed on the lower watershed peak flow rates. As a result, the project team elected to apply the DRFs separately in the upper and lower watersheds in order to avoid over-correcting for the contributing watershed area below the reservoir. Upstream of Rueter-Hess, the 2 square mile limit is exceeded at the confluence of Newlin Gulch, Spring Tributary, and Roundtop Tributary, with a combined area of 2.8 square miles. The contributing watershed area increases to 3.2 square miles at the edge of the projected normal reservoir pool. DRFs based on a 3 square mile area were interpolated from the 2 square mile and 5 square mile values listed in the draft criteria and applied to design points NG014 (edge of normal pool), NG013, and NG220 (total reservoir inflow). Downstream of Rueter-Hess (excluding the area contributing to the reservoir), the 2 square mile limit is exceeded at the confluence of Newlin Gulch and Sandpit Tributary, with an combined area of 2.2 square miles. The contributing watershed area increases to 4.5 square miles at the confluence of Newlin Gulch and Cherry Creek. For simplicity, the same 3 square mile DRF adjustment was made for the lower watershed, and applied to mainstem design points NG006 (at Stonegate Parkway) through NG000 (at the confluence with Cherry Creek).

Adjustment factors for the 3 square mile DRF are presented in **Table 3-2.** Rainfall distributions for all return periods, adjusted and unadjusted, are listed in **Table B-1, Appendix B**. Tables 4-1, 4-3, and 4-4 of the draft criteria update, which detail the applications of DRFs, are also included in **Appendix B**.

Table 3-2: Depth Reduction Factors

Time (minutes)	3 Square Mile Area DRF 2-, 5-, and 10-Year Design Rainfall
5	1.00
10	1.00
15	0.99
20	0.95
25	0.95
30	0.95
35	0.99
40	0.99
45	1.00
50	1.00
55	1.00
60	1.00
65-120	1.00

3.3 SUBWATERSHED CHARACTERISTICS

Subwatershed characteristics were defined according to the revised delineation and current mapping and land use information. For each subwatershed, the flow path from the highest point in the basin was determined from the project mapping and used to define the length and distance to centroid. The length-weighted slope along the flow path was then calculated according to the method described in the USDCM. Existing and future imperviousness was determined based on the land use assumptions outlined in **Section 2.2**. Hydrologic soil group classifications were determined via the Natural Resources Conservation Service Web Soil Survey. Based on the soil groups present in each subwatershed, weighted values were calculated for initial and final infiltration rates as well as for the Horton's decay coefficient. Depression losses in pervious and impervious areas were set at 0.5 and 0.1, respectively, to match the values used in the 1993 OSP. A unit hydrograph time increment of 1 minute was used, since some of the subwatersheds are less than 90 acres (USDCM Table RO-1).

A total of 98 subwatersheds were defined. Areas ranged from 22 acres to 177 acres, with an average size of 87 acres (excluding the Rueter-Hess basin A-220). At the outset of the study, the maximum desired subwatershed area was 130 acres, however, this requirement was relaxed to allow for more reasonable subwatershed delineations in undeveloped areas. With the exception of Rueter-Hess, four subwatersheds (A-165, A-210, C-110, and C-120) significantly exceed the 130 acre guideline.

Hydrologic soil groups, existing and future impervious values, and subwatershed boundaries are shown on the interactive hydrology map in **Figure B-1, Appendix B**. A summary of all subwatershed values used in CUHP is presented in **Table B-2**, **Appendix B**.

3.4 HYDROGRAPH ROUTING

A new SWMM model was created for routing of the hydrographs generated in CUHP. Channel geometry was approximated from the project mapping, utilizing 2' interval topography north of Rueter-Hess Reservoir, and 5' interval topography in the remainder of the watershed. Trapezoidal elements were used exclusively for conveyance. SWMM determines channel slopes based on the segment length and elevations of upstream and downstream nodes; node elevations were defined based on the project mapping. Manning's n values were calculated using the Jarrett equation (USDCM Equation RO-10), and then were compared to the 1993 OSP values. Design points were placed at the downstream end of each subwatershed, with additional points included to reflect flow rates before and after the confluence with each tributary channel. Two detention storage areas were identified as eligible for inclusion into the baseline hydrology: Rueter-Hess Reservoir and Bradbury Ranch Pond IV. These are further discussed in **Sections 3.4.1** and **3.4.2** below.

SWMM model conveyance elements, subwatershed nodes, design points and storage elements are shown on the interactive hydrology map in **Figure B-1, Appendix B**. SWMM routing schematics are provided as **Figures B-2 and B-3** in **Appendix B**. SWMM input parameters and output results for the 100-year future development condition are included in **Tables B-7 and B-8, Appendix B**.

3.4.1 Rueter-Hess Reservoir Routing

The most significant storage area within the Newlin Gulch watershed is Rueter-Hess Reservoir, located on the Newlin gulch mainstem. The reservoir is owned and operated by Parker Water and Sanitation District (PWSD). Although the reservoir is designed only for water storage, the reservoir surface area is so large relative to the tributary watershed that it provides significant inadvertent flood detention. Outflows from the reservoir are controlled through a gated, multi-chambered tower that connects to two 78-inch diameter outlet conduits. The service spillway is comprised of two of the upper openings in the outlet works tower, each approximately 10-feet wide and 5-feet tall. The maximum normal pool elevation for the reservoir is elevation 6215.1 (NAVD88) which is equal to the crest of the service spillway. According to an evaluation conducted by the reservoir design engineer, the service spillway can convey both the 100-year and 500-year storm events. An auxiliary (or emergency) spillway consisting of a 500-foot long labyrinth weir is located on the west side of the dam embankment. The auxiliary spillway crest is at elevation 6216.7, which is 1.6-feet above the service spillway crest. The auxiliary spillway is designed to convey extreme flood events (greater that the 500-year).

To determine the flood detention impacts of Rueter-Hess, several options for routing floods through the reservoir were evaluated with the SWMM model. These options included flood routing through the service spillway, routing through the auxiliary spillway, and routing without the reservoir. The results of the routing options are summarized in a memorandum completed in May 2013 entitled *Rueter-Hess Reservoir Flood Control Benefits*. This memorandum, along with a summary table comparing downstream flows for the different routing options, are provided in **Appendix C**. The project sponsors, in cooperation with

PWSD, selected the option of routing through the auxiliary spillway for the baseline hydrology. The modeling results for this option show that, in the future development condition, a peak 100-year inflow of over 10,000 cfs routed through the reservoir will be discharged downstream of the Reservoir at less than 1,000 cfs and the reservoir water surface will surcharge or rise by approximately 0.8-feet. No modification to the outlet works or spillways is necessary to achieve this flood detention/attenuation. The project sponsors and PWSD selected the auxiliary spillway routing option because it accounts for the significant inadvertent flood detention provided by the Reservoir, while still allowing for some flexibility to change the service spillway elevation in the future to accommodate additional water storage without altering 100-year flood discharges downstream.

The baseline hydrology model assumes the following for Rueter-Hess: the reservoir normal pool is 100% impervious, the reservoir is full to the auxiliary spillway crest (elev. 6216.7) prior to the storm event, the service spillway is ignored/blocked, and the upstream hydrograph is routed through the auxiliary spillway.

The project sponsors entered into an agreement with PWSD on November 13, 2014, entitled “Agreement Regarding the Intent to Assure the Flood Routing Capability of Rueter-Hess Reservoir in Douglas County, Agreement No. 14-05.05”. This agreement officially recognizes the inadvertent flood routing capability of the Reservoir for the 100-year discharge along Newlin Gulch and the intention to assure that this flood routing capability is maintained. A copy of the agreement is included as **Appendix D**.

The reservoir stage-area and stage-discharge curves used for the baseline SWMM model are included in **Table B-3, Appendix B**. These curves were taken directly from the original storage and discharge rating curves shown on Drawing No. A-05 of the reservoir record drawings. A copy of this drawing is also included in **Appendix B**.

3.4.2 Bradbury Ranch Pond IV

Currently, the only regional detention pond recognized in the Newlin Gulch watershed is the Bradbury Ranch Pond IV located along the Jordan Road Tributary just south of Mainstreet. The detention pond was built with Phase 1 of the Bradbury Ranch development in the late 1990’s and early 2000’s. Pond IV is referred to in many of the Phase III drainage reports for the various filings of the development, but despite extensive searching no design plans were found. A stage-area curve was developed based on Douglas County 5-foot interval topography. A stage-discharge curve was developed based on a detailed ground survey of the two-stage pond outlet works, which consist of a 60-inch open-ended culvert (lower stage), and a 30-foot broad-crested weir (upper stage). The SWMM analysis shows that the upper stage will overtop in storm events exceeding a 50-year recurrence. Overtopping flows will cross Mainstreet at Bradbury Parkway before rejoining the Jordan Road Tributary.

Stage-area and stage-discharge curves for Bradbury Ranch Pond IV are included in **Table B-3, Appendix B.**

3.5 PREVIOUS STUDIES

Newlin Gulch was previously analyzed in a 1977 FHAD and a 1993 OSP. The FHAD established the regulatory FEMA flow rates. Hydrographs were based on a 24-hour design storm with a Type IIA SCS rainfall distribution; peak discharges were calculated with the Soil Conservation Service’s computer programs WSP2 and TR20.

The 1993 OSP utilized 2-hour and 3-hour design storms. Hydrographs were generated with the PC version of CUHP and routed through UDSWM2-PC. In 1993, the OSP notes that less than five-percent of the watershed area was impervious. The future land-use assumptions made in the OSP significantly increased the watershed imperviousness, but are still much lower than the current future land use projections. The future land use maps included in the OSP indicate that the upper portion of the watershed was modeled as about 80% open space (2%), with about 15% large lot residential (10%) and a small area of high-density residential (45%). The future land use imperviousness estimated in this area in the current study is significantly higher.

3.6 MODEL CALIBRATION

Standard practice for master planning studies on previously studied watersheds includes calibration of the hydrologic model to reconcile the results within 10% of the previously published data. This practice ensures that changes in baseline hydrology are due to changes within the watershed or updates to criteria rather than differences in software. Calibration is generally done through adjustment of Cp and/or Ct values in the CUHP, which impact the peak flow rates and the time to peak, respectively. This study targeted the 1993 OSP existing condition peak flow rates for reconciliation. A calibration “Historic” model was prepared, using 2% imperviousness across the entire watershed, and 100-year 2-hour and 3-hour rainfall distributions.

The results were found to agree within 10% for the majority of mainstem design points compared. In portions of the upper watershed, the 1993 OSP and current historic model do not calibrate to within 10%. However, these areas are on the upper end of an undeveloped watershed, where little infrastructure has been designed and built based on the previous peak flows. These results were presented to the project sponsors at the progress meeting on March 18, 2013. It was agreed that the current study CUHP and SWMM models reconciled with the 1993 OSP, and that no calibration of the model was necessary. Results of the calibration analysis are shown in Table 3-3.

Table 3-3: Model Calibration

Location	FHAD Cross Section	OSP Design Point	Current Design Point	1977 FHAD * 100-Yr (cfs)	1993 OSP **		Current Study 100-Yr Historic† (cfs)	% Increase Historic Model vs 1993 OSP***	% Increase Historic Model vs. 1977
					Existing (cfs)	Future (cfs)			
Newlin Gulch									
Cherry Creek	28	180	NG000	4790	5357	5513	5674	6%	18%
Lincoln Ave. (U/S)		177	NG001		5198	5396	5637	8%	
Jordan Rd. (U/S)	23	176	NG002	4720	5220	5412	5636	8%	19%
Mainstreet (U/S)	16	166	NG006	4590	5330	5545	5269	-1%	15%
Mainstem and Tributary Inflow to Rueter-Hess		150	NG013		4969	5138	4454	-10%	
I-25 (U/S)		103	NG019		321	311	412	28%	
Tributaries									
Jordan Rd. Tributary at Newlin Confluence		276	SJ000		545	785	560	3%	
South Newlin at Mesa Confluence		128	SN001		1106	1167	1369	24%	
Mesa Tributary at South Newlin Confluence		224	MT000		420	470	490	17%	
Roundtop Tributary at Newlin Confluence		217	RT000		383	393	424	11%	
Spring Tributary at Newlin Confluence		219	ST000		773	840	885	14%	

Notes:

* 1977 FHAD flows based on 24-hour storm and WSP-2 and TR-20 models.

** 1993 OSP flows based on 3-hour storm and CUHP/UDSWM models.

*** Comparisons are based on current study historic model vs. the Existing Conditions 1993 OSP model and the 1977 FHAD model.

†Used 3-hour design storm where total watershed area is greater than 10 square miles. Used 2-hour design storm elsewhere.

3.7 RESULTS OF ANALYSIS

Newlin Gulch was analyzed for the 2-, 5-, 10-, 25-, 50-, and 100-year storm events under existing and future development conditions, using a 2-hour design storm. A comparison to previous studies is presented in **Table 3-4** below. Overall, while peak flow rates have increased somewhat in the upper watershed above Rueter-Hess Reservoir, peak flow rates in the lower watershed have decreased due to the effects of the reservoir. Though the reduction is drastic immediately below of the reservoir, the effect lessens as the mainstem approaches its confluence with Cherry Creek.

Detailed results are included in **Appendix B**. Peak flow rates at each design point are listed in **Table B-4**; runoff volumes and accumulated drainage areas at key locations are listed in **Tables B-5 and B-6**. Hydrographs at key locations for the 2-year and 100-year events are shown in **Figures B-4 and B-5**. Peak flow profiles for all storm events on the mainstem of Newlin Gulch are shown in **Figures B-6 and B-7**.

Table 3-4: Comparison to Previous Studies

					1993 OSP **		**Current Study**	
Location	**FHAD Cross Section**	**OSP Design Point**	**Current Design Point**	**1977 FHAD * 100-Yr (cfs)**	**100-Yr Existing (cfs)**	**100-Yr Future (cfs)**	**100-Yr Existing (cfs)**	**100-Yr Future (cfs)**
Newlin Gulch								
Cherry Creek	28	180	NG000	4790	5357	5513	2843	3581
Lincoln Ave. (U/S)		177	NG001		5198	5396	2795	3486
Jordan Rd. (U/S)	23	176	NG002	4720	5220	5412	2793	3478
Stonegate Parkway (U/S)			NG004				2212	2683
Mainstreet (U/S)	16	166	NG006	4590	5330	5545	1945	2253
Chambers Rd. (U/S)			NG009				905	1025
Hess Rd.			NG011				890	1010
Rueter-Hess Reservoir Outflow			NG012				880	995
RH Total Inflow (Including Reservoir Subwatershed)			NG220				8822	10381
Mainstem and Tributary Inflow to RH		150	NG013		4969	5138	5871	7657
Mainstem Inflow to RH			NG014				2454	3255
I-25 (U/S)		103	NG019		321	311	426	514
Tributaries								
Jordan Rd. Tributary at Newlin Confluence		276	SJ000		545	785	690	755
South Newlin at Mesa Confluence		128	SN001		1106	1167	1388	1564
Mesa Tributary at South Newlin Confluence		224	MT000		420	470	493	598
Roundtop Tributary at Newlin Confluence		217	RT000		383	393	429	504
Spring Tributary at Newlin Confluence		219	ST000		773	840	1009	1427

Notes:

* 1977 FHAD flows based on 24-hour storm and WSP-2 and TR-20 models.

** 1993 OSP flows based on 3-hour storm and CUHP/UDSWM models.

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Appendix A

PROJECT CORRESPONDENCE

MEETING MEMORANDUM

MULLER ENGINEERING COMPANY, INC.
CONSULTING ENGINEERS
777 SOUTH WADSWORTH BLVD., SUITE 4-100
LAKEWOOD, COLORADO 80226
(303) 988-4939

Project
Newlin Gulch MDP

Sponsors
UDFCD / Douglas County / Town of Parker

Meeting Location
UDFCD

Attendees
Shea Thomas, UDFCD
Bill DeGroot, UDFCD
Brad Robenstein, Douglas County
Tom Williams, Town of Parker
Jacob James, Town of Parker
Derek Johns, Muller Engineering Company
Jim Wulliman, Muller Engineering Company
Andy Pultorak, Muller Engineering Company

Purpose
Newlin Gulch MDP Kick-off Meeting

Meeting Date
Nov. 19, 2012

Issue Date
Nov. 28, 2012

MEC Project No.
12-050.01

Minutes Prepared By
Andy Pultorak

Routing
ASP / DDJ / JTW

Action Items

All action items are requested to be completed by December 7, 2012 unless otherwise noted.

Muller Action Items:

1. Muller will review the Baldwin Gulch mapping provided by Shea and update the survey request for Baldwin accordingly. Muller will then send the updated request to Shea.
2. Muller will contact Parker Water & Sanitation District (PWSD) to obtain the Reuter-Hess spillway configuration for use in modeling the Reservoir impacts to the downstream watershed.
3. Muller will provide a survey request figure to Shea with survey needs at Challenger Park (Recreation Drive).
4. Muller will coordinate with the sponsors to setup the first progress meeting.
5. Muller will contact Castle Pines to obtain the latest development plans for the upper watershed.
6. Muller will setup the project website and invite the project team to review before posting.

UDFCD Action Items:

1. ~~Shea will provide aerial mapping for Baldwin Gulch to Muller.~~ (Complete)
2. ~~Shea will invite Muller to the project Dropbox folder.~~ (Complete)
3. Shea will provide new 2-foot LiDAR mapping of the Newlin Gulch watershed once processing is complete (should be the week of November 25th).

Douglas County Action Items:

1. Brad (Douglas County) will provide Muller with the LOMR document for the Hess Rd. crossing (LOMR 11-08-0044P).
2. Brad (Douglas County) will provide Muller with drainage reports and as-built plans for the requested developments within the watershed.

Town of Parker Action Items:

1. Jacob will provide Muller with drainage reports and as-built documents for the requested developments within the watershed.
2. ~~Jacob will provide Muller with LOMR documents for the crossings at Lincoln, Jordan, and Chambers~~ (Complete).

Discussion

THE FOLLOWING IS OUR UNDERSTANDING OF THE SUBJECT MATTER COVERED IN THIS CONFERENCE. IF THIS DIFFERS WITH YOUR UNDERSTANDING, PLEASE NOTIFY US IMMEDIATELY.

Agenda

1. REVIEW PROJECT APPROACH AND SPONSOR GOALS

a. Derek introduced the project and stated that the goal was to update the Major Drainageway Plan for the Newlin Gulch watershed based on current and projected land use.

b. Reuter-Hess Reservoir impacts

  - Derek stated that the construction of the Reuter-Hess Reservoir significantly attenuates the downstream peak flows for major floods. Although the reservoir was not designed for flood storage, the large surface area provides significant storage for major floods. Derek said that evaluations complete by the design engineer for Reuter-Hess indicate that, with the reservoir at full capacity, the 100-year flood event would cause about 0.6-feet of rise in the reservoir. For the 100-year event, the reservoir will not crest the emergency spillway and the downstream peak flow will be reduced to near zero.
  - Derek said that recent infrastructure projects downstream of the dam utilized the reduced peak flow rates in design, resulting in significant cost savings. However, since FEMA does not recognize the reduced flow rate, the map revisions for these projects used the much higher regulatory flow rate. Therefore, these projects showed overtopping where none is likely to occur.
  - Tom said that from a land-use perspective he was in favor of keeping the FIS flow rates intact, since the watershed has already been significantly developed. However, from an infrastructure planning perspective, he saw value in having FEMA adopt the reduced flow rates so that smaller, most cost-effective crossing structures could be built.
  - Jim noted that FEMA would require an adequate assurances agreement to be entered into by Parker Water and Sanitation District (the reservoir operator) before the flood storage could be acknowledged by FEMA. Bill DeGroot said that at Standley Lake the reservoir operator had initially signed an adequate assurances agreement but later started work on a project which would have modified the reservoir operation and put houses in the floodplain. He also pointed out that designing channel crossings to the current FIS flow rate provided a factor of safety against clogging.
  - Muller will evaluate the watershed hydrology with and without the flood storage effects of Reuter-Hess, and present their findings to the team at a future progress meeting. The project team will decide which set of flow rates makes the most sense to publish for this study considering the issues mentioned above.
  - Tom stated that Reuter-Hess had held runoff from large storm events in June and July. The State Engineer’s Office required release of this water, which started at 20-30 cfs and increased to a few hundred cfs. This caused noticeable stream degradation in Newlin Gulch immediately downstream. The team expected that the frequency and duration of flow releases from reservoir operations could threaten the stability of Newlin Gulch in the future.

Tom has discussed operations with PWSD and would like Reuter-Hess to release at lower flow rates of 20-30 cfs over a longer time period when they have to release runoff. This study will develop recommendations to stabilize the channel and prevent downcutting and erosion.

c. Muller will make sure that the recommendations of the MDP are consistent with the goal of preserving natural and beneficial stream functions. The team would like to preserve the natural character of the Newlin Gulch floodplain.

d. As part of the study, the team would like Muller to prepare alternatives to address flood conveyance at the Recreation Drive "Texas" crossing in Challenger Park. The team noted that, despite flood warning devices, this area continued to pose a hazard to motorists. Tom said that one of the challenges at this location is to design a crossing in a manner that does not cause floodplain issues.

e. The Baldwin Gulch portion of the study will focus on a stability analysis of the spillway for the Soil Conservation Service dam east of Pine Lane. The stability of the Baldwin Gulch channel between the dam and Pine Lane will also be evaluated. Muller will prepare a list of supplemental survey needs for this area (see Action Items).

2. DATA FOR BASELINE HYDROLOGY.

a. Mapping
  - Muller presented a large scale figure of the Newlin Gulch watershed superimposed on 5-foot topography provided by Douglas County.
  - If necessary, Muller has access to the 2008 DNC LiDAR topo for areas north of Lincoln.
  - Shea thought that the new LiDAR topo she had flown this year for Newlin Gulch might cover the entire watershed.
  - Muller will use the new LiDAR topo provided by Shea (see Action Items) to delineate the basins and sub-basins, and will supplement with the Douglas County 5-foot topo as necessary.

b. Land Use
  - Shea provided Muller with aerial imagery from 2011 for the watershed.
  - Jacob will provide Muller with updated 2012 aerial photography.
  - Muller obtained zoning maps for Douglas County and Parker.
  - Muller has already obtained some drainage reports and as-built documents for the surrounding developments as part of the adjacent Happy Canyon Creek master plan. Muller will request additional drainage reports and as-builts as necessary (see Action Items).
  - The development plan in Castle Pines (upstream of Reuter-Hess) has changed significantly since the 1994 OSP. Muller will coordinate with Brad Meyering (Castle Pines Metro District) to obtain the latest development plan in this area.

c. Identify Existing Detention Ponds (regional and publically maintained)
  - With the exception of Reuter-Hess, Derek asked the project team if they were aware of any publically maintained detention ponds within the watershed. The team was not aware of any ponds.

d. Reuter-Hess Reservoir
  - As part of several design projects within Stonegate Village, Muller had already obtained some documentation regarding the operation of the Reuter-Hess Reservoir. Muller will coordinate with PWSD to obtain additional information needed to complete the baseline hydrology (see Action Items).
  - Derek mentioned that in his previous experiences modeling watersheds containing large reservoirs, certain unique challenges arose. Muller plans to model the reservoir full to the normal pool elevation prior to the storm and make the reservoir a sub-basin within the watershed with an imperviousness of 100%. The team agreed with this approach. Derek stated that some basin characteristics (such as average basin slope) were difficult to estimate for a reservoir. Shea said that she would work with Muller to adjust the Cp factor to create a reasonable time to peak for the reservoir sub-basin.

3. Approach to Baseline Hydrology

Derek summarized the steps for developing the baseline hydrology:

a. Convert CUHP/SWMM file from 1994 OSP
b. Update subwatershed boundaries and characteristics (excluding % imperv.)
c. Calibrate to the existing FEMA flow rates (per 1977 FHAD). The FEMA flow rates are published downstream of Reuter-Hess. Upstream of Reuter-Hess, Muller will compare their peak flow rates to the 1994 OSP, but no calibration is required. Muller will also compare, but not calibrate, their flow rates to those published as part of the recent Cherry Creek FHAD study.
d. Update % imperviousness values for existing and future land use.
e. Add eligible publically maintained detention ponds.

4. SUPPLEMENTAL FIELD SURVEY

a. Newlin Gulch MDP
  - The team discussed the need for supplemental ground survey at road crossings. Parker and Douglas County have LOMR studies for all of the major crossings and will send copies of these studies to Muller. The team decided that no supplemental crossing survey is warranted at this time.
  - Derek mentioned a private drive between Chambers Rd. and Hess Rd. This is a low-water crossing consisting of 18-inch culvert pipes. The team decided that no survey is necessary at this location.
  - Muller will coordinate with Shea to obtain ground survey of the Recreation Drive "Texas" crossing (see Action Items).

b. Baldwin Gulch
  - Shea has already obtained 2-foot aerial mapping of the SCS dam on Baldwin Gulch as part of a survey effort for another project. Muller will review this survey and determine if additional ground survey is warranted (see Action Items).

5. IDENTIFY AND CONTACT STAKEHOLDERS (WHO AND WHEN)

The team discussed contacting other stakeholders (below). Muller will contact PWSD and Castle Pines initially as part of the baseline hydrology task. At Shea's recommendation, the team will wait for the completion of the baseline hydrology to involve the other stakeholders in progress meetings.

a. Parker Water & Sanitation District
b. Castle Pines
c. CCBWQA and CDOT

6. PROJECT WEBSITE

a. The project website will be similar to the website Muller created for the Happy Canyon MDP & FHAD.
b. The website will contain sponsor logos but not individual contact information.
c. The website comment form will be setup so that comments are emailed to Muller. Muller will then distribute comments to the project sponsors.
d. Muller will create a draft version of the website for Shea to review before making it live.

7. **PROJECT SCHEDULE.**
   a. Derek presented a draft project schedule to the team.
   b. Muller anticipates completing the first draft of the baseline hydrology by early February. Shea thought that this was an appropriate timeframe.

8. **OTHER ITEMS AND NEXT MEETING.**
   a. The next meeting will be held in January. Muller will coordinate with the sponsors to establish an acceptable meeting time.
   b. There being no other business, the meeting was adjourned.

END OF MINUTES

MEETING
MEMORANDUM

MULLER ENGINEERING COMPANY, INC.
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LAKEWOOD, COLORADO 80226
(303) 988-4939

Project
Newlin Gulch MDP

Sponsors
UDFCD / Douglas County / Town of Parker

Meeting Location
UDFCD

Attendees
Shea Thomas, UDFCD
Bill DeGroot, UDFCD
Brad Robenstein, Douglas County
Tom Williams, Town of Parker
Jacob James, Town of Parker
Derek Johns, Muller Engineering Company
Jim Wulliman, Muller Engineering Company

Purpose
Newlin Gulch MDP – Progress Meeting #2

Meeting Date
March 18, 2013

Issue Date
April 21, 2013

MEC Project No.
12-050.01

Minutes Prepared By
Derek Johns

Routing
ASP / DDJ / JTW

Muller Action Items:

1. Muller will evaluate two other options for routing at Rueter-Hess Reservoir:
    a. Route flows through the auxiliary spillway.
    b. Eliminate Rueter-Hess Reservoir completely and model reservoir subwatershed based on historic conditions and 2% imperviousness.
2. Muller will email the Sandpit Tributary flow rates to the project team.
3. Muller will evaluate flow rates for smaller storm events (2-yr, 5-yr, etc.) on Newlin Gulch by the Parker Homestead development and email these to Parker.
4. Muller will update the project schedule.

UDFCD Action Items:

1. Shea will provide input to Muller regarding depression storage losses for subwatersheds.
2. Shea will provide input to Muller regarding using Jarrett's equation to compute n-values for SWMM channels.
3. Shea will get the project website linked up to the UDFCD website.

Douglas County Action Items:

1. Brad will investigate whether or not there is a regional detention pond on the Spring Tributary upstream of I-25.
2. Brad and Tom will setup a meeting with PWSD to discuss Rueter-Hess Reservoir routing.

Town of Parker Action Items:

1. Jacob will provide Muller with drainage and as-built information for the regional detention pond on the Jordan Road Tributary upstream of Mainstreet.

Discussion

THE FOLLOWING IS OUR UNDERSTANDING OF THE SUBJECT MATTER COVERED IN THIS CONFERENCE. IF THIS DIFFERS WITH YOUR UNDERSTANDING, PLEASE NOTIFY US IMMEDIATELY.

Derek provided an overview of the draft hydrology modeling completed since the last meeting and summarized the initial results. Below is a summary of the information discussed in the meeting.

1. SUBWATERSHEDS

a. Derek reviewed the mapping that was used for the hydrology analysis. The mapping consists of the following:
    - New 2-foot contour mapping for the Newlin Gulch channel corridor downstream of Rueter-Hess Reservoir. This mapping was completed in 2012 and provided by UDFCD.
    - Older 5-foot contour mapping for areas beyond the 2-foot mapping limits and for the watershed upstream of Rueter-Hess Reservoir. This older mapping was completed in 1996 and provided by Douglas County.
    - Aerial photography from Parker dated 2012.

b. Derek explained that the older 5-foot mapping does not always reflect drainage patterns correctly in newly developed areas. Therefore, land development drainage reports/maps were used to help delineate subwatersheds in newly developed areas.

c. Derek explained that the initial plan was to start with the subwatersheds from the 1993 Outfall Systems Plan (OSP) and then check the delineation based on the more current topographic mapping. However, it was discovered that the OSP subwatersheds were no longer application for the following reasons:
    - There have been many new developments since the OSP and these developments have changed drainage patterns within the watershed.
    - The Rueter-Hess Reservoir subwatershed is very large. The reservoir was delineated as a single subwatershed based on the normal pool elevation. The normal pool elevation is significantly higher than the current water level and this results in a subwatershed area of 1.8 square miles or approximately 12% of the entire Newlin Gulch watershed.
    - The OSP subwatersheds were delineated using older mapping.

d. Given these issues, a new subwatershed delineation was completed based on the more current mapping. The 15.0 square mile Newlin Gulch watershed was subdivided into 111 subwatersheds. The average subwatershed size is approximately 90 acres and only a few subwatersheds exceed 130 acres.

2. SOILS MAP

Derek handed out a map of the hydrologic soil types within the watershed. Most of the watershed consists of Type C/D soils. Type A and B soils exist along the Newlin Gulch channel.

3. LAND USE

a. Derek handed out land use maps for existing and future development conditions and explained that these were prepared based on the 2012 aerial photography and information provided in land development drainage reports. Imperviousness values were assigned according to UDFCD guidelines.

b. Douglas County. Land use for areas within unincorporated Douglas County include the following developments:
   1. Stonegate Village (existing) and Meridian Business Park (future).
   2. Happy Canyon Ranches, Sapphire Pointe, and development along Lemon Gulch Road.
      a. Brad (Douglas County) agreed that these were all large lot developments and would stay that way in the future. Brad thought that the development along Lemon Gulch Road was 35-acre lots.
      b. Brad agreed with the percent imperviousness values shown on the maps.

c. Town of Parker. Land use within Parker includes the following existing and future developments:
   1. Challenger Park and Bradbury Ranch (existing).
   2. New Horizon, Regency, Newlin Meadows (mostly developed).
   3. Newlin Crossing (on-hold).
   4. Parker Homestead (just started).
   5. Reuter-Hess WTP (just started).

d. Castle Pines. Land use within Castle Pines includes the following developments:
   1. The Canyons is a very large development being planned immediately upstream of Rueter-Hess Reservoir. Imperviousness values for this development were based on information provided in a Phase 1 drainage report.
   2. Lagae Ranch and Castle Pines Town Center (future).

e. Major Roads. Imperviousness values assumed for major roads were as follows:
   1. For I-25 and Hess Road, 60% imperviousness was assumed including ROW.
   2. For Chambers, Lincoln, Mainstreet, and Jordan Road, the imperviousness was assumed to be 100%.

f. For existing land use conditions, Derek said that the composite percent imperviousness for the entire watershed was 4.9% in the 1993 OSP Study and is 22.5% for the current study.

g. For future land use conditions, Derek said that the composite percent imperviousness for the entire watershed was 12.6% in the 1993 OSP Study and is significantly higher at 34.7% for the current study.

h. The Town of Parker and Douglas County will review the land use maps and provide comments to Muller.

4. CUHP MODEL

a. Derek said that both 2-hr and 3-hr rainfall events were modeled.

b. Derek stated that the depression losses used for the CUHP model approximately match the values used in the 1993 OSP. For pervious areas, a depression loss of 0.5-inches was used. For impervious areas, a depression loss of 0.1-inches was used (OSP ranged from 0.1 to 0.15-inches). These values are within the range listed in the UDFCD criteria manual but slightly higher than the “recommended” values. Shea stated that she will review these and get back to Muller with comments (see UDFCD Action Items).

c. Rueter-Hess Reservoir subwatershed. Derek stated that the subwatershed for Rueter-Hess Reservoir was delineated at its normal pool elevation. An imperviousness of 100% and a subwatershed slope of 0.1% were assumed. This is consistent with how similar reservoirs have been modeled within the District. The draft results of the CUHP modeling indicate a 100-year peak flow of 2958 cfs or 2.6 cfs/acre for the Rueter-Hess subwatershed. Derek noted that this is similar to the results of a study completed on Standley Lake in Westminster, Colorado, which yielded a unit discharge of 3.1 cfs/acre for the lake.

d. Derek said that Muller performed a unit discharge check of the CUHP results. It was found that for undeveloped areas the subwatershed unit discharge typically varied from 1.0 to 1.6 cfs/acre. For residential areas, the unit discharge ranged from 2.0 to 3.8 cfs/acre. For business/commercial areas, the unit discharge ranged from 3.8 to 4.9 cfs/acre. Shea said that the unit discharges for oddly shaped basins (i.e., not meeting the 4:1 shape factor) should be checked. If the unit discharges are outside the normal range, then the Cp value should be adjusted.

5. SWMM MODEL

a. Derek explained that Muller developed a new SWMM model for the Newlin Gulch watershed and did not use the 1993 OSP model. This approach was used for the same reasons mentioned earlier regarding the subwatershed delineation.

b. Natural Channel n-values.
   - Derek explained that initially Muller used typical channel n-values that would be used for hydraulic models and then increased them by 25% per UDFCD guidelines. However, it was found that the n-values computed in this way were typically lower than those in the 1993 OSP.
   - Therefore, Muller modified the n-values and used higher values that were closer to those in the 1993 OSP which were based on the Jarrett equation. Derek asked if the project sponsors had a preference on the approach for estimated n-values. Shea responded that she will look into the best approach for computing channel n-values for the SWMM model (see UDFCD Action Items).

c. Rueter-Hess Reservoir. Derek described the approach that was used to route flows through Rueter-Hess (RH) Reservoir.
   - Storage/discharge data for the reservoir was based on tables shown on construction drawings provided by Parker Water and Sanitation District (PWSD).
   - The reservoir was assumed to be full at its normal pool elevation of 6215.1 at the start of the storm event.
   - Flows were routed through the service spillway which consists of a rectangular opening in the outlet works tower.
   - Subwatersheds adjacent and upstream of the reservoir were not routed but instead directly added to the reservoir inflow hydrograph.
   - Several options for routing through the reservoir were modeled.
     1. Historic conditions prior to the reservoir being built (entire watershed including reservoir at 2% imperviousness).
     2. With the RH reservoir storage in-place and flow routed through the service spillway.
     3. Without the RH reservoir storage attenuation benefits (but reservoir footprint at 100% imperviousness).

d. Regional Detention Ponds. Derek stated that Muller was not aware of any eligible publically maintained detention ponds in the watershed.

- Tom and Bill mentioned that there is a regional pond on the Jordan Road Tributary upstream of Mainstreet. Jacob will send Muller information on this pond (see Parker Action Items).
- Brad said that there may be a regional pond on the Spring Tributary upstream of I-25 and will look into this further (see Douglas County Action Items).
- Tom mentioned that the Canyons development is proposing some regional detention ponds. However, since these are future ponds, they cannot be considered in the Baseline hydrology but would be applicable for the Master Plan conditions hydrology.

e. Draft Hydrology Results. Muller prepared a table that summarizes the draft peak discharges for the 100-year event and compares them to discharges reported in the 1977 FHAD and the 1993 OSP studies. The draft results indicate the following.

1. The 100-year peak discharges for the “Historic Conditions” model are very similar to the discharges reported in the 1993 OSP for existing conditions. Shea said that since these values are within 10-percent of each other, no further calibration adjustments are necessary.
2. The option of accounting for RH reservoir storage and routing through the service spillway results in peak discharges that are lower than both the1977 FHAD and 1993 OSP discharges.
3. The option of modeling without RH reservoir storage attenuation (but reservoir footprint at 100% imperviousness) results in peak discharges that are substantially larger (more than double) the 1977 FHAD and 1993 OSP discharges.
4. The reservoir surcharge (rise in water level) is approximately 0.8-feet in the 100-year event when routed through the service spillway.
5. The 100-year storm event never spills over the reservoir’s auxiliary spillway (emergency overflow spillway) because the auxiliary crest is 1.6-feet higher than the service spillway.

f. If the storage attenuation benefits of Rueter-Hess Reservoir are ignored, the peak 100-discharges are much higher than the 1977 FHAD discharges and would result in floodplain impacts to properties downstream of reservoir. Derek presented a floodplain exhibit of Newlin Gulch that was prepared for a separate project located downstream of the reservoir. The exhibit included the delineation of the 500-year event (based on the FHAD discharge of approximately 8000 cfs) and showed that the resulting 500-year floodplain encroaches on several properties. Since the current study 100-year flows without RH reservoir are even higher than 8000 cfs, it was concluded that there would be floodplain impacts to properties downstream if the RH storage benefits were ignored.

6. NEXT STEPS FOR BASELINE HYDROLOGY EVALUATION

a. The group discussed Rueter-Hess Reservoir routing options. To account for RH reservoir storage attenuation benefits, an “adequate assurances” agreement with the reservoir owner, PWSD, would be needed.
  - Derek suggested that perhaps routing through the auxiliary spillway should be considered to allow more flexibility in possible future changes to the reservoir. The auxiliary spillway would be more difficult to change and any changes would likely have minimal impacts to the attenuation benefits. The group agreed with evaluating this option.
  - Bill also requested that Muller look at the option of taking out RH reservoir completely and modeling the reservoir subwatershed based on historic conditions and 2% imperviousness.
  - There was some discussion regarding the reservoir’s emergency release rate of 590 cfs. This is the maximum discharge rate that the reservoir can release through the outlet works if there is a need to lower the water level for dam safety issues.

b. Muller will model the two additional routing options for the reservoir discussed above. Once this is complete, Tom and Brad will setup a meeting with PWSD to discuss the draft hydrology results and the associated impacts of Rueter-Hess Reservoir.

c. Shea said that regarding rainfall duration, only the 2-hr storm needs to be evaluated for the watershed given UDFCD’s new guidelines. The previous UDFCD guidelines require that the 3-hour storm be used for areas greater than 10 sq. miles. However, the new guidelines that are coming out soon recommend that the 2-hour storm be used for watershed areas up to 15 square miles and that the 3-hour storm be used for areas greater than 15 square miles.

7. PROJECT WEBSITE

Derek mentioned that the project website is complete and was sent to UDFCD. However, it appears that it has not been linked up to the “Master Plan” portion of the website. Shea will look into this (see UDFCD action items).

8. PROJECT SCHEDULE

Derek will review and update the project schedule.

9. OTHER ITEMS

a. The project sponsors were interested in the flow rates for the Sandpit Tributary and requested that Muller email these results to the group (see Muller Action Items).

b. Tom mentioned that a low water trail crossing of Newlin Gulch is being considered near the Parker Homestead development. Tom requested that Muller send draft peak flows at this locations for the smaller storm events such as the 2-yr, 5-yr, and 10-yr (see Muller Action Items).

c. Shea and Brad said that they would like Muller to complete the dam breach and hazard evaluation for the Baldwin Gulch dam. Shea will send Muller a scope for this work.

END OF MINUTES

MEETING MEMORANDUM

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Project
Newlin Gulch MDP

Sponsors
UDFCD / Douglas County / Town of Parker

Meeting Location
UDFCD

Attendees
Shea Thomas, UDFCD
Bill DeGroot, UDFCD
Fred Koch, Douglas County
Brad Robenstein, Douglas County
Tom Williams, Town of Parker
Jacob James, Town of Parker
Derek Johns, Muller Engineering Company
Jim Wulliman, Muller Engineering Company

Meeting Date
May 15, 2013

Issue Date
June 21, 2013

MEC Project No.
12-050.01

Minutes Prepared By
Derek Johns

Routing
ASP / DDJ / JTW

Purpose
Newlin Gulch MDP – Progress Meeting #3

Muller Action Items:

1. Muller will prepare a memorandum that summarizes the hydrologic evaluation of Rueter-Hess Reservoir and the flood control benefits associated with reservoir.
2. Muller will start preparing portions of the Draft Hydrology Report but will hold-off on finishing/publishing the report until PWSD Board approves the concept of officially recognizing the flood control benefits of Rueter-Hess Reservoir.
3. Muller will prepare a fee for a new FHAD study on Newlin Gulch.

UDFCD Action Items:

1. Shea will send an example "adequate assurances" agreement to Douglas County and Parker.

Douglas County and Town of Parker Action Items:

1. Douglas County and Parker will take the lead on coordinating with PWSD and working out the details for an adequate assurances agreement to officially recognize the flood control benefits of Rueter-Hess Reservoir.
2. Douglas County and Parker will pull out information from the Rueter-Hess memorandum and provide this to PWSD staff for their presentation to their Board.

Discussion

THE FOLLOWING IS OUR UNDERSTANDING OF THE SUBJECT MATTER COVERED IN THIS CONFERENCE. IF THIS DIFFERS WITH YOUR UNDERSTANDING, PLEASE NOTIFY US IMMEDIATELY.

1. MEETING WITH PWSD

Tom (Parker) and Fred (Douglas County) summarized the outcome of the meeting that the Town of Parker and Douglas County had with Parker Water and Sanitation District (PWSD). They met with Ron Redd/PWSD and it went well. PWSD is open to considering an agreement that would allow the flood control benefits of Rueter-Hess Reservoir to be officially recognized. PWSD sees this as an opportunity to show some of the other benefits of the reservoir. Specifics of the routing assumptions were not discussed, but Tom said that we should proceed with the option of routing through the auxiliary spillway. Tom said that in past conversations, Jim Nichol/PWSD has mentioned that PWSD would like to have the flexibility to possibly store more water in the future within the 1.6-foot zone between the service spillway and the auxiliary spillway.

2. RUETER-HESS RESERVOIR INFORMATION

Derek said that the hydrologic modeling of Rueter-Hess Reservoir was based on storage and discharge rating curves provided on as-built drawing. Muller does not have as-built drawings of the spillway dimensions. The group decided that the as-built drawing of the rating curves is sufficient documentation. Fred said that this as-built drawing should be included as part of the "adequate assurances" agreement with PWSD (the document that would be used to officially recognize the flood control benefits of Rueter-Hess Reservoir).

3. ADEQUATE ASSURANCES AGREEMENT

Bill and Shea said that UDFCD has an example "adequate assurances" agreement to start from and will send it to Fred. The agreement with PWSD will include Parker, Douglas County, and UDFCD. Parker and Douglas County will take the lead on this effort.

4. INFORMATION FOR PWSD BOARD MEETING

Tom said that the PWSD Board meets every two weeks. The group asked Muller to prepare a technical memorandum that summarizes the hydrologic evaluation and explains the flood control benefits of Rueter-Hess Reservoir. Parker and Douglas County will pull information from the memorandum and provide this to PWSD staff for their presentation to the Board. Fred said that Wendy Holmes (Douglas County) can help write/format this information which PWSD staff can use for their presentation to the Board and also as a press release.

The technical memorandum should include a summary of the hydrologic evaluation of Rueter-Hess Reservoir and document the flood control benefits. Specific items that were suggested to include in the memo are as follows:

a. Tom and Jacob suggested to state that storm flows would have increased with new development and list the percent increases.
b. Derek suggested showing an exhibit of the current floodplain in Stonegate Village and how it is currently close to residential properties. This exhibit would help to show that any significant increases in storm flows could result in properties being in the floodplain.
c. Tom said to mention flooding issues at Recreation Drive and how being able to recognize flood control benefits of Rueter-Hess Reservoir will allow improvements at this location to be accomplished more cost effectively.
d. Tom said to mention that the lower flows will also allow new bridges (i.e., Jordan Road) to be constructed more cost effectively.

The group requested that the memorandum be prepared as soon as possible (next week). Shea said that UDFCD will cover the cost for preparing the memo and Fred said that Douglas County could pay for any “extra” figures and graphics needed for marketing and/or press releases.

5. FHAD

Tom said that Parker would like to pursue doing a new Flood Hazard Area Delineation (FHAD) study that recognizes the lower peak flows from Rueter-Hess Reservoir. Tom thought that a new FHAD would be beneficial for the following reasons.

a. <u>Recreation Drive flooding issue.</u> A new bridge or culvert crossing is needed at this location that could at least convey small storms (i.e., 5-year event). A few years ago, Parker looked at putting in a new bridge at this location but there were floodplain issues along the adjacent commercial property. Recognizing lower flows from Rueter-Hess would allow for a more cost effective solution at this location.
b. <u>Jordan Road Bridge.</u> Tom said that Parker has a project underway to widen Jordan Road and add a turn lane where it crosses Newlin Gulch. To do this, the existing bridge will need to be widened but the hydraulic evaluations are indicating that there would be a rise in the floodplain which would cause problems at this location. To resolve the floodplain issue, they would have to tear out the existing bridges and build a new bridge with a longer span. Tom said that if flows are truly lower as a result of Rueter-Hess Reservoir, then it makes sense to officially recognize this. The lower flows would allow for a more cost effective solution at this location.
c. Tom added that any other new bridges or channel structures will be more cost effective by recognizing the lower flows in a new FHAD.
d. Fred mentioned some concern with developing a new FHAD using the lower flows because he does not want to constrict the existing floodplain. Tom does want to constrict the floodplain either. Tom said that the entire Newlin Gulch floodplain corridor downstream of Rueter-Hess has been dedicated as open space to Stonegate Village and the Town of Parker, so no new development can occur that would constrict the floodplain.
e. As an idea to provide more floodplain buffer, Jim mentioned the idea of adding the 590 cfs emergency flow release from Rueter-Hess Reservoir to peak storm flows. Tom thought this would be a little too conservative and not necessary.

f. The group decided to proceed with a new FHAD study. Bill and Shea did not originally plan on a new FHAD but said that they can find the funding for this. Shea asked Muller to provide a fee for a new FHAD.

6. DRAFT HYDROLOGY REPORT

Tom felt that we should hold-off on publishing the Draft Hydrology Report until the PWSD Board approves the concept of officially recognizing the flood control benefits of Rueter-Hess Reservoir. Shea said that Muller could start working on portions of the report but agreed with Tom that we should hold-off on finishing it until we get PWSD’s response. Shea said to not include all the sections in the draft report that are specified in the checklist. Some sections are not necessary at this phase of the project. Shea said to refer to the Coal Creek/Rock Creek draft hydrology report as a good example of sections that should be included.

END OF MINUTES

MEETING MEMORANDUM

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Project
Newlin Gulch MDP

Sponsors
UDFCD / Douglas County / Town of Parker

Meeting Location
UDFCD

Attendees
Shea Thomas, UDFCD
Brad Robenstein, Douglas County
Jacob James, Town of Parker
Derek Johns, Muller Engineering Company
Andy Pultorak, Muller Engineering Company

Meeting Date
December 17, 2014

Issue Date
January 5, 2015

MEC Project No.
12-050.01

Minutes Prepared By
Andy Pultorak

Routing
ASP / DDJ

Purpose
Newlin Gulch MDP – Progress Meeting #4

Muller Action Items:
1. Muller will run subwatershed hydrology using the latest version of CUHP (v. 1.4.4) to determine if peak flowrates or volumes are impacted.
2. Muller will finish the draft baseline hydrology and submit to UDFCD for review.
3. Muller will update the project website with the revised schedule.
4. Muller will email the project stakeholders (Stonegate Village, Cherry Creek Water Quality Basin Authority) regarding the FHAD study.

UDFCD Action Items:
1. Shea will send the executed adequate assurances agreement to Muller for inclusion in the appendices of the baseline hydrology report.

DISCUSSION:

THE FOLLOWING IS OUR UNDERSTANDING OF THE SUBJECT MATTER COVERED IN THIS MEETING. IF THIS DIFFERS WITH YOUR UNDERSTANDING, PLEASE NOTIFY US IMMEDIATELY.

1. INTRODUCTION

Derek (Muller) summarized the status of the project. The project was on-hold for approximately 1 ½ years waiting for the adequate assurances agreement between Parker Water and Sanitation District (PWSD) and the project Stakeholders to be finalized. Prior to stopping work, Muller had prepared hydrologic models and a memorandum summarizing the flood control benefits of Rueter-Hess Reservoir. The project Sponsors used this information over a year-long process to prepare the adequate assurances agreement with PWDS. The

agreement was signed in October, 2014. This was a major milestone, clearing the way for the masterplan to account for the flood control benefits of the reservoir.

2. DRAFT HYDROLOGY REPORT

Prior to stopping work, Muller had written much of the draft baseline hydrology report. The report and appendices need to be finalized and assembled before they can be submitted for review by the project team. The project team discussed several elements of the report as follows:

a. Adequate Assurances Agreement: The adequate assurances agreement formalizes the flood control benefits of Reuter-Hess Reservoir and the reduced peak flowrates downstream. The agreement is based on flowrates provided by Muller using the hydrologic models prepared for the eventual baseline hydrology submittal. Shea would like to include a copy of the adequate assurances agreement as an appendix in the report (see Action Items). The technical memorandum, prepared by Muller and used in the development of the agreement, should also be included as an appendix in the report. The team requested that none of the hydrologic model results which ignore the flood control benefits of Reuter-Hess be included in the text of the main report (to avoid confusion).

b. Land Use: Derek noted that the hydrologic models were prepared using the best available land use information during the development of the models. This included some conceptual and preliminary drainage reports for future developments, including the Canyons development in Castle Pines. Derek noted that these development plans may or may not have changed since the hydrologic models were prepared. This could potentially impact the imperviousness and infiltration assumptions used in the hydrologic models. Brad Robenstein (Douglas County) said that he was unaware of any major changes with the Canyons development. Shea agreed that the preliminary information used during the initial model development was adequate and did not need to be revisited. Jacob James (Town of Parker) noted that there were no changes to future land use assumptions within the Town boundaries.

c. Interactive PDF: Andy Pultorak (Muller) asked Shea if including static PDFs for land-use, routing, and subwatershed figures in the draft submittal was acceptable to UDFCD, since this would eliminate some repeated work if the figures changed between draft and final submittals. Shea agreed that static PDFs were acceptable for the draft submittal, as long as the interactive PDF was included in the final.

3. FLOOD HAZARD AREA DELINEATION

The scope of the masterplan work includes a Flood Hazard Area Delineation (FHAD) study of the portion of the Newlin Gulch mainstem downstream of the reservoir (upstream limits near Hess Road).

a. Derek noted that the scope of work did not include a schedule for the FHAD study. He anticipated starting work on the FHAD study after submitting the baseline hydrology report. The preliminary FHAD submittal is anticipated 10 weeks after the submittal of the draft baseline hydrology report. Shea was OK with this timeframe. Shea noted that Muller should plan to meet with Terri Fead (UDFCD) before she reviews the first preliminary submittal.

b. Derek mentioned that there are several challenges with the hydraulic modeling, particularly in the Stonegate reach, that might warrant a meeting earlier in the process. This includes channel work that post-dates the available LiDAR mapping. Shea agreed that this meeting could occur when Muller submits the draft cross-section locations map to UDFCD for review.

c. Shea said that the floodplain group is typically notifying all impacted property owners that a FHAD is in progress. Terri and David Mallory (UDFCD) will handle this notification process.

d. A public meeting (included in the current scope) may not be warranted for this project. The project team may decide to distribute a flyer or have individual meetings with impacted property owners instead. Muller was asked not to include a public meeting in the schedule.
e. Derek said that Muller had recently completed several channel improvement projects in Stonegate Village for which LOMRs had not been issued. He noted that Barbara Chongtoua (UDFCD), wanted incorporate these map revisions as part of the PMR issued following the current FHAD study, rather than issue individual LOMRs for these projects. Shea generally agreed with this approach and thought that LOMRs would not be necessary, but wanted to discuss it further with Terri Fead and David Mallory.

4. ALTERNATIVES ANALYSIS

The project team discussed the following items in regards to the Alternatives Analysis:

a. Jacob noted that Recreation Drive has been closed several times in the past two years due to flooding.
b. Derek noted that Tom Williams (Town of Parker) had mentioned a possible flood capacity issue at the Jordan Road over Newlin Gulch bridge. This may be improved by the reduction in flowrates resulting from the Rueter-Hess flood attenuation. Brad and Jacob were unaware of any specific concern at Jordan Road.
c. Jacob pointed out proposed trail crossing locations north and south of Chambers Road. The crossing south of Chambers (in Parker Homestead) was currently undergoing final design by Muller Engineering. The crossing north of Chambers (part of the Douglas County East-West Trail) was undergoing final design by Hartwig and Associates. Jacob noted that he would like to get a general sense for masterplanned drop structure locations in this area as soon as possible to help him locate the crossings and set inverts. Jacob would like to include the proposed crossings in the FHAD study.
d. Jacob noted that the Town has recently seen increased aggradation upstream of Chambers Road. Downstream of Jordan, a 3-foot headcut has formed at an existing check structure. Derek said that one focus of the study will be to estimate how the addition of the reservoir will impact long term sediment transport within the watershed.
e. Shea told Muller not to include a benefit cost analysis in the Alternatives Analysis report. She noted that a benefit cost analysis does not produce a reasonable result if there are no structures (or few structures) in the floodplain.

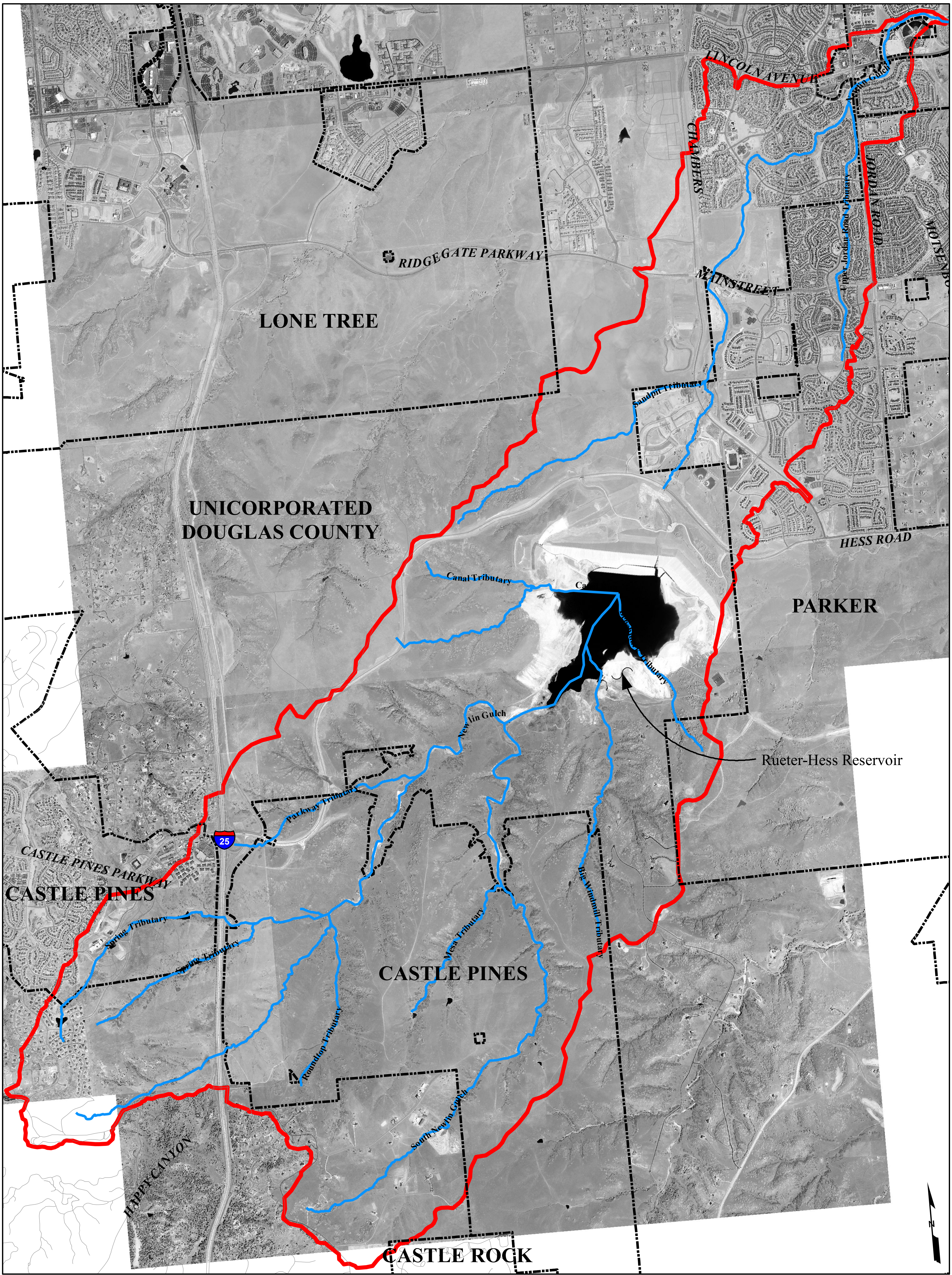
5. SCHEDULE

Derek presented an updated schedule for review by the project team. Shea agreed with the milestones as shown. Muller will submit the draft baseline hydrology report and start work on the FHAD study. Muller will schedule the next progress meeting for early February. The meeting will include discussion of the draft baseline hydrology report, early results of the alternatives analysis, and early results from the FHAD study. Muller will invite Stakeholders, including Stonegate Village and Cherry Creek Basin Water Quality Authority (CCBWQA). Jacob will contact PWSD by email regarding any future water and sewer crossings of Newlin Gulch. Muller will update the major milestones dates on the project website.

END OF MINUTES

Appendix B

HYDROLOGIC ANALYSIS



Map Legend

🟥 Watershed Boundary

▭ Municipal Boundaries

— Major Tributaries

— Roadway Centerline

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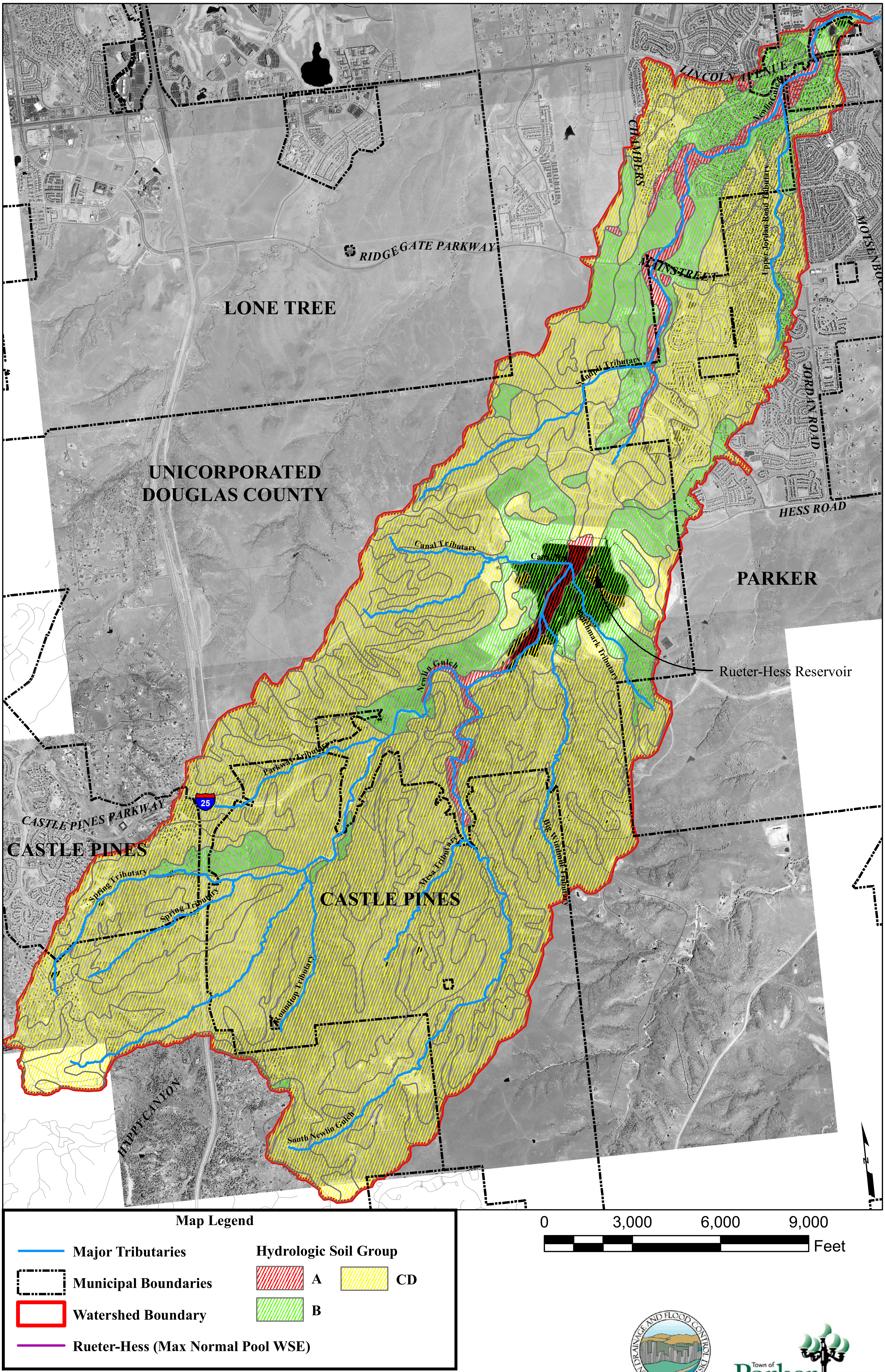
Newlin Gulch Major Drainageway Plan
Figure B: Hydrology Map
January 2015

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

Town of Parker COLORADO

DOUGLAS COUNTY COLORADO



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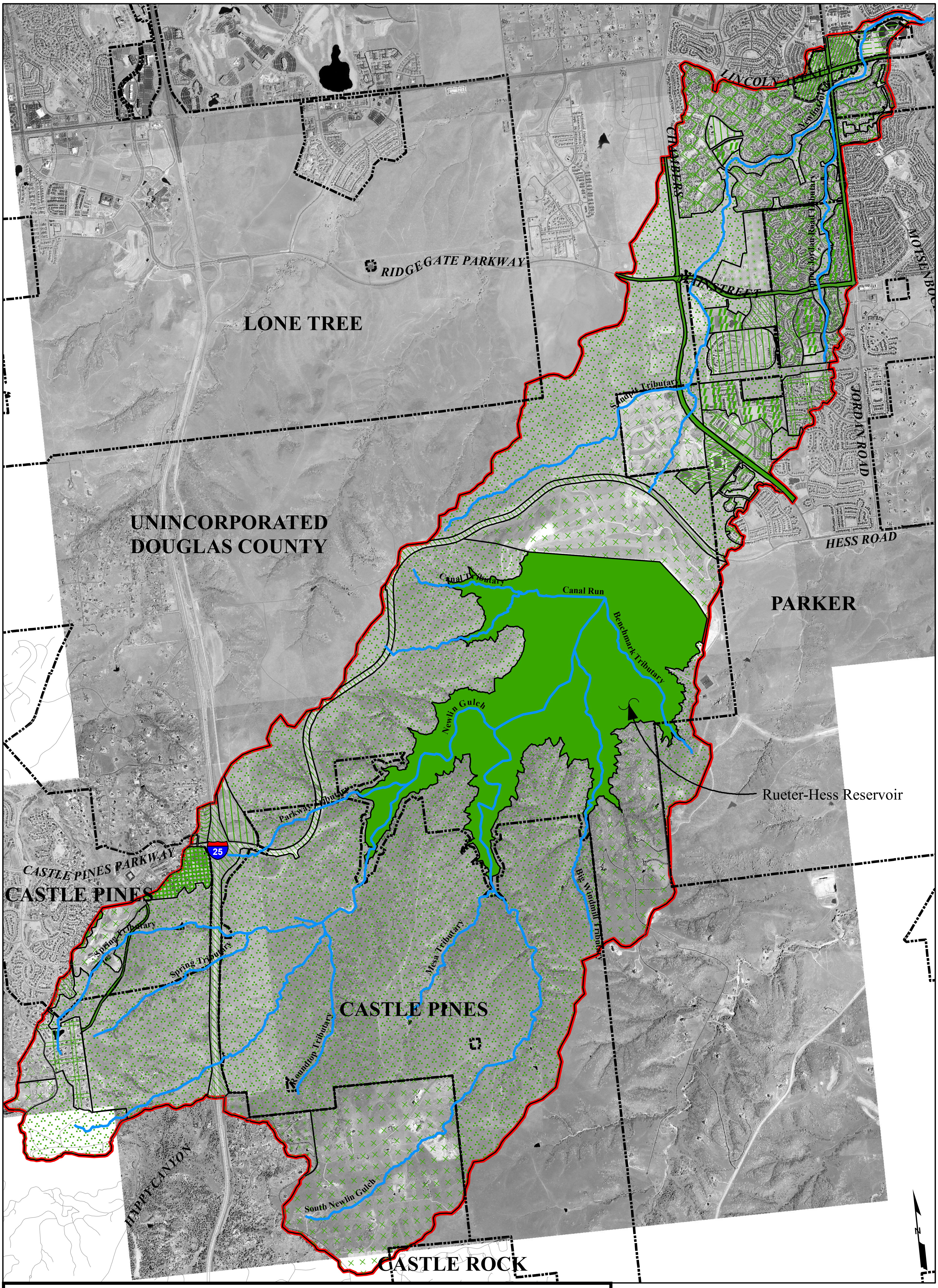

Map Legend

🟥 Watershed Boundary

━ Major Tributaries

▭ Municipal Boundaries

━ Rueter-Hess (Max Normal Pool WSE)

Existing Land Use - Imperviousness (%)

▨	2	▨	20	▨	45	▨	70
▨	5	▨	30	▨	50	▨	85
▨	10	▨	35	▨	60	▨	90
▨	15	▨	40	▨	65	🟩	100

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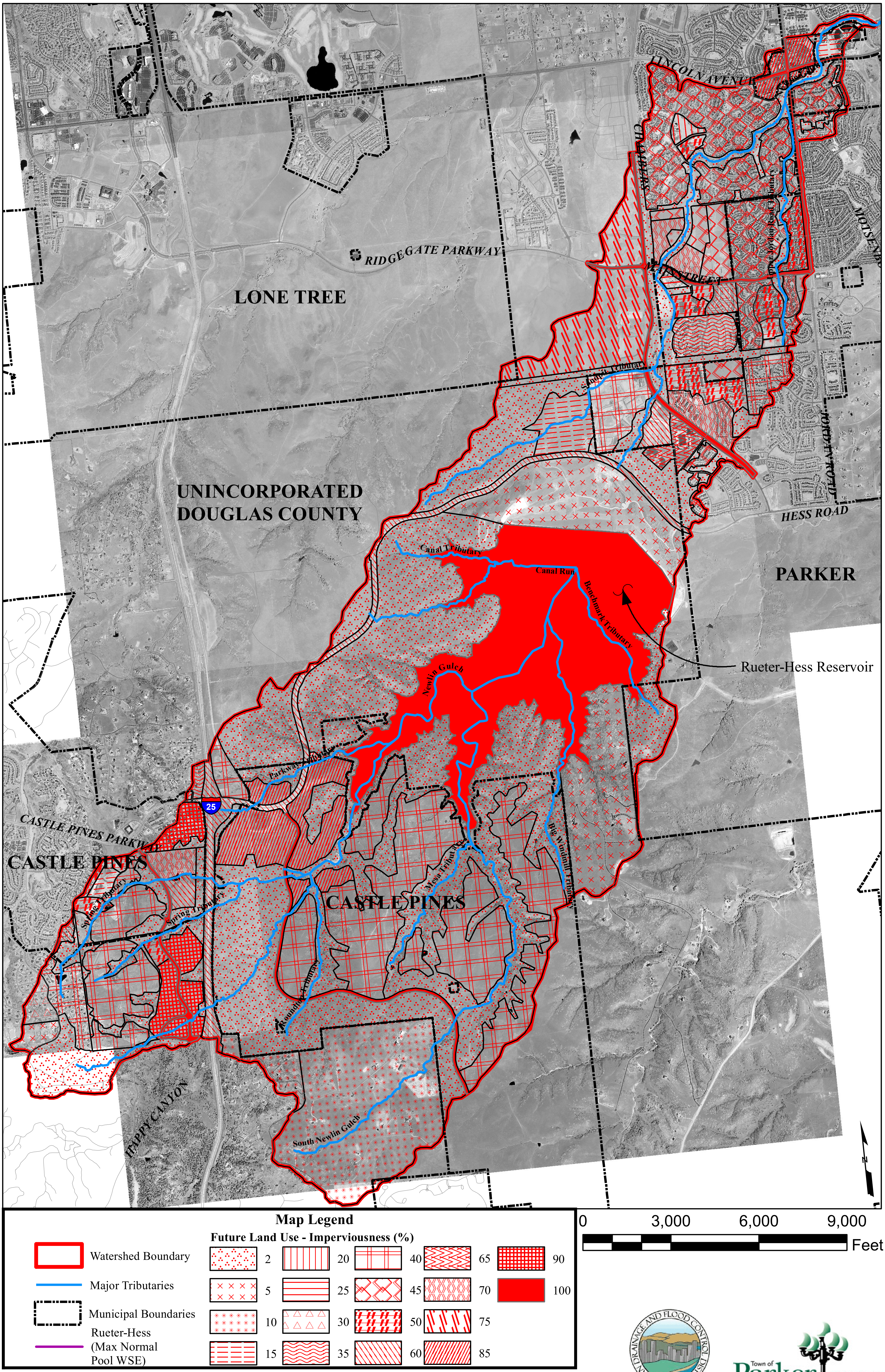

Newlin Gulch Major Drainageway Plan

Figure B: Hydrology Map

January 2015

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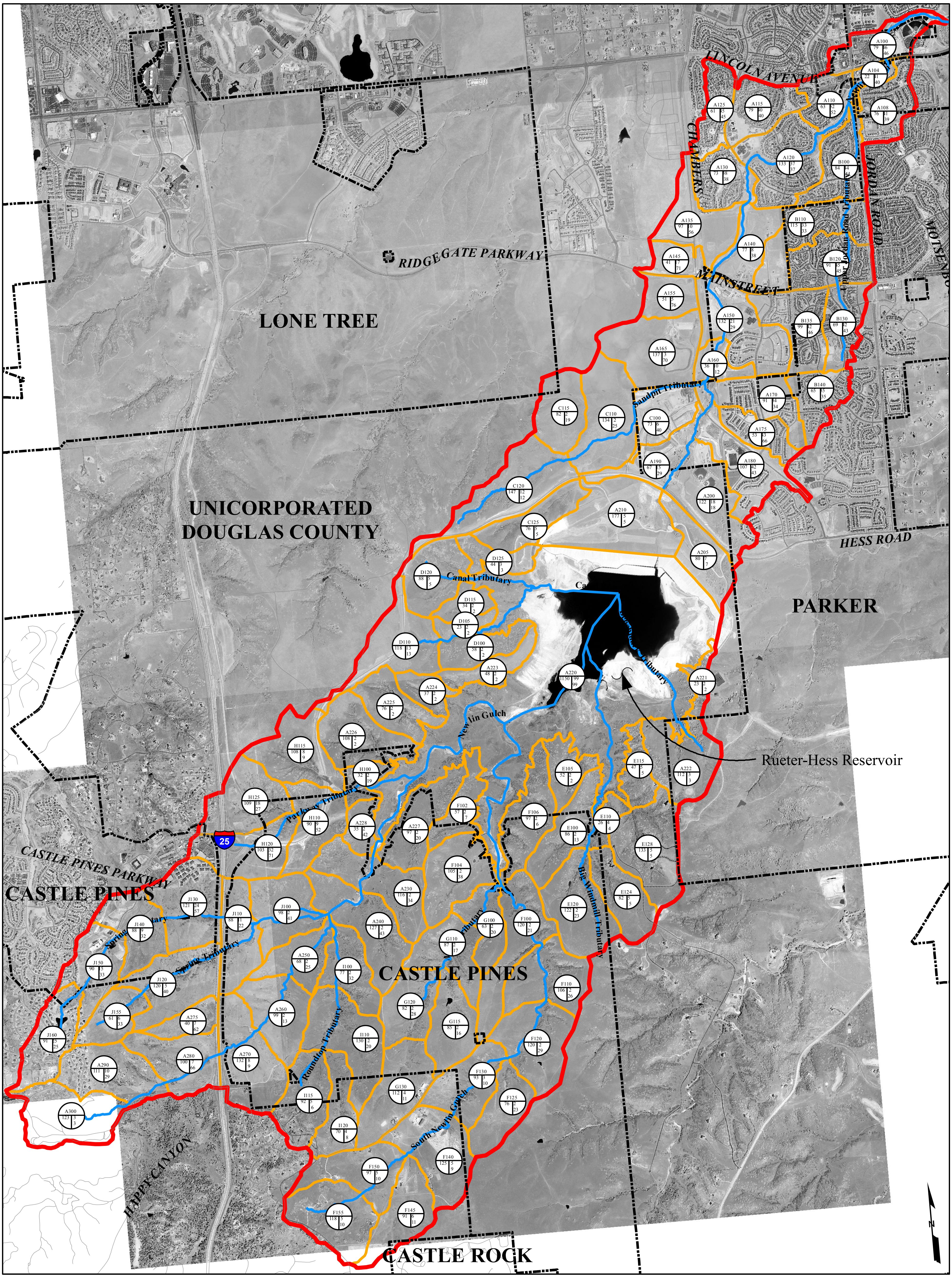
DOUGLAS COUNTY COLORADO



Map Legend

🟥	Watershed Boundary		Rueter-Hess (Max Normal Pool WSE)
		🟧	Subwatershed Boundaries
	Major Tributaries		Municipal Boundaries

Basin ID
Area (AC)
EX IMP%
FU IMP%

Subwatershed Boundaries

0 3,000 6,000 9,000
Feet

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Newlin Gulch Major Drainageway Plan
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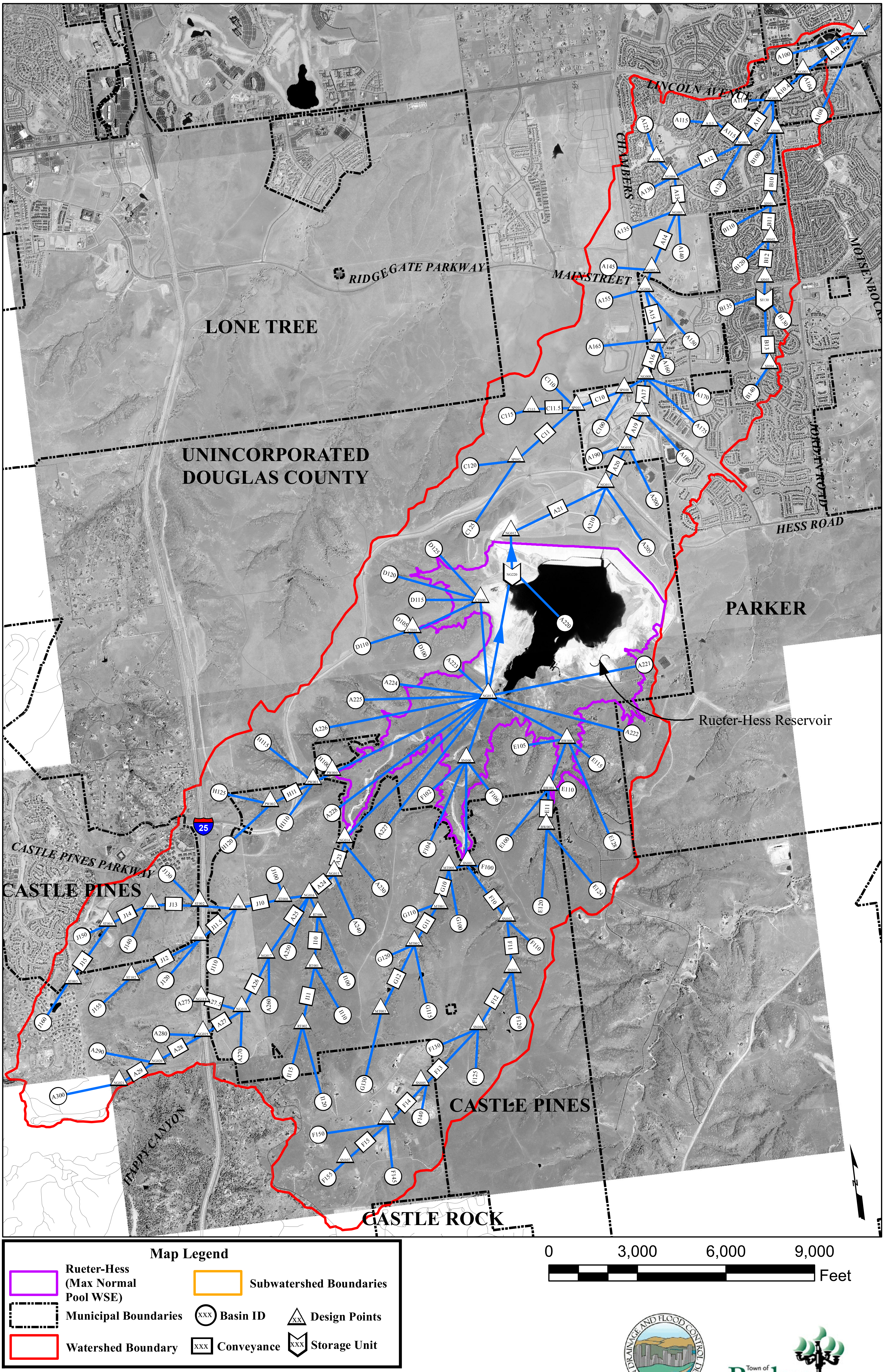
January 2015

Urban Drainage and Flood Control District
Town of Parker Colorado
Douglas County Colorado



Newlin Gulch Major Drainageway Plan
Figure B: Hydrology Map
January 2015

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Urban Drainage and Flood Control District
Town of Parker Colorado
Douglas County Colorado

Table B-1
Rainfall Distributions

	2-Hour Design Storm Rainfall Depth (in)								
	2-year		5-year		10-year		25-year	50-year	100-year
Time	no area adjustment	3 mi^2 area adjustment	no area adjustment	3 mi^2 area adjustment	no area adjustment	3 mi^2 area adjustment	no area adjustment	no area adjustment	no area adjustment
0:05	0.019	0.019	0.028	0.028	0.033	0.033	0.026	0.030	0.026
0:10	0.038	0.038	0.052	0.052	0.061	0.061	0.069	0.080	0.077
0:15	0.073	0.079	0.112	0.121	0.124	0.135	0.099	0.114	0.118
0:20	0.103	0.145	0.147	0.206	0.169	0.237	0.158	0.182	0.206
0:25	0.162	0.226	0.240	0.336	0.282	0.396	0.296	0.342	0.360
0:30	0.090	0.127	0.125	0.175	0.135	0.190	0.493	0.570	0.643
0:35	0.054	0.059	0.074	0.081	0.085	0.092	0.236	0.274	0.360
0:40	0.043	0.047	0.056	0.061	0.065	0.071	0.158	0.182	0.206
0:45	0.029	0.028	0.052	0.051	0.064	0.063	0.099	0.114	0.159
0:50	0.029	0.028	0.052	0.051	0.054	0.053	0.099	0.114	0.129
0:55	0.029	0.028	0.043	0.042	0.054	0.053	0.063	0.073	0.103
1:00	0.029	0.028	0.043	0.042	0.054	0.053	0.063	0.073	0.103
1:05	0.029	0.028	0.043	0.042	0.054	0.053	0.063	0.073	0.103
1:10	0.019	0.019	0.043	0.042	0.054	0.053	0.047	0.055	0.051
1:15	0.019	0.019	0.036	0.035	0.054	0.053	0.047	0.055	0.051
1:20	0.019	0.019	0.032	0.031	0.042	0.041	0.035	0.041	0.031
1:25	0.019	0.019	0.032	0.031	0.032	0.032	0.035	0.041	0.031
1:30	0.019	0.019	0.032	0.031	0.032	0.032	0.028	0.032	0.031
1:35	0.019	0.019	0.032	0.031	0.032	0.032	0.028	0.032	0.031
1:40	0.019	0.019	0.022	0.021	0.032	0.032	0.028	0.032	0.031
1:45	0.019	0.019	0.022	0.021	0.032	0.032	0.028	0.032	0.031
1:50	0.019	0.019	0.022	0.021	0.032	0.032	0.028	0.032	0.031
1:55	0.010	0.009	0.022	0.021	0.029	0.028	0.028	0.032	0.031
2:00	0.010	0.009	0.019	0.018	0.022	0.022	0.028	0.032	0.031

Table B-2
CUHP Input

								Weighted % Impervious		Depression Storage		Infiltration		
	Area		Dist to Centroid		Length		Length-Weighted Slope	Existing	Future	Pervious	Impervious	Initial Rate	Final Rate	Decay Coeff.
Subwatershed ID	acres	sq mi	ft	mi	ft	mi	ft/ft	%	%	watershed in	watershed in	in/hr	in/hr	1/second
Newlin Gulch														
A100	79	0.12334	2568	0.486	4965	0.940	0.0127	46.18	46.4	0.5	0.1	4.36	0.63	0.0016
A104	22	0.03412	1052	0.199	1595	0.302	0.0044	41.04	41.0	0.5	0.1	4.82	0.86	0.0011
A108	76	0.11808	2154	0.408	3574	0.677	0.0099	40.62	40.6	0.5	0.1	4.04	0.61	0.0017
A110	63	0.09787	556	0.105	2748	0.520	0.0109	52.16	52.3	0.5	0.1	4.64	0.71	0.0015
A115	79	0.12317	1631	0.309	2961	0.561	0.0176	40.39	40.4	0.5	0.1	3.35	0.52	0.0018
A120	133	0.20788	1735	0.329	4809	0.911	0.0098	37.06	37.2	0.5	0.1	4.43	0.66	0.0016
A125	61	0.09537	1211	0.229	3559	0.674	0.0088	44.65	44.7	0.5	0.1	3.00	0.50	0.0018
A130	73	0.11470	1082	0.205	3524	0.667	0.0216	37.76	37.8	0.5	0.1	3.90	0.67	0.0015
A135	97	0.15218	1820	0.345	4634	0.878	0.0134	9.53	56.0	0.5	0.1	4.00	0.59	0.0017
A140	77	0.11958	1485	0.281	3696	0.700	0.0177	7.98	44.2	0.5	0.1	4.62	0.71	0.0015
A145	41	0.06477	1101	0.209	2513	0.476	0.0297	16.52	71.4	0.5	0.1	4.01	0.59	0.0017
A150	132	0.20642	2025	0.384	4980	0.943	0.0165	20.92	29.2	0.5	0.1	3.72	0.62	0.0016
A155	51	0.08018	1081	0.205	2357	0.446	0.0349	5.40	75.8	0.5	0.1	4.46	0.60	0.0018
A160	36	0.05703	1056	0.200	2499	0.473	0.0161	10.16	12.0	0.5	0.1	4.20	0.72	0.0014
A165	137	0.21432	2262	0.428	4332	0.821	0.0265	2.83	70.2	0.5	0.1	3.64	0.54	0.0018
A170	91	0.14161	1918	0.363	4845	0.918	0.0285	34.06	41.0	0.5	0.1	3.21	0.53	0.0017
A175	53	0.08328	1864	0.353	3506	0.664	0.0372	42.84	65.7	0.5	0.1	3.23	0.52	0.0018
A180	107	0.16724	3092	0.586	4764	0.902	0.0262	42.28	51.0	0.5	0.1	3.38	0.54	0.0018
A190	67	0.10513	2282	0.432	5385	1.020	0.0236	15.02	28.6	0.5	0.1	3.75	0.58	0.0017
A200	122	0.19109	2356	0.446	4926	0.933	0.0347	18.12	24.1	0.5	0.1	3.32	0.52	0.0018
A205	80	0.12535	2541	0.481	4255	0.806	0.0445	6.87	6.9	0.5	0.1	3.96	0.56	0.0018
A210	177	0.27629	1904	0.361	4598	0.871	0.0326	5.06	5.1	0.5	0.1	3.56	0.54	0.0018
A220	1150	1.79681	5078	0.962	14239	2.697	0.0010	99.14	99.3	0.5	0.1	3.80	0.59	0.0017
A221	23	0.03657	307	0.058	456	0.086	0.0216	2.11	2.1	0.5	0.1	4.01	0.57	0.0018
A222	112	0.17480	836	0.158	2008	0.380	0.0546	2.91	2.9	0.5	0.1	3.20	0.51	0.0018
A223	48	0.07532	371	0.070	844	0.160	0.0567	2.00	2.0	0.5	0.1	3.28	0.52	0.0018
A224	37	0.05826	560	0.106	1743	0.330	0.0566	2.00	2.0	0.5	0.1	3.01	0.50	0.0018
A225	76	0.11903	905	0.171	2459	0.466	0.0474	2.00	2.0	0.5	0.1	3.12	0.51	0.0018
A226	108	0.16815	1387	0.263	2916	0.552	0.0456	2.15	2.2	0.5	0.1	3.18	0.51	0.0018
A227	97	0.15157	647	0.123	1571	0.298	0.0490	2.00	18.9	0.5	0.1	3.01	0.50	0.0018
A228	35	0.05437	504	0.095	1070	0.203	0.0552	2.00	42.3	0.5	0.1	3.00	0.50	0.0018
A230	116	0.18124	910	0.172	3193	0.605	0.0459	2.00	33.6	0.5	0.1	3.09	0.51	0.0018
A240	127	0.19807	1373	0.260	3827	0.725	0.0377	2.00	42.7	0.5	0.1	3.07	0.50	0.0018
A250	68	0.10593	1969	0.373	4102	0.777	0.0278	2.00	25.3	0.5	0.1	3.00	0.50	0.0018
A260	99	0.15492	1730	0.328	3591	0.680	0.0316	2.00	13.1	0.5	0.1	3.00	0.50	0.0018
A270	132	0.20610	904	0.171	2977	0.564	0.0439	8.43	9.2	0.5	0.1	3.02	0.50	0.0018

Table B-2
CUHP Input

								Weighted % Impervious		Depression Storage		Infiltration		
	Area		Dist to Centroid		Length		Length-Weighted Slope	Existing	Future	Pervious	Impervious	Initial Rate	Final Rate	Decay Coeff.
Subwatershed ID	**acres**	**sq mi**	**ft**	**mi**	**ft**	**mi**	**ft/ft**	**%**	**%**	**watershed in**	**watershed in**	**in/hr**	**in/hr**	**1/second**
Newlin Gulch														
A275	40	0.06230	922	0.175	2808	0.532	0.0370	6.61	61.8	0.5	0.1	3.00	0.50	0.0018
A280	100	0.15627	1232	0.233	3387	0.641	0.0420	7.18	66.2	0.5	0.1	3.00	0.50	0.0018
A290	111	0.17348	2138	0.405	4124	0.781	0.0452	9.88	28.9	0.5	0.1	3.00	0.50	0.0018
A300	123	0.19254	2369	0.449	4642	0.879	0.0406	2.59	3.4	0.5	0.1	3.00	0.50	0.0018
South Jordan Tributary														
B100	84	0.13156	2228	0.422	4831	0.915	0.0178	43.67	43.8	0.5	0.1	3.74	0.56	0.0018
B110	115	0.17999	2293	0.434	5041	0.955	0.0147	32.69	44.4	0.5	0.1	3.11	0.51	0.0018
B120	91	0.14226	810	0.153	3186	0.603	0.0189	44.57	45.0	0.5	0.1	3.00	0.50	0.0018
B130	69	0.10807	1293	0.245	3339	0.632	0.0214	42.09	42.9	0.5	0.1	3.45	0.53	0.0018
B135	99	0.15400	1248	0.236	3395	0.643	0.0230	42.00	45.7	0.5	0.1	3.03	0.50	0.0018
B140	65	0.10231	848	0.161	3006	0.569	0.0376	34.72	38.1	0.5	0.1	3.07	0.50	0.0018
Sandpit Tributary														
C100	73	0.11409	1627	0.308	3571	0.676	0.0210	5.68	39.5	0.5	0.1	3.53	0.54	0.0018
C110	134	0.21009	1631	0.309	3241	0.614	0.0291	2.09	24.6	0.5	0.1	3.00	0.50	0.0018
C115	82	0.12791	942	0.178	1917	0.363	0.0541	2.00	19.1	0.5	0.1	3.29	0.52	0.0018
C120	147	0.23006	2253	0.427	6042	1.144	0.0366	12.37	12.4	0.5	0.1	3.00	0.50	0.0018
C125	76	0.11915	2169	0.411	4310	0.816	0.0405	5.35	5.4	0.5	0.1	3.64	0.54	0.0018
Canal Tributary														
D100	58	0.09018	485	0.092	1515	0.287	0.0315	2.00	2.0	0.5	0.1	3.00	0.50	0.0018
D105	23	0.03628	707	0.134	1316	0.249	0.0494	2.00	2.0	0.5	0.1	3.00	0.50	0.0018
D110	118	0.18431	1478	0.280	4687	0.888	0.0160	13.20	13.2	0.5	0.1	3.00	0.50	0.0018
D115	34	0.05294	489	0.093	1747	0.331	0.0545	2.00	2.0	0.5	0.1	3.00	0.50	0.0018
D120	88	0.13720	650	0.123	1747	0.331	0.0556	4.86	4.9	0.5	0.1	3.00	0.50	0.0018
D125	44	0.06920	509	0.096	759	0.144	0.0247	2.70	2.7	0.5	0.1	3.00	0.50	0.0018
Big Windmill Tributary														
E100	86	0.13510	917	0.174	2973	0.563	0.0486	2.00	13.3	0.5	0.1	3.00	0.50	0.0018
E105	52	0.08142	275	0.052	1912	0.362	0.0433	2.00	2.0	0.5	0.1	3.00	0.50	0.0018
E110	26	0.04037	528	0.100	879	0.166	0.0628	4.38	4.4	0.5	0.1	3.00	0.50	0.0018
E115	47	0.07349	515	0.098	907	0.172	0.0602	5.02	5.0	0.5	0.1	3.00	0.50	0.0018
E120	122	0.18987	2043	0.387	3851	0.729	0.0411	2.16	22.6	0.5	0.1	3.00	0.50	0.0018
E124	82	0.12759	1970	0.373	3842	0.728	0.0383	4.57	4.6	0.5	0.1	3.00	0.50	0.0018
E128	133	0.20792	1700	0.322	4095	0.775	0.0401	4.90	4.9	0.5	0.1	3.00	0.50	0.0018

Table B-2
CUHP Input

								Weighted % Impervious		Depression Storage		Infiltration		
	Area		Dist to Centroid		Length		Length-Weighted Slope	Existing	Future	Pervious	Impervious	Initial Rate	Final Rate	Decay Coeff.
Subwatershed ID	acres	sq mi	ft	mi	ft	mi	ft/ft	%	%	watershed in	watershed in	in/hr	in/hr	1/second
South Newlin Gulch														
F100	120	0.18764	3124	0.592	6498	1.231	0.0283	2.00	20.9	0.5	0.1	3.00	0.50	0.0018
F102	57	0.08830	627	0.119	1847	0.350	0.0496	2.00	7.0	0.5	0.1	3.01	0.50	0.0018
F104	105	0.16419	1101	0.209	3021	0.572	0.0490	2.00	37.9	0.5	0.1	3.00	0.50	0.0018
F106	97	0.15209	822	0.156	1734	0.328	0.0565	2.00	5.7	0.5	0.1	3.00	0.50	0.0018
F110	106	0.16600	1210	0.229	3346	0.634	0.0293	2.00	26.5	0.5	0.1	3.00	0.50	0.0018
F120	120	0.18673	1883	0.357	3939	0.746	0.0287	2.00	28.6	0.5	0.1	3.00	0.50	0.0018
F125	76	0.11910	1779	0.337	3518	0.666	0.0384	2.00	22.5	0.5	0.1	3.00	0.50	0.0018
F130	93	0.14500	1739	0.329	3729	0.706	0.0240	2.91	10.0	0.5	0.1	3.00	0.50	0.0018
F140	125	0.19559	2298	0.435	4151	0.786	0.0311	4.79	9.5	0.5	0.1	3.00	0.50	0.0018
F145	91	0.14255	1879	0.356	4122	0.781	0.0392	5.95	11.0	0.5	0.1	3.00	0.50	0.0018
F150	97	0.15083	1880	0.356	4552	0.862	0.0403	5.07	10.0	0.5	0.1	3.00	0.50	0.0018
F155	118	0.18503	1212	0.229	2798	0.530	0.0467	5.00	10.0	0.5	0.1	3.00	0.50	0.0018
Mesa Tributary														
G100	63	0.09892	1730	0.328	3584	0.679	0.0413	2.00	19.5	0.5	0.1	3.00	0.50	0.0018
G110	87	0.13587	1335	0.253	3530	0.668	0.0324	2.00	17.1	0.5	0.1	3.00	0.50	0.0018
G115	85	0.13319	2000	0.379	3834	0.726	0.0402	2.04	16.3	0.5	0.1	3.00	0.50	0.0018
G120	82	0.12759	1650	0.313	3485	0.660	0.0318	2.00	27.7	0.5	0.1	3.00	0.50	0.0018
G130	112	0.17453	1716	0.325	4081	0.773	0.0383	4.05	10.8	0.5	0.1	3.00	0.50	0.0018
Parkway Tributary														
H100	32	0.05073	479	0.091	1001	0.190	0.0541	2.00	19.0	0.5	0.1	3.00	0.50	0.0018
H110	90	0.14116	1729	0.327	3867	0.732	0.0364	9.43	52.2	0.5	0.1	3.01	0.50	0.0018
H115	108	0.16810	2025	0.384	3886	0.736	0.0417	8.13	9.3	0.5	0.1	3.00	0.50	0.0018
H120	103	0.16166	2052	0.389	4317	0.818	0.0377	32.08	71.2	0.5	0.1	3.02	0.50	0.0018
H125	109	0.17012	1720	0.326	3764	0.713	0.0412	18.42	27.0	0.5	0.1	3.00	0.50	0.0018
Roundtop Tributary														
I100	77	0.11958	1930	0.365	4134	0.783	0.0332	2.00	32.0	0.5	0.1	3.01	0.50	0.0018
I110	130	0.20300	1783	0.338	4637	0.878	0.0333	2.38	19.7	0.5	0.1	3.00	0.50	0.0018
I115	92	0.14452	1633	0.309	3760	0.712	0.0409	5.33	5.8	0.5	0.1	3.09	0.51	0.0018
I120	70	0.10934	2167	0.410	3979	0.754	0.0436	4.49	8.0	0.5	0.1	3.00	0.50	0.0018
Spring Tributary														
J100	98	0.15269	1484	0.281	3416	0.647	0.0327	2.00	41.0	0.5	0.1	3.56	0.54	0.0018
J110	88	0.13699	986	0.187	2878	0.545	0.0398	11.11	22.2	0.5	0.1	3.32	0.52	0.0018
J120	120	0.18808	1955	0.370	4659	0.882	0.0341	5.39	40.3	0.5	0.1	3.00	0.50	0.0018
J130	121	0.18902	1178	0.223	2519	0.477	0.0386	23.83	57.4	0.5	0.1	3.28	0.52	0.0018
J140	88	0.13737	998	0.189	2976	0.564	0.0357	8.50	31.7	0.5	0.1	3.00	0.50	0.0018
J150	90	0.14075	1606	0.304	3843	0.728	0.0370	14.65	32.6	0.5	0.1	3.00	0.50	0.0018
J155	61	0.09556	1141	0.216	2440	0.462	0.0490	5.82	33.1	0.5	0.1	3.00	0.50	0.0018
J160	91	0.14257	2047	0.388	4398	0.833	0.0403	25.01	25.0	0.5	0.1	3.00	0.50	0.0018

Table B-3
Detention Rating Curves

Rueter-Hess Reservoir (SWMM element NG220)

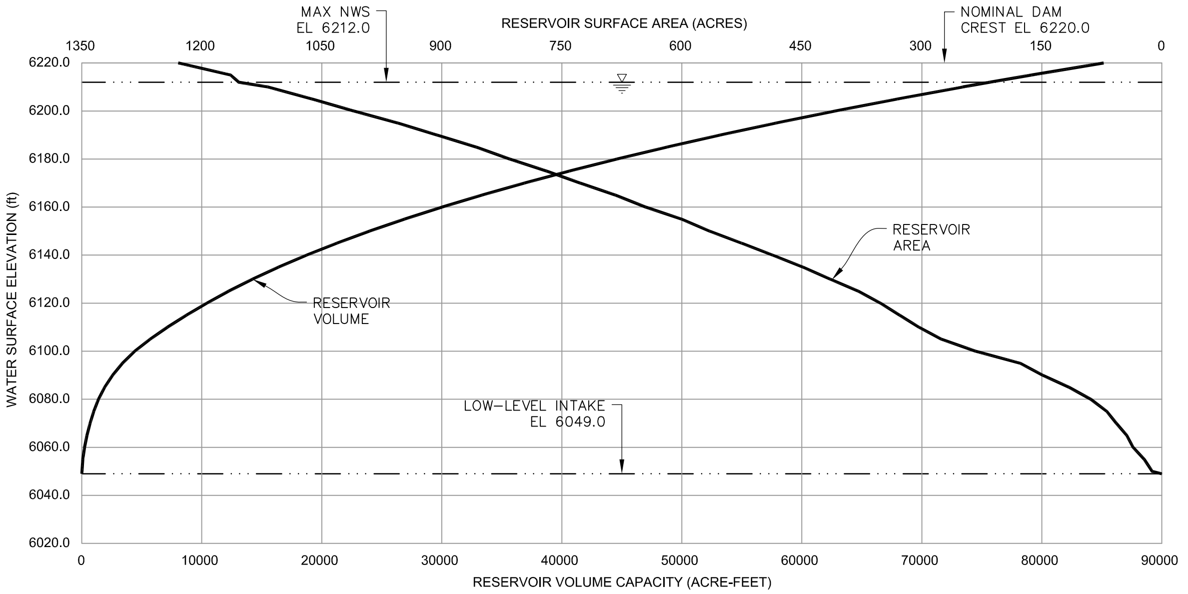
	Storage Curve		Outlet Curve	
Elevation (ft)	**Stage (ft)**	**Area (sq ft)**	**Stage (ft)**	**Discharge (cfs)**
6216.7	0	50,660,280	0	0
6217.1			0.4	359
6217.6			0.9	1,220
6218.1	1.4	50,965,200	1.4	2,381
6218.6			1.9	3,785
6219.1			2.4	5,403
6219.6			2.9	7,217
6220.1			3.4	9,213
6220.6			3.9	11,380
6221.1			4.4	13,712
6221.6			4.9	16,202
6222.1			5.4	18,846
6222.6			5.9	21,640
6223.1	6.4	53,622,360	6.4	24,579

Rueter-Hess Reservoir storage curve based on a starting WSEL at the Auxiliary Spillway crest (Elev. 6216.7). Outlet curve based on flow through the Auxiliary Spillway only based on the table "Service Spillway and Auxiliary Spillway Rating Curves" taken from record drawings from the Rueter-Hess Dam and Reservoir project (DWG. A-05), dated 10/12.

Jordan Rd. Tributary Pond IV (SWMM element SJ130)

	Storage Curve		Outlet Curve	
Elevation (ft)	**Stage (ft)**	**Area (sq ft)**	**Stage (ft)**	**Discharge (cfs)**
5918.7	0	0	0.0	0
5921.7			3.0	67
5922.2			3.5	95
5922.7			4.0	116
5923.2			4.5	134
5923.7			5.0	149
5924.2			5.5	164
5924.7			6.0	177
5925	6.3	82,308		
5925.2			6.5	189
5925.7			7.0	201
5926.2			7.5	211
5926.7			8.0	222
5927.2			8.5	232
5927.5	8.8	150,181		
5927.7			9.0	247
5928.2			9.5	290
5928.7			10.0	351
5929.2			10.5	427
5929.7			11.0	516
5930	11.3	218,054	11.3	576

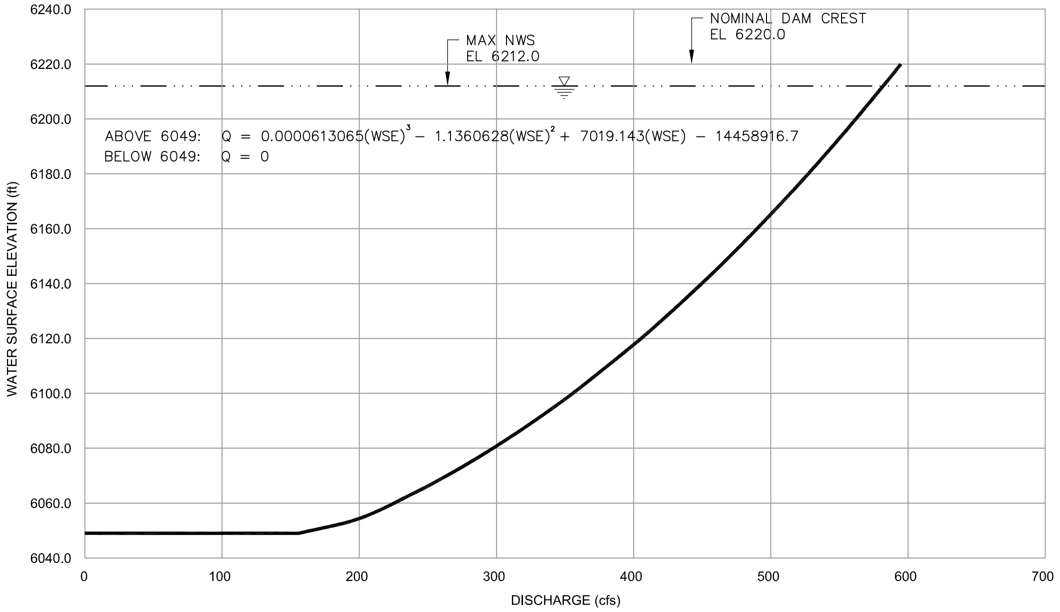
Pond IV storage curve based on 5-ft Douglas County topography. Outlet curve was developed based on supplemental ground survey of outlet structure conducted in April 2013.



RESERVOIR ELEVATION-AREA-VOLUME CURVE

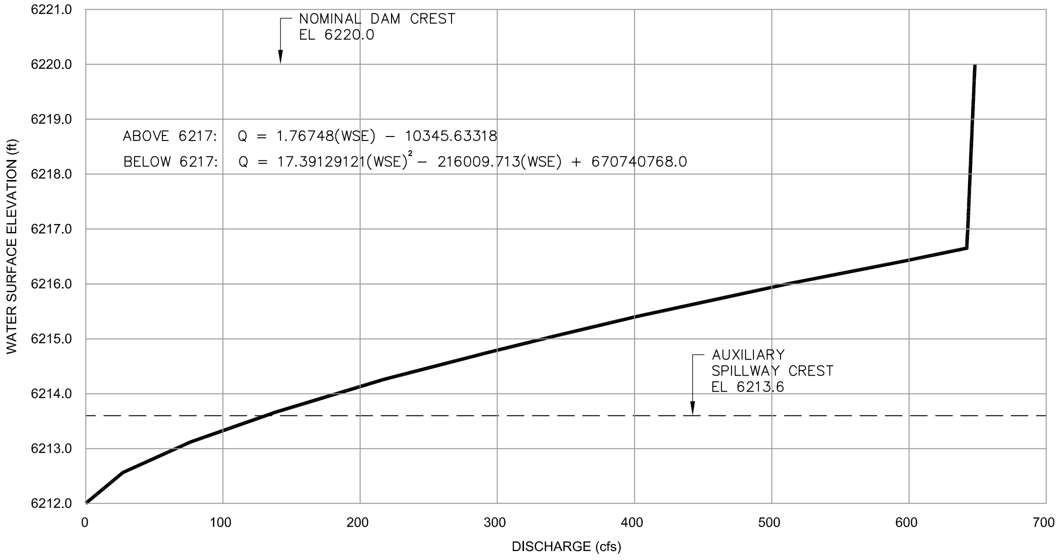
OUTLET WORKS RATING CURVE AND RESERVOIR STORAGE VOLUME & AREA VALUES

GAGE HEIGHT (FEET)	ELEVATION (FEET)	OUTLET WORKS RATING CURVE (CFS)	RESERVOIR STORAGE VOLUME (ACRE-FEET)	RESERVOIR STORAGE AREA (ACRES)
0	6049	0	0	12
6	6055	203.0	87	22
11	6060	225.1	232	36
16	6065	245.2	432	44
21	6070	263.8	686	57
26	6075	281.2	1,001	69
31	6080	297.6	1,395	89
36	6085	313.1	1,907	116
41	6090	327.8	2,569	149
46	6095	342.0	3,386	177
51	6100	355.6	4,411	233
56	6105	368.6	5,683	276
61	6110	381.3	7,134	304
66	6115	393.5	8,714	328
71	6120	405.3	10,413	352
76	6125	416.9	12,242	380
81	6130	428.1	14,229	415
86	6135	439	16,391	449
91	6140	449.6	18,731	487
96	6145	460.1	21,265	526
101	6150	470.2	23,995	566
106	6155	480.2	26,912	601
111	6160	490.0	30,031	646
116	6165	499.5	33,356	684
121	6170	508.9	36,887	728
126	6175	518.1	40,631	770
131	6180	527.2	44,597	816
136	6185	536.1	48,785	858
141	6190	544.9	53,199	907
146	6195	553.5	57,857	956
151	6200	562.0	62,773	1,011
156	6205	570.3	67,959	1,064
161	6210	578.6	73,415	1,119
163	6212	581.8	75,689	1,155
166	6215	586.7	79,175	1,170
171	6220	594.7	85,176	1,231



OUTLET WORKS RATING CURVE

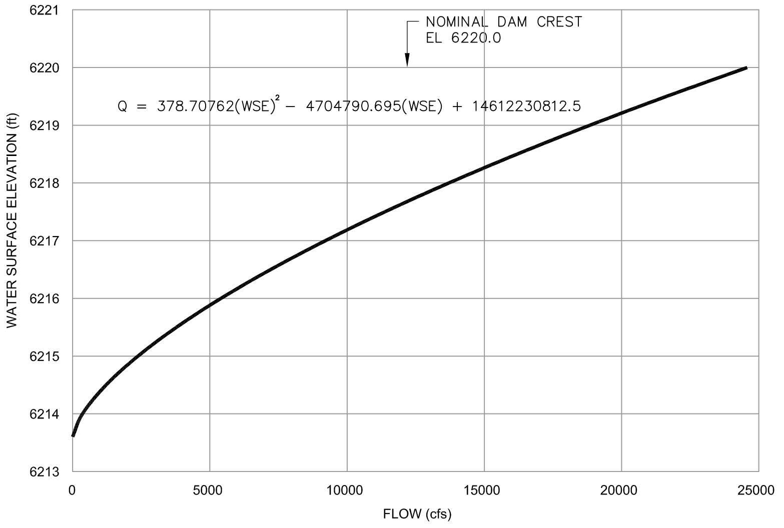
NOTE 1



SERVICE SPILLWAY RATING CURVE

SERVICE SPILLWAY AND AUXILIARY SPILLWAY RATING CURVES

GAGE HEIGHT (FEET)	ELEVATION (FEET)	SERVICE SPILLWAY (CFS)	AUXILIARY SPILLWAY (CFS)
163	6212.0	0.0	———
163.5	6212.5	22.6	———
164	6213.0	64.0	———
164.6	6213.6	117.6	0
165	6214.0	181.0	359
165.5	6214.5	253.0	1,220
166	6215.0	332.6	2,381
166.5	6215.5	419.1	3,785
167	6216.0	512.0	5,403
167.5	6216.5	610.9	7,217
168	6217.0	642.8	9,213
168.5	6217.5	643.7	11,380
169	6218.0	644.6	13,712
169.5	6218.5	645.4	16,202
170	6219.0	646.3	18,846
170.5	6219.5	647.2	21,640
171	6220.0	648.0	24,579



AUXILIARY SPILLWAY RATING CURVE

NOTES:

1. OUTLET WORKS RATING CURVE ASSUMES THE FOLLOWING: FLOW IS THROUGH THE LOW–LEVEL INTAKE, CONVEYED THROUGH THE UPSTREAM CONDUIT AND LEFT PIPE OF THE DOWNSTREAM CONDUIT TO THE IMPACT BASIN; ALL GATES ALONG THIS REACH ARE FULLY OPEN; THE LOW–LEVEL INTAKE IS HYDRAULICALLY SUBMERGED; AND THE LOW–LEVEL INTAKE TRASHRACK IS FREE OF DEBRIS.
2. RATING CURVES BASED ON THEORETICAL VALUES AND ACTUAL FIELD PERFORMANCE COULD VARY.

C–1834

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NO.	DATE	ISSUE/REVISION	DES	DRN	CHK	APP
0	10/12	RECORD DRAWINGS	JDN	ZMR	ERF	RJH

RJH CONSULTANTS, INC.

PARKER WATER AND SANITATION DISTRICT

RJH PROJECT 05101

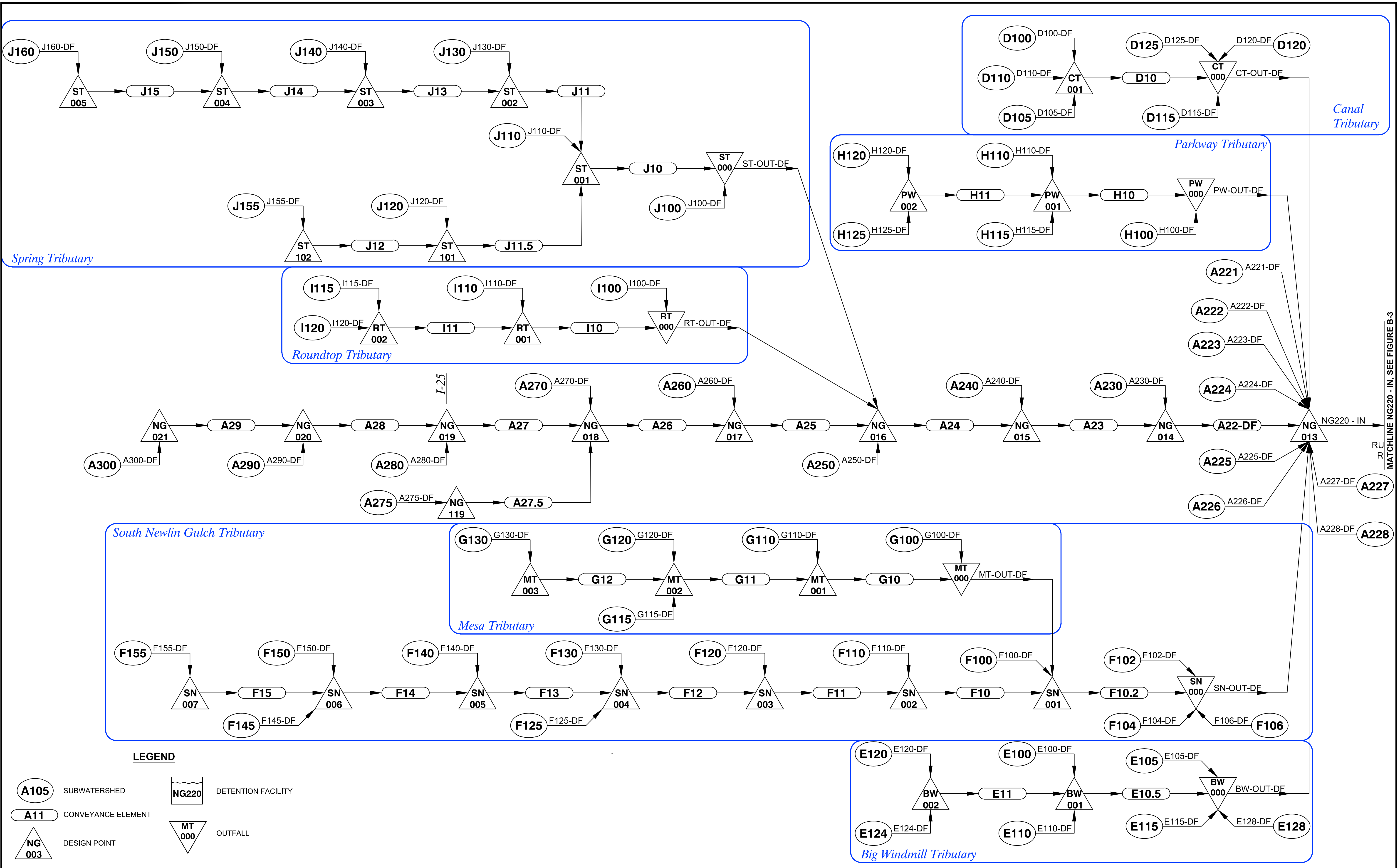
RUETER-HESS
DAM AND RESERVOIR
RECORD DRAWINGS
DOUGLAS COUNTY,
COLORADO

HYDRAULIC INFORMATION

DWG. NO.
A-05

SHEET NO.
5 of 167

P:\07111 – RUETER–HESS ENLARGEMENT CONSTRUCTION\CAD\RECORD DRAWINGS\RECORD A PACKAGE\07111 SHEET A–05.DWG 1/21/2013



No.	DATE	REVISIONS	APPR.

MULLER

MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
777 SOUTH WADSWORTH BLVD. 4-100
LAKEWOOD, COLORADO
80226 (303) 988-4939

PROJECT NO. 12-050.01

DESIGN ASP
DRAWN RJT
CHECK ASP

Town of Parker COLORADO

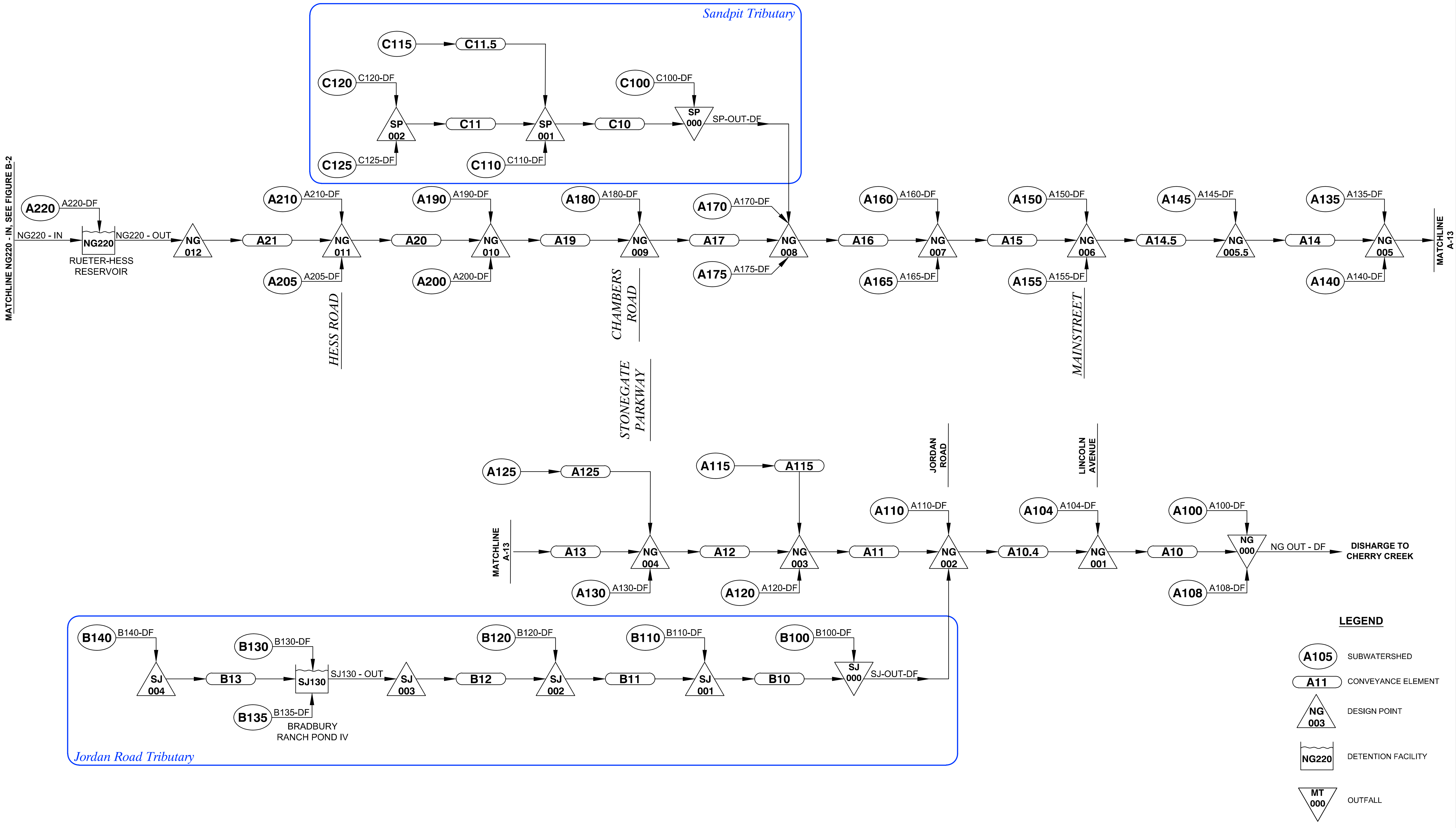
NEWLIN GULCH
MAJOR DRAINAGEWAY PLAN

FIGURE B-2
SWMM SCHEMATIC - UPPER WATERSHED

DATE
JANUARY 2015

FIGURE NO.
B-2

NAME: P:\12-050.01 Newlin Gulch MDP - UDFCD\7 AUTOCAD FILES\Baseline Hydrology\12050-SWMM Schematic.dwg DATE: JAN 16, 2015 TIME: 4:24 PM



NAME: P:\12-050.01 Newlin Gulch MDP - UDFCD\7 AUTOCAD FILES\Baseline Hydrology\12050-SWMM Schematic.dwg DATE: JAN 16, 2015 TIME: 3:56 PM

No.	DATE	REVISIONS	APPR.

MULLER ENGINEERING CO., INC.
CONSULTING ENGINEERS
777 SOUTH WADSWORTH BLVD. 4-100
LAKEWOOD, COLORADO
80226 (303) 988-4939
PROJECT NO. 12-050.01

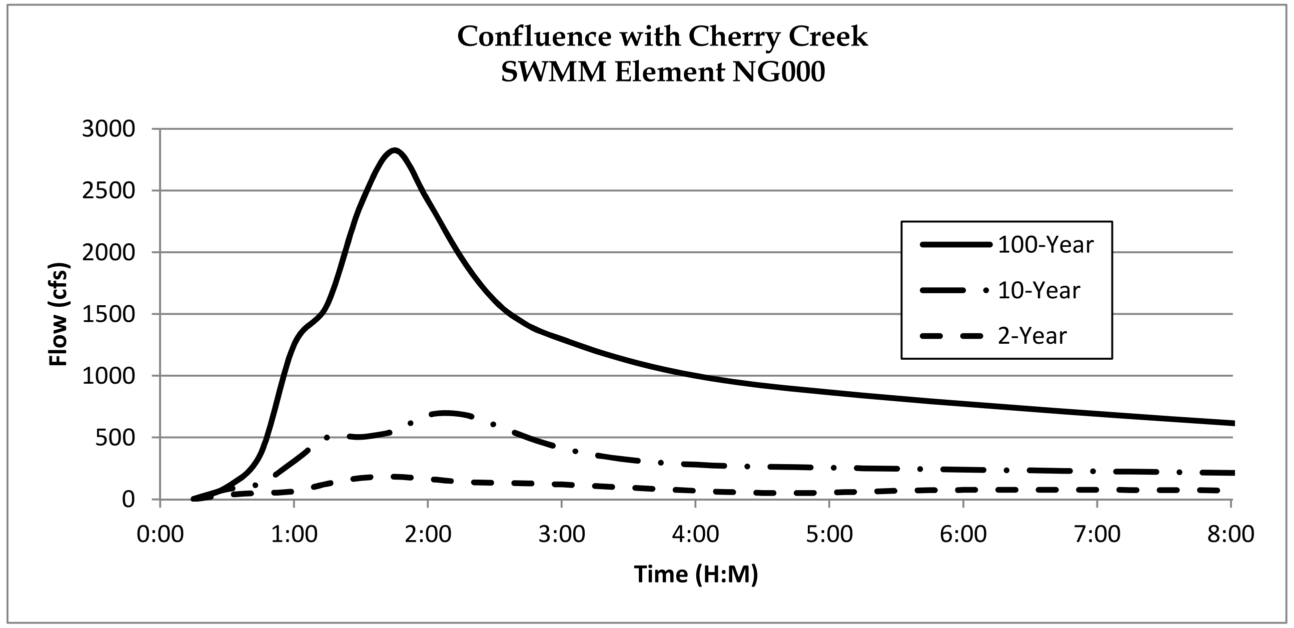
DESIGN ASP
DRAWN RJT
CHECK ASP

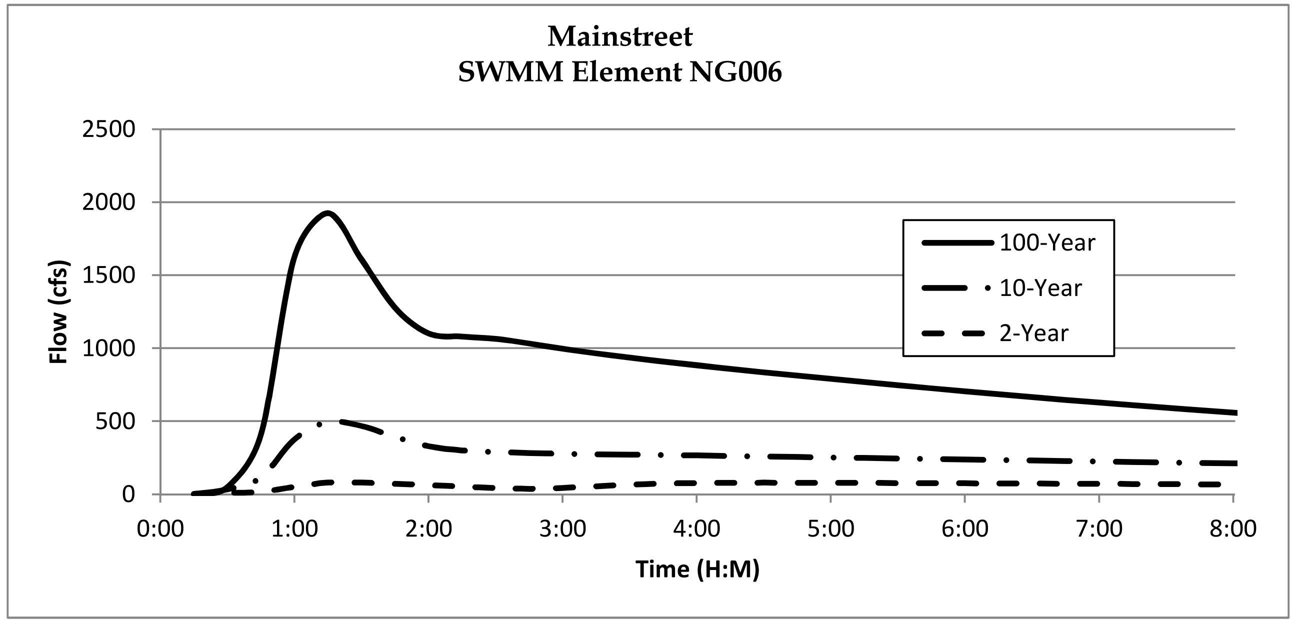
NEWLIN GULCH
MAJOR DRAINAGEWAY PLAN

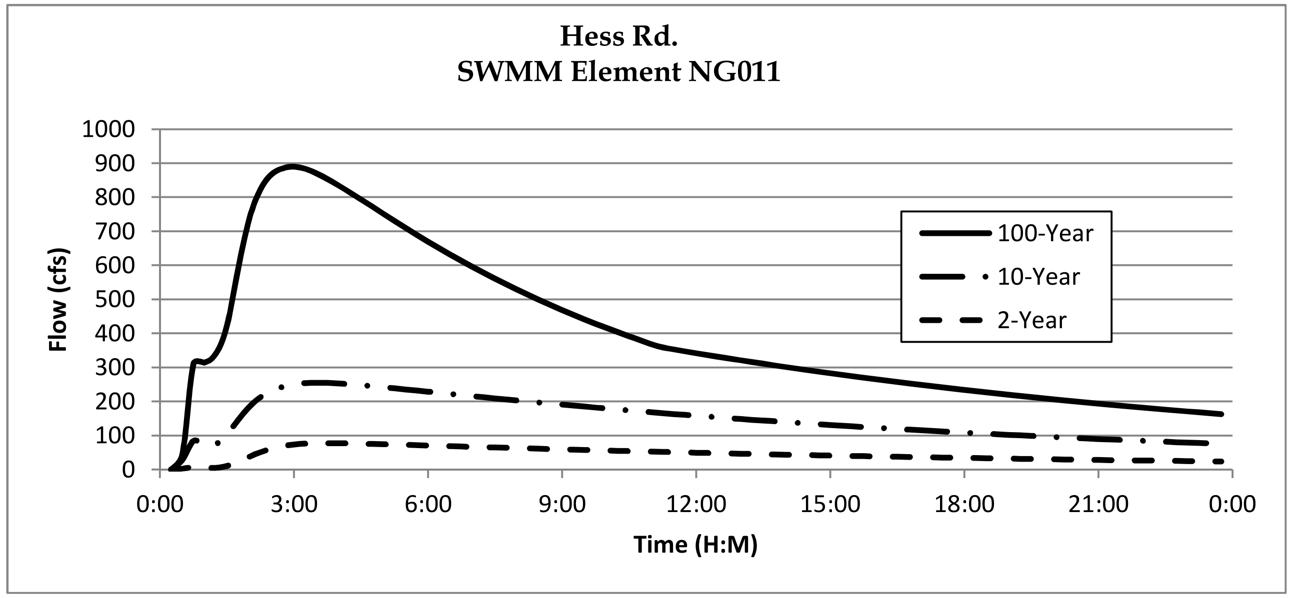
FIGURE B-3
SWMM SCHEMATIC - LOWER WATERSHED

DATE JANUARY 2015
FIGURE NO. B-3

Figure B-4
Existing Development Hydrographs


Confluence with Cherry Creek
SWMM Element NG000


Mainstreet
SWMM Element NG006


Hess Rd.
SWMM Element NG011

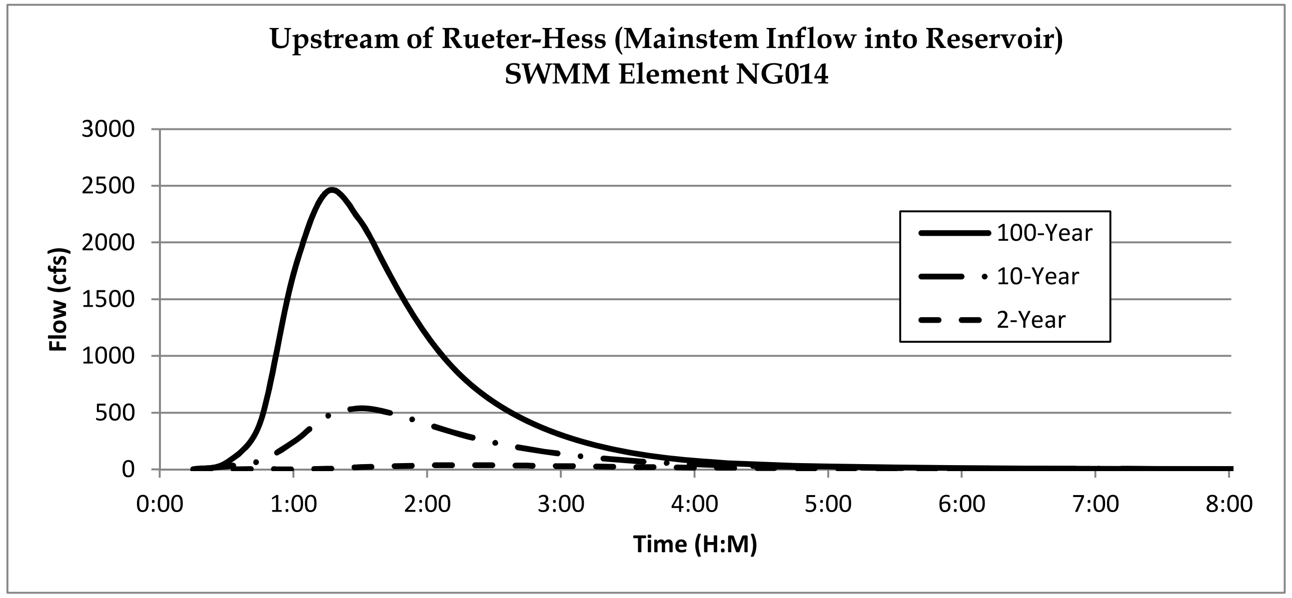

Upstream of Rueter-Hess (Mainstem Inflow into Reservoir)
SWMM Element NG014

Figure B-5
Future Development Hydrographs

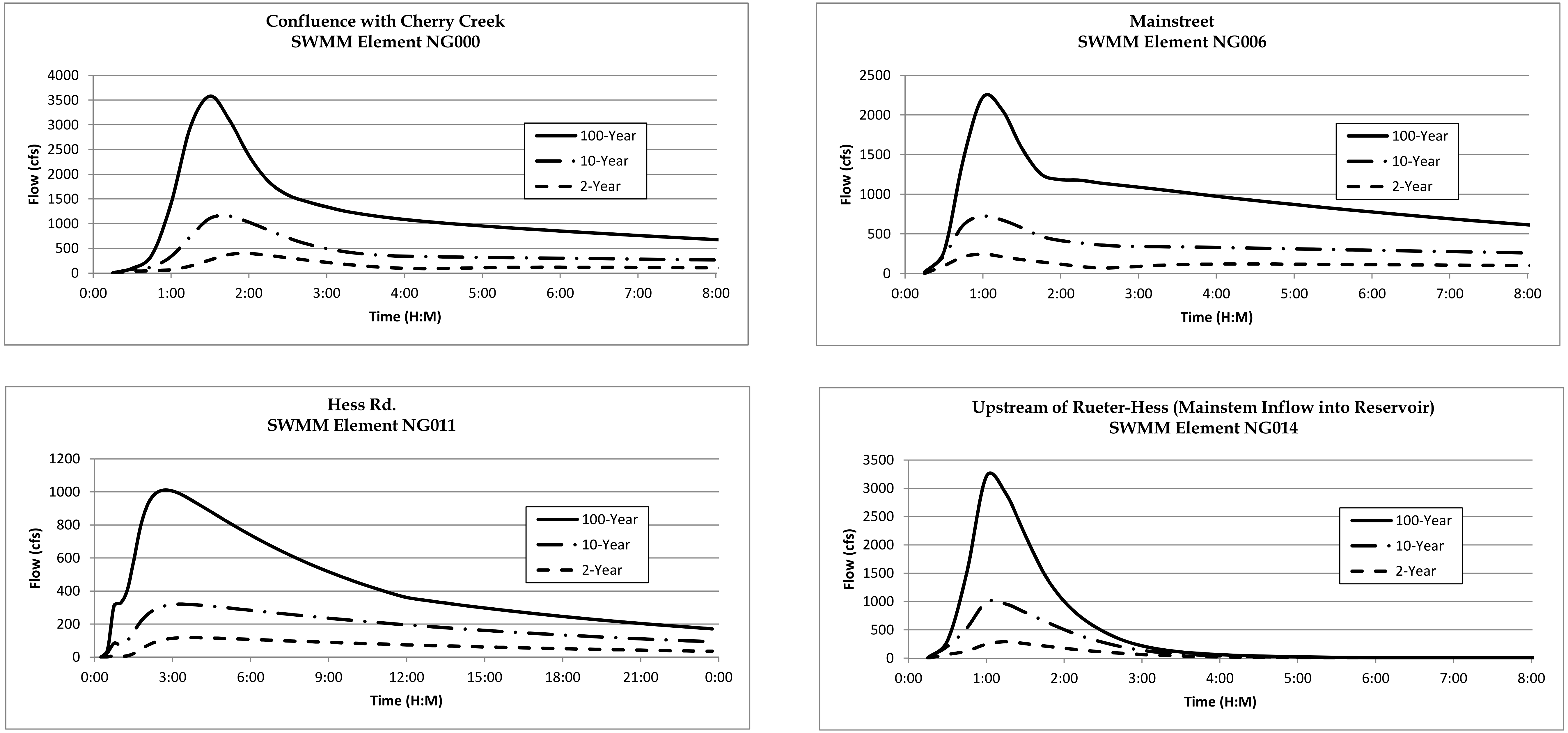


Figure B-6
Peak Flow Profile - Existing Development

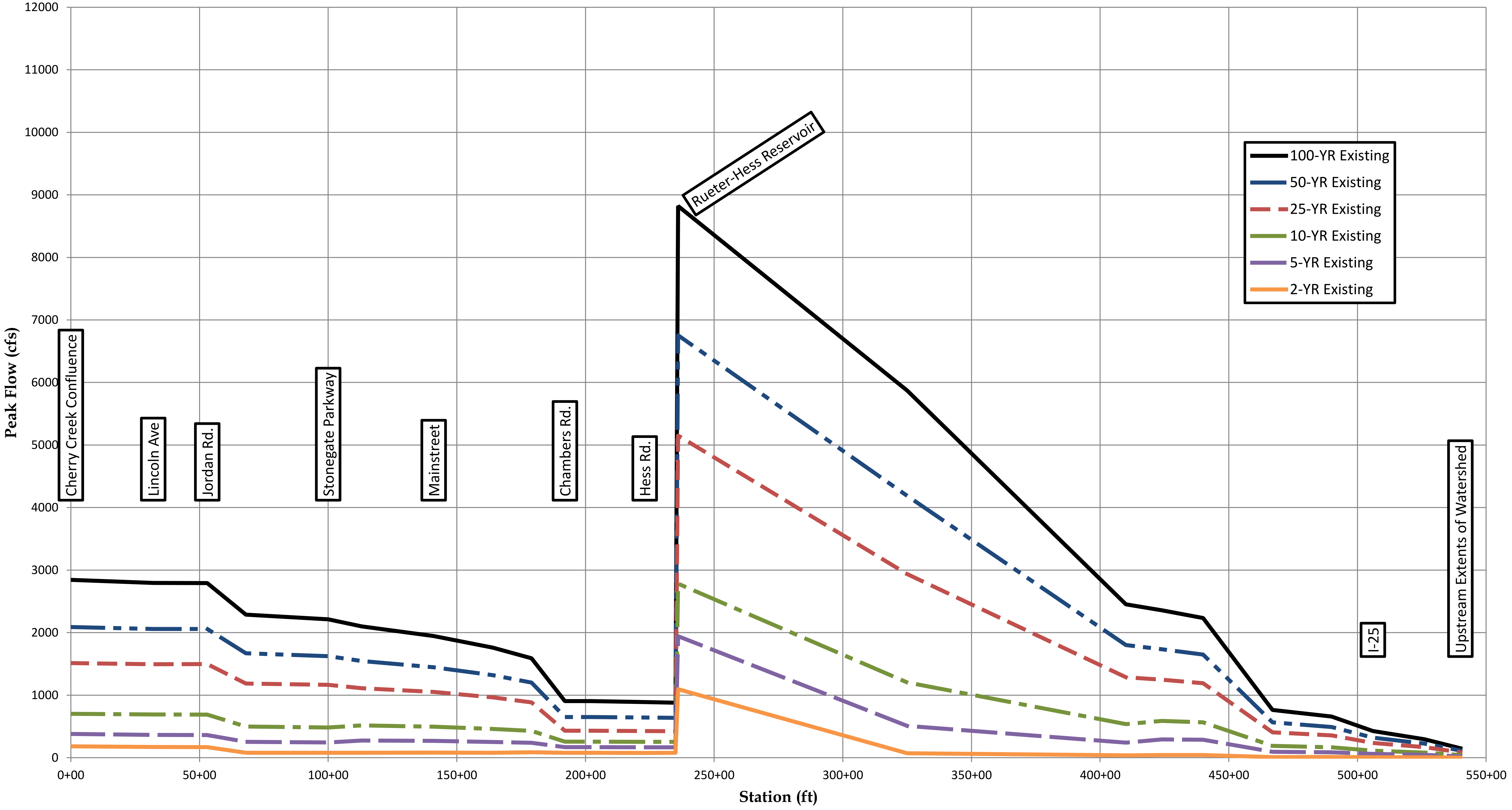


Figure B-7
Peak Flow Profile - Future Development

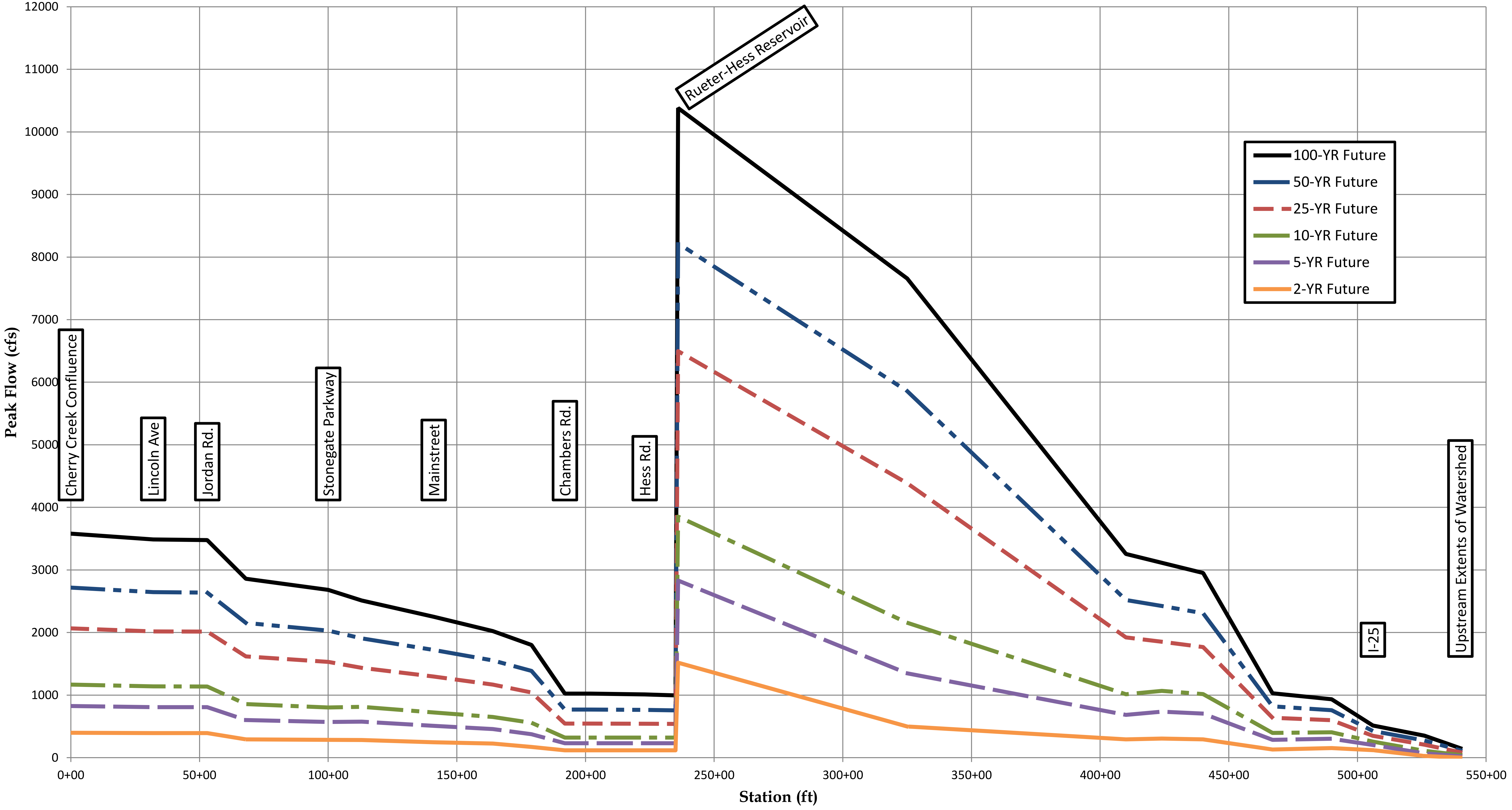


Table B-4
Peak Flow Rates

SWMM Node	Station (ft)	Channel Reach	Landmark	3 Square Mile Area Adjustment 2-yr, 5-yr, 10-yr	EXISTING DEVELOPMENT						FUTURE DEVELOPMENT					
					100-YR (cfs)	50-YR (cfs)	25-YR (cfs)	10-YR (cfs)	5-YR (cfs)	2-YR (cfs)	100-YR (cfs)	50-YR (cfs)	25-YR (cfs)	10-YR (cfs)	5-YR (cfs)	2-YR (cfs)
NEWLIN GULCH MAINSTEM																
NG000	0		Cherry Creek	yes	2843	2090	1514	703	380	183	3581	2717	2068	1168	826	398
NG001	3200		Lincoln Ave (U/S)	yes	2795	2059	1496	691	364	171	3486	2645	2018	1139	808	392
NG002	5300		Jordan Rd. (U/S)	yes	2793	2058	1497	690	363	169	3478	2639	2014	1136	807	392
NG003	6800			yes	2288	1670	1186	498	253	79	2859	2155	1618	856	601	293
NG004	10000		Stonegate Parkway (U/S)	yes	2212	1625	1165	483	245	80	2683	2031	1531	803	570	285
NG005	11300				2101	1546	1112	516	276	79	2512	1906	1437	814	577	282
NG006	14100		Mainstreet (U/S)		1945	1447	1051	496	270	82	2253	1722	1297	724	510	247
NG007	16400				1759	1320	965	459	251	80	2023	1553	1168	650	458	227
NG008	17900				1589	1202	884	429	240	86	1800	1387	1042	559	375	172
NG009	19200		Chambers Rd. (U/S)		905	651	432	257	169	78	1025	768	546	322	230	118
NG010	20200				905	651	432	257	169	78	1023	768	546	322	230	118
NG011	22300		Hess Rd. (U/S)		890	642	427	255	168	77	1010	763	544	321	230	118
NG012	23500		Rueter-Hess Reservoir Outflow		880	637	425	255	168	78	995	755	540	320	230	119
NG220	23600		Rueter-Hess Reservoir Total Inflow	yes	8822	6754	5150	2781	1942	1097	10381	8220	6497	3853	2831	1518
NG013	32500			yes	5871	4187	2935	1204	510	72	7657	5858	4386	2156	1349	499
NG014	41000		Rueter-Hess Reservoir Inflow from Mainstem	yes	2454	1801	1288	537	241	37	3255	2520	1922	1014	683	293
NG015	42400				2357	1735	1247	589	294	42	3115	2424	1852	1067	735	306
NG016	44000				2233	1649	1191	565	288	42	2952	2309	1767	1017	704	293
NG017	46700				763	565	407	190	95	11	1028	821	638	395	285	130
NG018	49000				659	492	356	168	86	12	933	758	600	406	304	154
NG019	50600		I-25 (U/S)		426	322	236	113	60	8	514	427	348	258	203	120
NG020	52600				296	227	168	82	45	6	352	274	207	110	69	27
NG021	54000		Upstream Extents of Watershed		151	116	86	42	22	2	152	117	87	42	23	2
JORDAN ROAD TRIBUTARY																
SJ000	60000		Confluence w/ Newlin Gulch		690	557	444	282	211	99	755	612	489	309	234	114
SJ001	63300		Stonegate Parkway (U/S)		568	465	377	246	187	89	635	521	416	268	207	101
SJ002	64500				368	312	262	186	146	71	376	319	270	194	154	77
SJ003	66400		Mainstreet		302	232	208	157	126	62	314	237	212	163	133	67
SJ004	69000				197	160	125	82	59	27	214	174	138	93	67	32
SANDPIT TRIBUTARY																
SP000	70000		Confluence w/ Newlin Gulch		654	494	360	165	83	10	782	605	455	241	152	51
SP001	72600				584	444	325	151	78	10	660	512	385	201	124	38
SP002	75700				276	214	161	82	48	11	276	214	161	82	48	11
CANAL TRIBUTARY																
CT000	80000		Edge of Reuter-Hess Normal Pool		684	537	400	207	118	16	684	536	400	207	118	16
CT001	86500				313	245	183	95	56	10	313	245	183	95	56	10
BIG WINDMILL TRIBUTARY																
BW000	90000		Edge of Reuter-Hess Normal Pool		857	658	486	237	126	11	953	746	559	295	178	38
BW001	96600				453	348	257	123	65	4	536	422	319	175	110	31
BW002	97400				265	204	151	74	40	3	323	255	194	110	71	23

Table B-4
Peak Flow Rates

					EXISTING DEVELOPMENT						FUTURE DEVELOPMENT					
SWMM Node	**Station (ft)**	**Channel Reach**	**Landmark**	**3 Square Mile Area Adjustment 2-yr, 5-yr, 10-yr**	**100-YR (cfs)**	**50-YR (cfs)**	**25-YR (cfs)**	**10-YR (cfs)**	**5-YR (cfs)**	**2-YR (cfs)**	**100-YR (cfs)**	**50-YR (cfs)**	**25-YR (cfs)**	**10-YR (cfs)**	**5-YR (cfs)**	**2-YR (cfs)**
SOUTH NEWLIN GULCH																
SN000	100000		Edge of Reuter-Hess Normal Pool		1522	1083	741	334	134	7	1707	1251	895	482	296	93
SN001	107100				1388	999	694	317	132	7	1564	1154	835	446	252	82
SN002	109800				891	648	456	210	93	6	963	717	519	273	149	42
SN003	111800				816	599	426	198	91	7	882	659	481	251	138	30
SN004	114600				725	538	387	182	89	8	778	586	430	218	122	23
SN005	117400				569	432	316	150	79	8	598	459	341	171	98	18
SN006	119700				442	340	252	123	67	8	465	361	271	140	82	16
SN007	121700				219	172	128	66	37	5	230	182	137	74	45	10
MESA TRIBUTARY																
MT000	130000		Edge of Reuter-Hess Normal Pool		493	363	261	119	55	3	598	457	343	184	115	34
MT001	131900				435	324	234	107	52	3	524	404	304	162	102	31
MT002	133900				338	255	186	86	43	3	406	316	238	128	81	27
MT003	136600				154	119	89	44	24	3	165	129	98	52	32	7
PARKWAY TRIBUTARY																
PW000	140000		Edge of Reuter-Hess Normal Pool		730	573	435	239	153	46	1121	917	730	483	364	184
PW001	142000		Hess Rd. (D/S)		674	531	405	226	147	46	1046	859	686	460	349	180
PW002	144500				420	339	263	158	109	44	666	556	450	323	251	143
ROUNDTOP TRIBUTARY																
RT000	150000		Confluence w/ Newlin Gulch		429	320	232	106	51	3	504	385	288	151	92	27
RT001	152300				360	274	200	94	48	4	399	308	230	118	70	18
RT002	154400				204	158	117	58	32	4	208	161	120	61	35	6
SPRING TRIBUTARY																
ST000	160000		Confluence w/ Newlin Gulch		1009	749	546	267	146	30	1427	1128	870	521	374	175
ST001	162500				906	678	498	249	140	33	1244	983	758	458	332	162
ST002	163800		I-25 (U/S)		566	426	316	166	99	31	659	524	415	293	222	126
ST003	165800				402	309	232	122	75	21	489	385	296	170	117	47
ST004	167300				280	219	166	91	59	19	324	256	197	113	78	30
ST005	169700				161	129	100	60	41	16	159	128	99	59	40	16

Table B-5
Runoff Volumes - Existing Development

SWMM Node	Station (ft)	Cumulative Drainage Area (ac)	Landmark	3 Square Mile Area Adjustment 2-yr, 5-yr, 10-yr	EXISTING DEVELOPMENT											
					100-YR		50-YR		25-YR		10-YR		5-YR		2-YR	
					(cf)	(in)	(cf)	(in)	(cf)	(in)	(cf)	(in)	(cf)	(in)	(cf)	(in)
NEWLIN GULCH MAINSTEM																
NG000	0	9609	Cherry Creek	yes	60,057,128	1.72	47,512,820	1.36	36,664,400	1.05	22,077,031	0.63	14,400,081	0.41	7,114,818	0.20
NG001	3200	9455	Lincoln Ave (U/S)	yes	58,939,681	1.72	46,596,430	1.36	35,928,347	1.05	21,589,092	0.63	14,026,440	0.41	6,891,168	0.20
NG002	5300	9433	Jordan Rd. (U/S)	yes	58,803,860	1.72	46,488,415	1.36	35,842,390	1.05	21,526,395	0.63	13,973,769	0.41	6,854,539	0.20
NG004	10000	8635	Stonegate Parkway (U/S)	yes	53,179,195	1.70	41,885,881	1.34	32,167,341	1.03	19,049,270	0.61	12,135,910	0.39	5,839,359	0.19
NG006	14100	8285	Mainstreet (U/S)		51,154,448	1.70	40,321,536	1.34	30,987,999	1.03	19,747,624	0.66	12,875,706	0.43	5,821,312	0.19
NG009	19200	7271	Chambers Rd. (U/S)		45,506,656	1.72	36,012,701	1.36	27,795,809	1.05	17,964,174	0.68	11,864,402	0.45	5,472,670	0.21
NG011	22300	6974	Hess Rd. (U/S)		43,634,708	1.72	34,525,222	1.36	26,646,813	1.05	17,224,378	0.68	11,372,587	0.45	5,246,346	0.21
NG012	23500	6717	Rueter-Hess Reservoir Outflow		42,265,404	1.73	33,500,283	1.37	25,903,141	1.06	16,847,395	0.69	11,188,106	0.46	5,193,141	0.21
NG220	23600	6717	Rueter-Hess Reservoir Total Inflow	yes	42,270,618	1.73	33,505,363	1.37	25,908,221	1.06	15,785,025	0.65	10,255,273	0.42	5,036,332	0.21
NG014	41000	2042	Rueter-Hess Reservoir Inflow from Mainstem	yes	11,387,826	1.54	8,661,518	1.17	6,381,172	0.86	3,232,963	0.44	1,597,900	0.22	379,924	0.05
NG019	50600	334	I-25 (U/S)		1,832,244	1.51	1,387,752	1.14	1,016,918	0.84	561,731	0.46	290,223	0.24	49,061	0.04

Table B-6
Runoff Volumes - Future Development

SWMM Node	Station (ft)	Cumulative Drainage Area (ac)	Landmark	3 Square Mile Area Adjustment 2-yr, 5-yr, 10-yr	FUTURE DEVELOPMENT											
					100-YR		50-YR		25-YR		10-YR		5-YR		2-YR	
					(cf)	(in)	(cf)	(in)	(cf)	(in)	(cf)	(in)	(cf)	(in)	(cf)	(in)
NEWLIN GULCH MAINSTEM																
NG000	0	9609	Cherry Creek	yes	65,852,239	1.89	53,565,936	1.54	42,512,181	1.22	28,252,867	0.81	20,252,540	0.58	10,973,680	0.31
NG001	3200	9455	Lincoln Ave (U/S)	yes	64,742,545	1.89	52,657,568	1.53	41,784,016	1.22	27,773,083	0.81	19,886,519	0.58	10,755,645	0.31
NG002	5300	9433	Jordan Rd. (U/S)	yes	64,608,195	1.89	52,550,890	1.53	41,699,529	1.22	27,711,589	0.81	19,834,785	0.58	10,719,551	0.31
NG004	10000	8635	Stonegate Parkway (U/S)	yes	58,868,429	1.88	47,831,250	1.53	37,909,380	1.21	25,111,878	0.80	17,878,216	0.57	9,614,402	0.31
NG006	14100	8285	Mainstreet (U/S)		56,335,692	1.87	45,737,792	1.52	36,212,555	1.20	25,231,389	0.84	18,077,803	0.60	9,370,433	0.31
NG009	19200	7271	Chambers Rd. (U/S)		49,578,606	1.88	40,273,143	1.53	31,905,191	1.21	22,271,271	0.84	15,954,935	0.60	8,263,547	0.31
NG011	22300	6974	Hess Rd. (U/S)		47,578,859	1.88	38,653,186	1.53	30,627,994	1.21	21,397,125	0.85	15,336,121	0.61	7,950,731	0.31
NG012	23500	6717	Rueter-Hess Reservoir Outflow		46,203,406	1.89	37,622,364	1.54	29,878,840	1.23	21,015,329	0.86	15,147,897	0.62	7,895,387	0.32
NG220	23600	6717	Rueter-Hess Reservoir Total Inflow	yes	46,210,090	1.90	37,627,444	1.54	29,883,787	1.23	19,961,916	0.82	14,230,305	0.58	7,636,044	0.31
NG014	41000	2042	Rueter-Hess Reservoir Inflow from Mainstem	yes	13,510,160	1.82	10,879,434	1.47	8,528,370	1.15	5,503,015	0.74	3,770,632	0.51	1,845,746	0.25
NG019	50600	334	I-25 (U/S)		2,213,104	1.82	1,784,386	1.47	1,401,120	1.15	959,569	0.79	670,548	0.55	321,639	0.27

Table B-7
Sample SWMM Input

```
[TITLE]
Newlin Gulch MDP
Baseline Hydrology Model

[OPTIONS]
FLOW_UNITS           CFS
INFILTRATION         HORTON
FLOW_ROUTING         KINWAVE
START_DATE           01/01/2005
START_TIME           00:00:00
REPORT_START_DATE    01/01/2005
REPORT_START_TIME    00:00:00
END_DATE             01/10/2005
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:15:00
WET_STEP             00:05:00
DRY_STEP             01:00:00
ROUTING_STEP         0:00:30
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         DEPTH
MIN_SLOPE            0

[FILES]
USE INFLOWS "P:\12-050.01 Newlin Gulch MDP - UDFCD\1 HYDROLOGY\Baseline\CUHP 2005
- v. 1.3.3\Output Files\Future\NewlinGulch_FU_100_2hr_CUHP Output.mdb.txt"

[EVAPORATION]
;;Type       Parameters
;;---------- ----------
CONSTANT     0.0
DRY_ONLY     NO

[JUNCTIONS]
;;               Invert     Max.       Init.      Surcharge  Ponded
;;Name           Elev.      Depth      Depth      Depth      Area
;;-------------- ---------- ---------- ---------- ---------- ----------
NG001            5802       0          0          0          0
A100             5767       0          0          0          0
NG000            5766       0          0          0          0
A104             5803       0          0          0          0
A108             5767       0          0          0          0
A110             5815       0          0          0          0
NG002            5814       0          0          0          0
SJ000            5818       0          0          0          0
NG003            5832       0          0          0          0
A115             5846       0          0          0          0
A120             5833       0          0          0          0
A125             5874       0          0          0          0
NG004            5860       0          0          0          0
A130             5861       0          0          0          0
NG005            5867.5     0          0          0          0
A135             5868.5     0          0          0          0
A140             5868.5     0          0          0          0
NG006            5902       0          0          0          0
A145             5903       0          0          0          0
A155             5903       0          0          0          0
A150             5903       0          0          0          0
NG005.5          5901       0          0          0          0
NG007            5924.5     0          0          0          0
A165             5925.5     0          0          0          0
NG008            5938       0          0          0          0
A170             5939       0          0          0          0
NG009            5948       0          0          0          0
A175             5939       0          0          0          0
A180             5949       0          0          0          0
NG011            5992       0          0          0          0
NG010            5964       0          0          0          0
A200             5965       0          0          0          0
A190             5965       0          0          0          0
A210             5993       0          0          0          0
A205             5993       0          0          0          0
NG012            6216.5     0          0          0          0
A220             6217       0          0          0          0
NG013            6217       0          0          0          0
A221             6218       0          0          0          0
A222             6218       0          0          0          0
A223             6218       0          0          0          0
A224             6218       0          0          0          0
A225             6218       0          0          0          0
A226             6218       0          0          0          0
A227             6218       0          0          0          0
A228             6218       0          0          0          0
NG014            6218       0          0          0          0
A230             6219       0          0          0          0
NG015            6235       0          0          0          0
A240             6236       0          0          0          0
```

Table B-7
Sample SWMM Input

NG016	6250	0	0	0	0
NG017	6295	0	0	0	0
A250	6251	0	0	0	0
A260	6296	0	0	0	0
NG018	6333	0	0	0	0
A270	6334	0	0	0	0
NG019	6380	0	0	0	0
NG119	6395	0	0	0	0
NG020	6410	0	0	0	0
A280	6381	0	0	0	0
NG021	6450	0	0	0	0
A290	6411	0	0	0	0
A300	6451	0	0	0	0
ST000	6251	0	0	0	0
ST001	6294	0	0	0	0
J100	6252	0	0	0	0
J110	6295	0	0	0	0
ST002	6325	0	0	0	0
ST101	6345	0	0	0	0
J130	6326	0	0	0	0
ST003	6363	0	0	0	0
J120	6346	0	0	0	0
A275	6396	0	0	0	0
J140	6364	0	0	0	0
ST004	6397	0	0	0	0
ST005	6471	0	0	0	0
J150	6398	0	0	0	0
J160	6472	0	0	0	0
ST102	6428	0	0	0	0
J155	6429	0	0	0	0
RT000	6251	0	0	0	0
RT001	6297	0	0	0	0
I100	6252	0	0	0	0
I110	6298	0	0	0	0
RT002	6360	0	0	0	0
I120	6361	0	0	0	0
I115	6361	0	0	0	0
SN000	6218	0	0	0	0
F106	6219	0	0	0	0
F102	6219	0	0	0	0
F104	6219	0	0	0	0
SN001	6219	0	0	0	0
SN002	6264	0	0	0	0
F100	6220	0	0	0	0
SN003	6294	0	0	0	0
F110	6265	0	0	0	0
SN004	6335	0	0	0	0
F120	6295	0	0	0	0
F125	6336	0	0	0	0
F130	6336	0	0	0	0
SN005	6377	0	0	0	0
F140	6378	0	0	0	0
SN006	6415	0	0	0	0
F145	6416	0	0	0	0
F150	6416	0	0	0	0
SN007	6470	0	0	0	0
F155	6471	0	0	0	0
MT000	6220	0	0	0	0
G100	6221	0	0	0	0
MT001	6248	0	0	0	0
G110	6249	0	0	0	0
MT002	6285	0	0	0	0
MT003	6354	0	0	0	0
G120	6286	0	0	0	0
G115	6286	0	0	0	0
G130	6355	0	0	0	0
PW000	6218	0	0	0	0
PW001	6228	0	0	0	0
H100	6219	0	0	0	0
H115	6229	0	0	0	0
PW002	6277	0	0	0	0
H125	6278	0	0	0	0
H120	6278	0	0	0	0
H110	6229	0	0	0	0
BW000	6218	0	0	0	0
BW001	6219	0	0	0	0
BW002	6235	0	0	0	0
E105	6219	0	0	0	0
E115	6219	0	0	0	0
E128	6219	0	0	0	0
E100	6220	0	0	0	0
E110	6220	0	0	0	0
E120	6236	0	0	0	0
E124	6236	0	0	0	0
CT001	6219	0	0	0	0
CT000	6218	0	0	0	0
D110	6220	0	0	0	0
D100	6220	0	0	0	0
D105	6220	0	0	0	0
D115	6219	0	0	0	0
D120	6219	0	0	0	0
D125	6219	0	0	0	0
SP000	5948	0	0	0	0
SP001	5978	0	0	0	0
SP002	6072	0	0	0	0
C115	6012	0	0	0	0

Table B-7

Sample SWMM Input

```
C120             6073       0          0          0          0
C110             5979       0          0          0          0
C100             5949       0          0          0          0
B100             5819       0          0          0          0
SJ001            5874       0          0          0          0
B110             5875       0          0          0          0
SJ002            5884       0          0          0          0
B120             5885       0          0          0          0
SJ003            5903.20    0          0          0          0
B135             5921       0          0          0          0
B130             5921       0          0          0          0
SJ004            5970       0          0          0          0
B140             5971       0          0          0          0
A160             5925.5     0          0          0          0
C125             6073       0          0          0          0

[OUTFALLS]
;;               Invert     Outfall    Stage/Table      Tide
;;Name           Elev.      Type       Time Series      Gate
;;-------------- ---------- ---------- ---------------- ----
NG-OUT           5765       FREE                        NO
```

Table B-7
Sample SWMM Input

```
[STORAGE]

;;               Invert   Max.     Init.    Storage    Curve                      Ponded   Evap.
;;Name           Elev.    Depth    Depth    Curve      Params                     Area     Frac.    Infiltration Parameters
;;-------------- -------- -------- -------- ---------- -------- -------- -------- -------- -------- -----------------------
NG220            6216.7   8        0        TABULAR    A220_STORAGE_RH_AUX-ONLY            0        0
SJ130            5918.7   5929.5   0        TABULAR    B130_STORAGE_PONDIV            0        0

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet      Outlet     Init.      Max.
;;Name           Node             Node             Length     N          Offset     Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ---------- ----------
A10              NG001            NG000            3050       0.065      0          0          0          0
A10.4            NG002            NG001            1578       0.065      0          0          0          0
A100-DF          A100             NG000            10         0.01       0          0          0          0
A104-DF          A104             NG001            10         0.01       0          0          0          0
A108-DF          A108             NG000            10         0.01       0          0          0          0
A11              NG003            NG002            1930       0.085      0          0          0          0
A110-DF          A110             NG002            10         0.01       0          0          0          0
A115             A115             NG003            1050       0.060      0          0          0          0
A12              NG004            NG003            3190       0.085      0          0          0          0
A14              NG005.5          NG005            3090       0.06       0          0          0          0
A14.5            NG006            NG005.5          100        0.065      0          0          0          0
A120-DF          A120             NG003            10         0.01       0          0          0          0
A125             A125             NG004            950        0.065      0          0          0          0
A13              NG005            NG004            1200       0.065      0          0          0          0
A130-DF          A130             NG004            10         0.01       0          0          0          0
A135-DF          A135             NG005            10         0.01       0          0          0          0
A140-DF          A140             NG005            10         0.01       0          0          0          0
A145-DF          A145             NG005.5          10         0.01       0          0          0          0
A15              NG007            NG006            2156       0.06       0          0          0          0
A150-DF          A150             NG006            10         0.01       0          0          0          0
A155-DF          A155             NG006            10         0.01       0          0          0          0
A16              NG008            NG007            1550       0.06       0          0          0          0
A160-DF          A160             NG007            10         0.01       0          0          0          0
A165-DF          A165             NG007            10         0.01       0          0          0          0
A17              NG009            NG008            780        0.06       0          0          0          0
A170-DF          A170             NG008            10         0.01       0          0          0          0
A175-DF          A175             NG008            10         0.01       0          0          0          0
A180-DF          A180             NG009            10         0.01       0          0          0          0
A19              NG010            NG009            1450       0.06       0          0          0          0
A190-DF          A190             NG010            10         0.01       0          0          0          0
A20              NG011            NG010            2075       0.06       0          0          0          0
A200-DF          A200             NG010            10         0.01       0          0          0          0
A205-DF          A205             NG011            10         0.01       0          0          0          0
A21              NG012            NG011            4074       0.08       0          0          0          0
A210-DF          A210             NG011            10         0.01       0          0          0          0
A22              NG014            NG013            10         0.01       0          0          0          0
```

Table B-7
Sample SWMM Input

```
A220-DF          A220             NG220            10         0.01       0          0          0          0
A221-DF          A221             NG013            10         0.01       0          0          0          0
A222-DF          A222             NG013            10         0.01       0          0          0          0
A223-DF          A223             NG013            10         0.01       0          0          0          0
A224-DF          A224             NG013            10         0.01       0          0          0          0
A225-DF          A225             NG013            10         0.01       0          0          0          0
A226-DF          A226             NG013            10         0.01       0          0          0          0
A227-DF          A227             NG013            10         0.01       0          0          0          0
A228-DF          A228             NG013            10         0.01       0          0          0          0
A23              NG015            NG014            1318       0.06       0          0          0          0
A230-DF          A230             NG014            10         0.01       0          0          0          0
A24              NG016            NG015            1619       0.06       0          0          0          0
A240-DF          A240             NG015            10         0.01       0          0          0          0
A25              NG017            NG016            2673       0.075      0          0          0          0
A250-DF          A250             NG016            10         0.01       0          0          0          0
A26              NG018            NG017            2266       0.075      0          0          0          0
A260-DF          A260             NG017            10         0.01       0          0          0          0
A27              NG019            NG018            1637       0.075      0          0          0          0
A27.5            NG119            NG018            1584       0.065      0          0          0          0
A270-DF          A270             NG018            10         0.01       0          0          0          0
A275-DF          A275             NG119            10         0.01       0          0          0          0
A28              NG020            NG019            1818       0.075      0          0          0          0
A280-DF          A280             NG019            10         0.01       0          0          0          0
A29              NG021            NG020            1474       0.075      0          0          0          0
A290-DF          A290             NG020            10         0.01       0          0          0          0
A300-DF          A300             NG021            10         0.01       0          0          0          0
B10              SJ001            SJ000            3247       0.075      0          0          0          0
B100-DF          B100             SJ000            10         0.01       0          0          0          0
B11              SJ002            SJ001            1261       0.085      0          0          0          0
B110-DF          B110             SJ001            10         0.01       0          0          0          0
B12              SJ003            SJ002            1877       0.085      0          0          0          0
B120-DF          B120             SJ002            10         0.01       0          0          0          0
B13              SJ004            SJ130            3351       0.075      0          0          0          0
B130-DF          B130             SJ130            10         0.01       0          0          0          0
B135-DF          B135             SJ130            10         0.01       0          0          0          0
B140-DF          B140             SJ004            10         0.01       0          0          0          0
BW-OUT           BW000            NG013            10         0.01       0          0          0          0
C10              SP001            SP000            2104       0.075      0          0          0          0
C100-DF          C100             SP000            10         0.01       0          0          0          0
C11              SP002            SP001            3220       0.09       0          0          0          0
C11.5            C115             SP001            1577       0.09       0          0          0          0
C110-DF          C110             SP001            10         0.01       0          0          0          0
C120-DF          C120             SP002            10         0.01       0          0          0          0
C125-DF          C125             SP002            10         0.01       0          0          0          0
CT-OUT           CT000            NG013            10         0.01       0          0          0          0
D10              CT001            CT000            10         0.01       0          0          0          0
D100-DF          D100             CT001            10         0.01       0          0          0          0
D105-DF          D105             CT001            10         0.01       0          0          0          0
```

Table B-7
Sample SWMM Input

```
D110-DF          D110             CT001            10         0.01       0          0          0          0
D115-DF          D115             CT000            10         0.01       0          0          0          0
D120-DF          D120             CT000            10         0.01       0          0          0          0
D125-DF          D125             CT000            10         0.01       0          0          0          0
E10.5            BW001            BW000            10         0.01       0          0          0          0
E100-DF          E100             BW001            10         0.01       0          0          0          0
E105-DF          E105             BW000            10         0.01       0          0          0          0
E11              BW002            BW001            770        0.085      0          0          0          0
E110-DF          E110             BW001            10         0.01       0          0          0          0
E115-DF          E115             BW000            10         0.01       0          0          0          0
E120-DF          E120             BW002            10         0.01       0          0          0          0
E124-DF          E124             BW002            10         0.01       0          0          0          0
E128-DF          E128             BW000            10         0.01       0          0          0          0
F10              SN002            SN001            2768       0.075      0          0          0          0
F10.2            SN001            SN000            10         0.01       0          0          0          0
F100-DF          F100             SN001            10         0.01       0          0          0          0
F102-DF          F102             SN000            10         0.01       0          0          0          0
F104-DF          F104             SN000            10         0.01       0          0          0          0
F106-DF          F106             SN000            10         0.01       0          0          0          0
F11              SN003            SN002            1889       0.075      0          0          0          0
F110-DF          F110             SN002            10         0.01       0          0          0          0
F12              SN004            SN003            2764       0.075      0          0          0          0
F120-DF          F120             SN003            10         0.01       0          0          0          0
F125-DF          F125             SN004            10         0.01       0          0          0          0
F13              SN005            SN004            2822       0.075      0          0          0          0
F130-DF          F130             SN004            10         0.01       0          0          0          0
F14              SN006            SN005            2295       0.085      0          0          0          0
F140-DF          F140             SN005            10         0.01       0          0          0          0
F145-DF          F145             SN006            10         0.01       0          0          0          0
F15              SN007            SN006            2047       0.09       0          0          0          0
F150-DF          F150             SN006            10         0.01       0          0          0          0
F155-DF          F155             SN007            10         0.01       0          0          0          0
G10              MT001            MT000            1907       0.075      0          0          0          0
G100-DF          G100             MT000            10         0.01       0          0          0          0
G11              MT002            MT001            1883       0.085      0          0          0          0
G110-DF          G110             MT001            10         0.01       0          0          0          0
G115-DF          G115             MT002            10         0.01       0          0          0          0
G12              MT003            MT002            2682       0.085      0          0          0          0
G120-DF          G120             MT002            10         0.01       0          0          0          0
G130-DF          G130             MT003            10         0.01       0          0          0          0
H10              PW001            PW000            676        0.07       0          0          0          0
H100-DF          H100             PW000            10         0.01       0          0          0          0
H11              PW002            PW001            1853       0.085      0          0          0          0
H110-DF          H110             PW001            10         0.01       0          0          0          0
H115-DF          H115             PW001            10         0.01       0          0          0          0
H120-DF          H120             PW002            10         0.01       0          0          0          0
H125-DF          H125             PW002            10         0.01       0          0          0          0
I10              RT001            RT000            2491       .08        0          0          0          0
```

Table B-7
Sample SWMM Input

```
I100-DF          I100             RT000            10         0.01       0          0          0          0
I11              RT002            RT001            2223       0.085      0          0          0          0
I110-DF          I110             RT001            10         0.01       0          0          0          0
I115-DF          I115             RT002            10         0.01       0          0          0          0
I120-DF          I120             RT002            10         0.01       0          0          0          0
J10              ST001            ST000            2439       0.06       0          0          0          0
J100-DF          J100             ST000            10         0.01       0          0          0          0
J11              ST002            ST001            1373       0.08       0          0          0          0
J11.5            ST101            ST001            1694       0.08       0          0          0          0
J110-DF          J110             ST001            10         0.01       0          0          0          0
J12              ST102            ST101            3031       0.09       0          0          0          0
J120-DF          J120             ST101            10         0.01       0          0          0          0
J13              ST003            ST002            2060       0.08       0          0          0          0
J130-DF          J130             ST002            10         0.01       0          0          0          0
J14              ST004            ST003            1514       0.09       0          0          0          0
J140-DF          J140             ST003            10         0.01       0          0          0          0
J15              ST005            ST004            2361       0.09       0          0          0          0
J150-DF          J150             ST004            10         0.01       0          0          0          0
J155-DF          J155             ST102            10         0.01       0          0          0          0
J160-DF          J160             ST005            10         0.01       0          0          0          0
MT-OUT           MT000            SN001            10         0.01       0          0          0          0
NG220-IN         NG013            NG220            10         0.01       0          0          0          0
NG-OUT           NG000            NG-OUT           10         0.01       0          0          0          0
PW-OUT           PW000            NG013            10         0.01       0          0          0          0
RT-OUT           RT000            NG016            10         0.01       0          0          0          0
SJ-OUT           SJ000            NG002            10         0.01       0          0          0          0
SN-OUT           SN000            NG013            10         0.01       0          0          0          0
SP-OUT           SP000            NG008            20         0.01       0          0          0          0
ST-OUT           ST000            NG016            10         0.01       0          0          0          0

[OUTLETS]
;;               Inlet            Outlet           Outflow    Outlet          Qcoeff/                     Flap
;;Name           Node             Node             Height     Type            QTable           Qexpon     Gate
;;-------------- ---------------- ---------------- ---------- --------------- ---------------- ---------- ----
NG220-OUT        NG220            NG012            0          TABULAR/DEPTH   A220_OUTFLOW_RH_AUX-ONLY            NO
SJ130-OUT        SJ130            SJ003            0          TABULAR/DEPTH   B130_OUTFLOW_PONDIV            NO
```

Table B-7

Sample SWMM Input

```
[XSECTIONS]
;;Link          Shape        Geom1            Geom2      Geom3      Geom4      
Barrels
;;-------------- ------------ ---------------- ---------- ---------- ---------- --
--------
A10              TRAPEZOIDAL  15               130        6          6          1
A10.4            TRAPEZOIDAL  15               75         6          5          1
A100-DF          DUMMY        0                0          0          0          1
A104-DF          DUMMY        0                0          0          0          1
A108-DF          DUMMY        0                0          0          0          1
A11              TRAPEZOIDAL  15               60         5          5          1
A110-DF          DUMMY        0                0          0          0          1
A115             TRAPEZOIDAL  10               10         5          5          1
A12              TRAPEZOIDAL  10               65         5          5          1
A14              TRAPEZOIDAL  10               109        5          5          1
A14.5            TRAPEZOIDAL  10               109        5          5          1
A120-DF          DUMMY        0                0          0          0          1
A125             TRAPEZOIDAL  10               20         6          6          1
A13              TRAPEZOIDAL  10               110        5          5          1
A130-DF          DUMMY        0                0          0          0          1
A135-DF          DUMMY        0                0          0          0          1
A140-DF          DUMMY        0                0          0          0          1
A145-DF          DUMMY        0                0          0          0          1
A15              TRAPEZOIDAL  10               111        10         3.5        1
A150-DF          DUMMY        0                0          0          0          1
A155-DF          DUMMY        0                0          0          0          1
A16              TRAPEZOIDAL  10               110        20         10         1
A160-DF          DUMMY        0                0          0          0          1
A165-DF          DUMMY        0                0          0          0          1
A17              TRAPEZOIDAL  10               100        6          6          1
A170-DF          DUMMY        0                0          0          0          1
A175-DF          DUMMY        0                0          0          0          1
A180-DF          DUMMY        0                0          0          0          1
A19              TRAPEZOIDAL  10               80         3          5          1
A190-DF          DUMMY        0                0          0          0          1
A20              TRAPEZOIDAL  10               180        10         10         1
A200-DF          DUMMY        0                0          0          0          1
A205-DF          DUMMY        0                0          0          0          1
A21              TRAPEZOIDAL  10               330        5          5          1
A210-DF          DUMMY        0                0          0          0          1
A22              DUMMY        0                0          0          0          1
A220-DF          DUMMY        0                0          0          0          1
A221-DF          DUMMY        0                0          0          0          1
A222-DF          DUMMY        0                0          0          0          1
A223-DF          DUMMY        0                0          0          0          1
A224-DF          DUMMY        0                0          0          0          1
A225-DF          DUMMY        0                0          0          0          1
A226-DF          DUMMY        0                0          0          0          1
A227-DF          DUMMY        0                0          0          0          1
A228-DF          DUMMY        0                0          0          0          1
A23              TRAPEZOIDAL  10               80         10         10         1
A230-DF          DUMMY        0                0          0          0          1
A24              TRAPEZOIDAL  10               80         10         10         1
A240-DF          DUMMY        0                0          0          0          1
A25              TRAPEZOIDAL  10               50         10         10         1
A250-DF          DUMMY        0                0          0          0          1
A26              TRAPEZOIDAL  10               60         10         10         1
A260-DF          DUMMY        0                0          0          0          1
A27              TRAPEZOIDAL  10               32         10         10         1
A27.5            TRAPEZOIDAL  10               20         10         10         1
A270-DF          DUMMY        0                0          0          0          1
A275-DF          DUMMY        0                0          0          0          1
A28              TRAPEZOIDAL  10               30         10         10         1
A280-DF          DUMMY        0                0          0          0          1
A29              TRAPEZOIDAL  10               40         10         10         1
A290-DF          DUMMY        0                0          0          0          1
A300-DF          DUMMY        0                0          0          0          1
B10              TRAPEZOIDAL  10               32         9          5          1
B100-DF          DUMMY        0                0          0          0          1
B11              TRAPEZOIDAL  10               35         10         15         1
B110-DF          DUMMY        0                0          0          0          1
B12              TRAPEZOIDAL  10               35         10         10         1
B120-DF          DUMMY        0                0          0          0          1
B13              TRAPEZOIDAL  10               25         5          5          1
B130-DF          DUMMY        0                0          0          0          1
B135-DF          DUMMY        0                0          0          0          1
B140-DF          DUMMY        0                0          0          0          1
BW-OUT           DUMMY        0                0          0          0          1
C10              TRAPEZOIDAL  10               30         4          4          1
C100-DF          DUMMY        0                0          0          0          1
C11              TRAPEZOIDAL  10               20         4          4          1
C11.5            TRAPEZOIDAL  10               60         15         15         1
C110-DF          DUMMY        0                0          0          0          1
C120-DF          DUMMY        0                0          0          0          1
C125-DF          DUMMY        0                0          0          0          1
CT-OUT           DUMMY        0                0          0          0          1
D10              DUMMY        0                0          0          0          1
D100-DF          DUMMY        0                0          0          0          1
D105-DF          DUMMY        0                0          0          0          1
D110-DF          DUMMY        0                0          0          0          1
D115-DF          DUMMY        0                0          0          0          1
D120-DF          DUMMY        0                0          0          0          1
D125-DF          DUMMY        0                0          0          0          1
E10.5            DUMMY        0                0          0          0          1
E100-DF          DUMMY        0                0          0          0          1
E105-DF          DUMMY        0                0          0          0          1
```

Table B-7

Sample SWMM Input

```
E11              TRAPEZOIDAL  10               30         10         15         1
E110-DF          DUMMY        0                0          0          0          1
E115-DF          DUMMY        0                0          0          0          1
E120-DF          DUMMY        0                0          0          0          1
E124-DF          DUMMY        0                0          0          0          1
E128-DF          DUMMY        0                0          0          0          1
F10              TRAPEZOIDAL  10               60         10         10         1
F10.2            DUMMY        0                0          0          0          1
F100-DF          DUMMY        0                0          0          0          1
F102-DF          DUMMY        0                0          0          0          1
F104-DF          DUMMY        0                0          0          0          1
F106-DF          DUMMY        0                0          0          0          1
F11              TRAPEZOIDAL  10               40         9          10         1
F110-DF          DUMMY        0                0          0          0          1
F12              TRAPEZOIDAL  10               60         10         10         1
F120-DF          DUMMY        0                0          0          0          1
F125-DF          DUMMY        0                0          0          0          1
F13              TRAPEZOIDAL  10               25         10         10         1
F130-DF          DUMMY        0                0          0          0          1
F14              TRAPEZOIDAL  10               20         10         10         1
F140-DF          DUMMY        0                0          0          0          1
F145-DF          DUMMY        0                0          0          0          1
F15              TRAPEZOIDAL  10               20         10         10         1
F150-DF          DUMMY        0                0          0          0          1
F155-DF          DUMMY        0                0          0          0          1
G10              TRAPEZOIDAL  10               35         15         15         1
G100-DF          DUMMY        0                0          0          0          1
G11              TRAPEZOIDAL  10               30         15         10         1
G110-DF          DUMMY        0                0          0          0          1
G115-DF          DUMMY        0                0          0          0          1
G12              TRAPEZOIDAL  10               20         15         11         1
G120-DF          DUMMY        0                0          0          0          1
G130-DF          DUMMY        0                0          0          0          1
H10              TRAPEZOIDAL  10               70         10         10         1
H100-DF          DUMMY        0                0          0          0          1
H11              TRAPEZOIDAL  10               30         15         15         1
H110-DF          DUMMY        0                0          0          0          1
H115-DF          DUMMY        0                0          0          0          1
H120-DF          DUMMY        0                0          0          0          1
H125-DF          DUMMY        0                0          0          0          1
I10              TRAPEZOIDAL  10               35         10         10         1
I100-DF          DUMMY        0                0          0          0          1
I11              TRAPEZOIDAL  10               30         10         10         1
I110-DF          DUMMY        0                0          0          0          1
I115-DF          DUMMY        0                0          0          0          1
I120-DF          DUMMY        0                0          0          0          1
J10              TRAPEZOIDAL  10               40         7          10         1
J100-DF          DUMMY        0                0          0          0          1
J11              TRAPEZOIDAL  10               30         10         10         1
J11.5            TRAPEZOIDAL  10               60         10         10         1
J110-DF          DUMMY        0                0          0          0          1
J12              TRAPEZOIDAL  10               60         10         10         1
J120-DF          DUMMY        0                0          0          0          1
J13              TRAPEZOIDAL  10               25         6          6          1
J130-DF          DUMMY        0                0          0          0          1
J14              TRAPEZOIDAL  10               25         10         10         1
J140-DF          DUMMY        0                0          0          0          1
J15              TRAPEZOIDAL  10               30         10         10         1
J150-DF          DUMMY        0                0          0          0          1
J155-DF          DUMMY        0                0          0          0          1
J160-DF          DUMMY        0                0          0          0          1
MT-OUT           DUMMY        0                0          0          0          1
NG220-IN         DUMMY        0                0          0          0          1
NG-OUT           DUMMY        0                0          0          0          1
PW-OUT           DUMMY        0                0          0          0          1
RT-OUT           DUMMY        0                0          0          0          1
SJ-OUT           DUMMY        0                0          0          0          1
SN-OUT           DUMMY        0                0          0          0          1
SP-OUT           DUMMY        0                0          0          0          1
ST-OUT           DUMMY        0                0          0          0          1

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate 
;;-------------- ---------- ---------- ---------- ----------

[CURVES]
;;Name           Type       X-Value    Y-Value   
;;-------------- ---------- ---------- ----------
;A rating curve based on the aux. spillway outflow only
A220_OUTFLOW_RH_AUX-ONLY Rating     0.0        0.0       
A220_OUTFLOW_RH_AUX-ONLY            0.4        359.0     
A220_OUTFLOW_RH_AUX-ONLY            0.9        1220.0    
A220_OUTFLOW_RH_AUX-ONLY            1.4        2381.0    
A220_OUTFLOW_RH_AUX-ONLY            1.9        3785.0    
A220_OUTFLOW_RH_AUX-ONLY            2.4        5403.0    
A220_OUTFLOW_RH_AUX-ONLY            2.9        7217.0    
A220_OUTFLOW_RH_AUX-ONLY            3.4        9213.0    
A220_OUTFLOW_RH_AUX-ONLY            3.9        11380.0   
A220_OUTFLOW_RH_AUX-ONLY            4.4        13712.0   
A220_OUTFLOW_RH_AUX-ONLY            4.9        16202.0   
A220_OUTFLOW_RH_AUX-ONLY            5.4        18846.0   
A220_OUTFLOW_RH_AUX-ONLY            5.9        21640.0   
A220_OUTFLOW_RH_AUX-ONLY            6.4        24579.0   

B130_OUTFLOW_PONDIV Rating     0.00       0.00      
B130_OUTFLOW_PONDIV            3.00       66.85     
```

Table B-7
Sample SWMM Input

```
B130_OUTFLOW_PONDIV            3.50       94.54
B130_OUTFLOW_PONDIV            4.00       115.79
B130_OUTFLOW_PONDIV            4.50       133.70
B130_OUTFLOW_PONDIV            5.00       149.48
B130_OUTFLOW_PONDIV            5.50       163.75
B130_OUTFLOW_PONDIV            6.00       176.87
B130_OUTFLOW_PONDIV            6.50       189.08
B130_OUTFLOW_PONDIV            7.00       200.55
B130_OUTFLOW_PONDIV            7.50       211.40
B130_OUTFLOW_PONDIV            8.00       221.72
B130_OUTFLOW_PONDIV            8.50       231.58
B130_OUTFLOW_PONDIV            9.00       247.00
B130_OUTFLOW_PONDIV            9.50       290.23
B130_OUTFLOW_PONDIV            10.00      351.23
B130_OUTFLOW_PONDIV            10.50      426.96
B130_OUTFLOW_PONDIV            11.00      516.27
B130_OUTFLOW_PONDIV            11.30      576.13
;Storage curve for RH res. using only the volume above the aux. spillway

A220_STORAGE_RH_AUX-ONLY Storage    0          50660280
A220_STORAGE_RH_AUX-ONLY            1.4        50965200
A220_STORAGE_RH_AUX-ONLY            6.4        53622360
;Based on Douglas County 5-Foot Contours

B130_STORAGE_PONDIV Storage    0          0
B130_STORAGE_PONDIV            6.3        82308
B130_STORAGE_PONDIV            8.8        150181
B130_STORAGE_PONDIV            11.3       218054

[REPORT]
INPUT      NO
CONTROLS   NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS 3159265.825 1580659.249 3213328.325 1624721.749
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
NG001            3200434.454        1620248.042
A100             3199970.010        1620764.091
NG000            3202451.782        1621343.740
A104             3199678.939        1619983.260
A108             3201271.874        1620001.381
A110             3198372.235        1619389.734
NG002            3199282.115        1619471.773
SJ000            3199156.882        1619020.601
NG003            3198094.255        1618124.588
A115             3197290.806        1618920.633
A120             3197057.927        1616791.729
A125             3195098.188        1617980.024
NG004            3195670.146        1617209.123
A130             3194762.473        1617225.702
NG005            3195641.134        1616077.641
A135             3194874.378        1615828.963
A140             3195906.390        1615041.484
NG006            3194231.961        1613793.952
A145             3193519.086        1614245.716
A155             3193137.780        1613449.948
A150             3195011.151        1612732.928
NG005.5          3194365.598        1614031.019
NG007            3194447.957        1611819.688
A165             3193686.138        1612676.218
NG008            3193817.912        1610563.717
A170             3194880.340        1609987.206
NG009            3193620.251        1609542.469
A175             3194386.187        1609443.639
A180             3193937.332        1608764.179
NG011            3192067.790        1607137.595
NG010            3192969.618        1608467.688
A200             3193344.350        1607817.054
A190             3192269.569        1608434.745
A210             3190737.697        1607425.850
A205             3192920.202        1605823.973
NG012            3187913.217        1605737.905
A220             3189079.770        1604635.080
NG013            3187199.223        1600654.683
A221             3192630.208        1601386.761
A222             3191847.800        1599039.537
A223             3186560.371        1601880.913
A224             3184451.988        1601263.223
A225             3183611.929        1600489.051
A226             3182640.097        1599311.321
A227             3184050.826        1597685.449
A228             3181973.792        1597703.176
NG014            3181801.525        1596233.164
A230             3182054.183        1595429.252
NG015            3181342.146        1595234.016
A240             3181835.978        1594200.414
NG016            3180193.700        1594510.495
```

Table B-7
Sample SWMM Input

NG017	3178792.595	1592707.434
A250	3179481.663	1592856.732
A260	3178781.111	1591558.987
NG018	3177667.117	1591042.186
A270	3177288.130	1589801.864
NG019	3176231.559	1590376.087
NG119	3176346.404	1591616.409
NG020	3174531.859	1589664.050
A280	3175140.535	1590548.354
NG021	3173119.269	1589204.672
A290	3172981.456	1590123.429
A300	3171408.084	1588860.138
ST000	3179952.526	1594499.010
ST001	3177896.807	1594499.010
J100	3178746.657	1595268.469
J110	3177380.006	1594981.358
ST002	3176667.969	1594751.668
ST101	3176484.218	1593545.800
J130	3175576.945	1595383.314
ST003	3174910.846	1594832.060
J120	3175485.069	1592569.620
A275	3175393.193	1591581.956
J140	3174462.952	1594085.569
ST004	3173601.617	1594453.072
ST005	3172051.214	1592822.278
J150	3172797.704	1593017.514
J160	3171511.444	1592271.024
ST102	3174083.964	1592558.136
J155	3173348.959	1592098.757
RT000	3180342.905	1594247.620
RT001	3180294.275	1592229.463
I100	3180829.208	1593019.705
I110	3180750.184	1590728.003
RT002	3179686.397	1590253.858
I120	3180111.912	1589111.047
I115	3178926.549	1589141.441
SN000	3186307.280	1599343.304
F106	3187030.685	1597199.506
F102	3184580.514	1597121.723
F104	3184914.981	1595721.625
SN001	3185816.056	1595035.028
SN002	3186967.613	1592981.551
F100	3186105.958	1593770.730
SN003	3186927.349	1591274.346
F110	3186548.865	1592039.367
SN004	3185534.206	1589470.507
F120	3187048.142	1589969.784
F125	3185437.572	1588318.950
F130	3184229.644	1589365.820
SN005	3183601.521	1587859.937
F140	3183239.143	1586716.432
SN006	3182095.638	1586635.904
F145	3182039.268	1585427.976
F150	3180992.397	1586772.802
SN007	3180509.226	1585548.769
F155	3179864.998	1585081.703
MT000	3185501.994	1594865.918
G100	3185348.990	1593819.047
MT001	3184745.026	1593843.206
G110	3184543.705	1592828.547
MT002	3183738.420	1592554.750
MT003	3182337.224	1590380.480
G120	3182321.118	1591668.936
G115	3183851.160	1591411.245
G130	3181999.004	1589075.918
PW000	3181829.894	1598602.441
PW001	3181024.609	1598425.279
H100	3181523.886	1599005.084
H115	3179800.575	1599874.792
PW002	3179494.567	1597861.579
H125	3178326.903	1598723.234
H120	3178326.903	1596669.757
H110	3180460.909	1597555.571
BW000	3189200.837	1599595.230
BW001	3188983.065	1596577.241
BW002	3188671.911	1595900.527
E105	3188345.222	1598716.279
E115	3190422.034	1598467.373
E128	3190484.261	1596445.009
E100	3188345.222	1596701.694
E110	3189200.837	1596351.669
E120	3188104.094	1594834.896
E124	3189410.852	1594951.571
CT001	3184871.446	1603034.804
CT000	3187390.478	1603865.758
D110	3183464.713	1602910.488
D100	3185048.105	1602465.568
D105	3184727.501	1603466.638
D115	3185525.740	1604238.706
D120	3184433.069	1605102.374
D125	3187161.475	1605351.006
SP000	3193378.721	1610469.741
SP001	3191378.524	1609929.337
SP002	3189160.763	1608399.362
C115	3189673.094	1610083.738
C120	3188269.447	1608209.870

Table B-7

Sample SWMM Input

```
C110             3190515.282        1610645.197
C100             3192038.238        1609206.459
B100             3198457.573        1617400.937
SJ001            3198772.565        1615926.776
B110             3197922.087        1615384.991
SJ002            3198577.270        1614855.805
B120             3197449.600        1614068.326
SJ003            3198158.692        1613331.669
B135             3197229.106        1612468.169
B130             3197985.086        1612134.278
SJ004            3197985.086        1610464.822
B140             3197418.101        1609872.638
A160             3194441.016        1610864.530
C125             3188689.458        1607247.040
NG-OUT           3202809.768        1621537.649
NG220            3188520.098        1604504.431
SJ130            3198194.942        1613052.542

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
A100-DF          3199916.049        1620821.678


[BACKDROP]
FILE       "P:\12-050.01 Newlin Gulch MDP - UDFCD\1 HYDROLOGY\Baseline\EPA SWMM -
v. 5.0\Input Files\SWMM_Background.jpg"
DIMENSIONS 3159262.493 1580662.582 3213324.993 1624725.082
```

Table B-8
Sample SWMM Output

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.0 (Build 5.0.021)
--------------------------------------------------------------

Newlin Gulch MDP
Baseline Hydrology Model
Future Development 100-yr

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Flow Routing Method ...... KINWAVE
Starting Date ............ JAN-01-2005 00:00:00
Ending Date .............. JAN-10-2005 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Routing Time Step ........ 30.00 sec


**************************        Volume         Volume
Flow Routing Continuity        acre-feet       10^6 gal
**************************     ---------      ---------
Dry Weather Inflow .......         0.000          0.000
Wet Weather Inflow .......         0.000          0.000
Groundwater Inflow .......         0.000          0.000
RDII Inflow ..............         0.000          0.000
External Inflow ..........      1487.738        484.802
External Outflow .........      1511.793        492.640
Internal Outflow .........         0.000          0.000
Storage Losses ...........         0.000          0.000
Initial Stored Volume ....         0.000          0.000
Final Stored Volume ......         0.116          0.038
Continuity Error (%) .....        -1.625
```

```
********************************
Highest Flow Instability Indexes
********************************
Link SJ130-OUT (3)
Link B12 (3)
Link B11 (3)
Link SJ-OUT (3)
Link B10 (3)


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    30.00 sec
Average Time Step           :    30.00 sec
Maximum Time Step           :    30.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00


******************
Node Depth Summary
******************

---------------------------------------------------------------------
                               Average  Maximum  Maximum  Time of Max
                                 Depth    Depth      HGL   Occurrence
Node                 Type         Feet     Feet     Feet  days hr:min
---------------------------------------------------------------------
NG001                JUNCTION     0.38     5.92  5807.92     0  01:23
A100                 JUNCTION     0.00     0.00  5767.00     0  00:00
NG000                JUNCTION     0.25     3.98  5769.98     0  01:30
A104                 JUNCTION     0.00     0.00  5803.00     0  00:00
A108                 JUNCTION     0.00     0.00  5767.00     0  00:00
A110                 JUNCTION     0.00     0.00  5815.00     0  00:00
NG002                JUNCTION     0.47     6.47  5820.47     0  01:22
SJ000                JUNCTION     0.03     2.80  5820.80     0  01:00
NG003                JUNCTION     0.46     6.48  5838.48     0  01:17
A115                 JUNCTION     0.01     2.48  5848.48     0  00:39
A120                 JUNCTION     0.00     0.00  5833.00     0  00:00
A125                 JUNCTION     0.01     1.67  5875.67     0  00:41
NG004                JUNCTION     0.44     6.16  5866.16     0  01:10
A130                 JUNCTION     0.00     0.00  5861.00     0  00:00
NG005                JUNCTION     0.31     4.38  5871.88     0  01:08
A135                 JUNCTION     0.00     0.00  5868.50     0  00:00
```

Table B-8

Sample SWMM Output

```
A140                JUNCTION     0.00      0.00  5868.50      0  00:00
NG006               JUNCTION     0.27      3.61  5905.61      0  01:04
A145                JUNCTION     0.00      0.00  5903.00      0  00:00
A155                JUNCTION     0.00      0.00  5903.00      0  00:00
A150                JUNCTION     0.00      0.00  5903.00      0  00:00
NG005.5             JUNCTION     0.27      3.61  5904.61      0  01:04
NG007               JUNCTION     0.25      3.13  5927.63      0  00:59
A165                JUNCTION     0.00      0.00  5925.50      0  00:00
NG008               JUNCTION     0.25      2.93  5940.93      0  00:58
A170                JUNCTION     0.00      0.00  5939.00      0  00:00
NG009               JUNCTION     0.28      2.53  5950.53      0  02:41
A175                JUNCTION     0.00      0.00  5939.00      0  00:00
A180                JUNCTION     0.00      0.00  5949.00      0  00:00
NG011               JUNCTION     0.16      1.47  5993.47      0  02:46
NG010               JUNCTION     0.28      2.53  5966.53      0  02:37
A200                JUNCTION     0.00      0.00  5965.00      0  00:00
A190                JUNCTION     0.00      0.00  5965.00      0  00:00
A210                JUNCTION     0.00      0.00  5993.00      0  00:00
A205                JUNCTION     0.00      0.00  5993.00      0  00:00
NG012               JUNCTION     0.08      0.80  6217.30      0  02:43
A220                JUNCTION     0.00      0.00  6217.00      0  00:00
NG013               JUNCTION     0.00      0.00  6217.00      0  00:00
A221                JUNCTION     0.00      0.00  6218.00      0  00:00
A222                JUNCTION     0.00      0.00  6218.00      0  00:00
A223                JUNCTION     0.00      0.00  6218.00      0  00:00
A224                JUNCTION     0.00      0.00  6218.00      0  00:00
A225                JUNCTION     0.00      0.00  6218.00      0  00:00
A226                JUNCTION     0.00      0.00  6218.00      0  00:00
A227                JUNCTION     0.00      0.00  6218.00      0  00:00
A228                JUNCTION     0.00      0.00  6218.00      0  00:00
NG014               JUNCTION     0.04      4.22  6222.22      0  01:04
A230                JUNCTION     0.00      0.00  6219.00      0  00:00
NG015               JUNCTION     0.04      4.47  6239.47      0  01:02
A240                JUNCTION     0.00      0.00  6236.00      0  00:00
NG016               JUNCTION     0.04      4.48  6254.48      0  00:58
NG017               JUNCTION     0.02      2.99  6297.99      0  00:51
A250                JUNCTION     0.00      0.00  6251.00      0  00:00
A260                JUNCTION     0.00      0.00  6296.00      0  00:00
NG018               JUNCTION     0.02      2.64  6335.64      0  00:41
A270                JUNCTION     0.00      0.00  6334.00      0  00:00
NG019               JUNCTION     0.02      2.15  6382.15      0  00:38
NG119               JUNCTION     0.00      1.23  6396.23      0  00:35
NG020               JUNCTION     0.02      2.09  6412.09      0  00:52
A280                JUNCTION     0.00      0.00  6381.00      0  00:00
NG021               JUNCTION     0.01      1.03  6451.03      0  00:53
A290                JUNCTION     0.00      0.00  6411.00      0  00:00
A300                JUNCTION     0.00      0.00  6451.00      0  00:00
```

```
ST000               JUNCTION     0.02      3.21  6254.21      0  00:55
ST001               JUNCTION     0.02      3.23  6297.23      0  00:49
J100                JUNCTION     0.00      0.00  6252.00      0  00:00
J110                JUNCTION     0.00      0.00  6295.00      0  00:00
ST002               JUNCTION     0.02      2.85  6327.85      0  00:58
ST101               JUNCTION     0.01      1.50  6346.50      0  00:45
J130                JUNCTION     0.00      0.00  6326.00      0  00:00
ST003               JUNCTION     0.02      2.87  6365.87      0  00:52
J120                JUNCTION     0.00      0.00  6346.00      0  00:00
A275                JUNCTION     0.00      0.00  6396.00      0  00:00
J140                JUNCTION     0.00      0.00  6364.00      0  00:00
ST004               JUNCTION     0.02      2.16  6399.16      0  00:51
ST005               JUNCTION     0.01      1.28  6472.28      0  00:46
J150                JUNCTION     0.00      0.00  6398.00      0  00:00
J160                JUNCTION     0.00      0.00  6472.00      0  00:00
ST102               JUNCTION     0.00      1.00  6429.00      0  00:38
J155                JUNCTION     0.00      0.00  6429.00      0  00:00
RT000               JUNCTION     0.02      2.08  6253.08      0  01:07
RT001               JUNCTION     0.02      2.12  6299.12      0  00:56
I100                JUNCTION     0.00      0.00  6252.00      0  00:00
I110                JUNCTION     0.00      0.00  6298.00      0  00:00
RT002               JUNCTION     0.01      1.48  6361.48      0  00:51
I120                JUNCTION     0.00      0.00  6361.00      0  00:00
I115                JUNCTION     0.00      0.00  6361.00      0  00:00
SN000               JUNCTION     0.00      0.00  6218.00      0  00:00
F106                JUNCTION     0.00      0.00  6219.00      0  00:00
F102                JUNCTION     0.00      0.00  6219.00      0  00:00
F104                JUNCTION     0.00      0.00  6219.00      0  00:00
SN001               JUNCTION     0.03      2.68  6221.68      0  01:28
SN002               JUNCTION     0.03      3.05  6267.05      0  01:22
F100                JUNCTION     0.00      0.00  6220.00      0  00:00
SN003               JUNCTION     0.03      3.07  6297.07      0  01:16
F110                JUNCTION     0.00      0.00  6265.00      0  00:00
SN004               JUNCTION     0.03      2.90  6337.90      0  01:13
F120                JUNCTION     0.00      0.00  6295.00      0  00:00
F125                JUNCTION     0.00      0.00  6336.00      0  00:00
F130                JUNCTION     0.00      0.00  6336.00      0  00:00
SN005               JUNCTION     0.02      2.95  6379.95      0  01:01
F140                JUNCTION     0.00      0.00  6378.00      0  00:00
SN006               JUNCTION     0.02      2.87  6417.87      0  00:51
F145                JUNCTION     0.00      0.00  6416.00      0  00:00
F150                JUNCTION     0.00      0.00  6416.00      0  00:00
SN007               JUNCTION     0.01      1.88  6471.88      0  00:42
F155                JUNCTION     0.00      0.00  6471.00      0  00:00
MT000               JUNCTION     0.02      2.31  6222.31      0  01:09
G100                JUNCTION     0.00      0.00  6221.00      0  00:00
MT001               JUNCTION     0.02      2.33  6250.33      0  01:01
```

Table B-8

Sample SWMM Output

```
  G110                 JUNCTION     0.00      0.00  6249.00      0  00:00
  MT002                JUNCTION     0.02      2.21  6287.21      0  00:55
  MT003                JUNCTION     0.01      1.50  6355.50      0  00:48
  G120                 JUNCTION     0.00      0.00  6286.00      0  00:00
  G115                 JUNCTION     0.00      0.00  6286.00      0  00:00
  G130                 JUNCTION     0.00      0.00  6355.00      0  00:00
  PW000                JUNCTION     0.01      2.61  6220.61      0  00:45
  PW001                JUNCTION     0.01      2.61  6230.61      0  00:43
  H100                 JUNCTION     0.00      0.00  6219.00      0  00:00
  H115                 JUNCTION     0.00      0.00  6229.00      0  00:00
  PW002                JUNCTION     0.01      2.51  6279.51      0  00:38
  H125                 JUNCTION     0.00      0.00  6278.00      0  00:00
  H120                 JUNCTION     0.00      0.00  6278.00      0  00:00
  H110                 JUNCTION     0.00      0.00  6229.00      0  00:00
  BW000                JUNCTION     0.00      0.00  6218.00      0  00:00
  BW001                JUNCTION     0.01      1.94  6220.94      0  00:50
  BW002                JUNCTION     0.01      1.94  6236.94      0  00:47
  E105                 JUNCTION     0.00      0.00  6219.00      0  00:00
  E115                 JUNCTION     0.00      0.00  6219.00      0  00:00
  E128                 JUNCTION     0.00      0.00  6219.00      0  00:00
  E100                 JUNCTION     0.00      0.00  6220.00      0  00:00
  E110                 JUNCTION     0.00      0.00  6220.00      0  00:00
  E120                 JUNCTION     0.00      0.00  6236.00      0  00:00
  E124                 JUNCTION     0.00      0.00  6236.00      0  00:00
  CT001                JUNCTION     0.00      0.00  6219.00      0  00:00
  CT000                JUNCTION     0.00      0.00  6218.00      0  00:00
  D110                 JUNCTION     0.00      0.00  6220.00      0  00:00
  D100                 JUNCTION     0.00      0.00  6220.00      0  00:00
  D105                 JUNCTION     0.00      0.00  6220.00      0  00:00
  D115                 JUNCTION     0.00      0.00  6219.00      0  00:00
  D120                 JUNCTION     0.00      0.00  6219.00      0  00:00
  D125                 JUNCTION     0.00      0.00  6219.00      0  00:00
  SP000                JUNCTION     0.03      3.39  5951.39      0  01:00
  SP001                JUNCTION     0.03      3.41  5981.41      0  00:54
  SP002                JUNCTION     0.02      2.32  6074.32      0  00:52
  C115                 JUNCTION     0.00      1.15  6013.15      0  00:38
  C120                 JUNCTION     0.00      0.00  6073.00      0  00:00
  C110                 JUNCTION     0.00      0.00  5979.00      0  00:00
  C100                 JUNCTION     0.00      0.00  5949.00      0  00:00
  B100                 JUNCTION     0.00      0.00  5819.00      0  00:00
  SJ001                JUNCTION     0.03      2.88  5876.88      0  00:47
  B110                 JUNCTION     0.00      0.00  5875.00      0  00:00
  SJ002                JUNCTION     0.03      2.53  5886.53      0  00:45
  B120                 JUNCTION     0.00      0.00  5885.00      0  00:00
  SJ003                JUNCTION     0.02      2.25  5905.45      0  01:10
  B135                 JUNCTION     0.00      0.00  5921.00      0  00:00
  B130                 JUNCTION     0.00      0.00  5921.00      0  00:00
  SJ004                JUNCTION     0.01      1.93  5971.93      0  00:37
  B140                 JUNCTION     0.00      0.00  5971.00      0  00:00
  A160                 JUNCTION     0.00      0.00  5925.50      0  00:00
  C125                 JUNCTION     0.00      0.00  6073.00      0  00:00
  NG-OUT               OUTFALL      0.00      0.00  5765.00      0  00:00
  NG220                STORAGE      0.06      0.77  6217.47      0  02:43
  SJ130                STORAGE      0.08      9.70  5928.40      0  01:10
```

Table B-8
Sample SWMM Output

```
*******************
Node Inflow Summary
*******************

-------------------------------------------------------------------------------------
                                Maximum  Maximum                  Lateral       Total
                                Lateral    Total  Time of Max      Inflow      Inflow
                                 Inflow   Inflow   Occurrence      Volume      Volume
Node                 Type           CFS      CFS  days hr:min    10^6 gal    10^6 gal
-------------------------------------------------------------------------------------
NG001                JUNCTION      0.00  3486.26     0  01:23       0.000     484.303
A100                 JUNCTION    167.97   167.97     0  00:45       4.035       4.035
NG000                JUNCTION      0.00  3581.36     0  01:29       0.000     492.604
A104                 JUNCTION     37.17    37.17     0  00:44       0.910       0.910
A108                 JUNCTION    148.87   148.87     0  00:45       3.679       3.679
A110                 JUNCTION    235.91   235.91     0  00:35       3.268       3.268
NG002                JUNCTION      0.00  3478.08     0  01:20       0.000     483.298
SJ000                JUNCTION      0.00   755.24     0  00:58       0.000      28.481
NG003                JUNCTION      0.00  2859.43     0  01:17       0.000     451.366
A115                 JUNCTION    214.76   214.76     0  00:39       4.082       4.082
A120                 JUNCTION    281.96   281.96     0  00:43       6.185       6.185
A125                 JUNCTION    160.69   160.69     0  00:41       3.299       3.299
NG004                JUNCTION      0.00  2682.93     0  01:10       0.000     440.362
A130                 JUNCTION    188.31   188.31     0  00:39       3.424       3.424
NG005                JUNCTION      0.00  2511.75     0  01:08       0.000     433.539
A135                 JUNCTION    303.03   303.03     0  00:40       5.461       5.461
A140                 JUNCTION    200.54   200.54     0  00:40       3.711       3.711
NG006                JUNCTION      0.00  2252.59     0  01:04       0.000     421.416
A145                 JUNCTION    180.47   180.47     0  00:35       2.581       2.581
A155                 JUNCTION    249.69   249.69     0  00:34       3.284       3.284
A150                 JUNCTION    230.43   230.43     0  00:46       5.893       5.893
NG005.5              JUNCTION      0.00  2301.06     0  01:03       0.000     423.997
NG007                JUNCTION      0.00  2023.25     0  00:59       0.000     412.025
A165                 JUNCTION    579.09   579.09     0  00:37       8.577       8.577
NG008                JUNCTION      0.00  1800.49     0  00:58       0.000     402.100
A170                 JUNCTION    231.08   231.08     0  00:41       4.691       4.691
NG009                JUNCTION      0.00  1024.58     0  02:39       0.000     370.870
A175                 JUNCTION    199.21   199.21     0  00:38       3.267       3.267
A180                 JUNCTION    301.64   301.64     0  00:41       5.917       5.917
NG011                JUNCTION      0.00  1010.40     0  02:46       0.000     355.911
NG010                JUNCTION      0.00  1023.09     0  02:37       0.000     364.883
A200                 JUNCTION    204.70   204.70     0  00:46       5.602       5.602
A190                 JUNCTION     94.03    94.03     0  00:51       3.060       3.060
A210                 JUNCTION    243.71   243.71     0  00:49       6.792       6.792
A205                 JUNCTION     84.61    84.61     0  00:55       3.041       3.041
NG012                JUNCTION      0.00   995.22     0  02:43       0.000     345.622
A220                 JUNCTION   2957.75  2957.75     0  01:07      88.127      88.127
```

Table B-8
Sample SWMM Output

```
  NG013                JUNCTION      0.00  7656.93     0  00:57        0.000      257.545
  A221                 JUNCTION     58.24    58.24     0  00:37        0.844        0.844
  A222                 JUNCTION    252.52   252.52     0  00:39        4.341        4.341
  A223                 JUNCTION    140.08   140.08     0  00:36        1.843        1.843
  A224                 JUNCTION     72.34    72.34     0  00:41        1.459        1.459
  A225                 JUNCTION    137.18   137.18     0  00:43        2.954        2.954
  A226                 JUNCTION    176.66   176.66     0  00:45        4.157        4.157
  A227                 JUNCTION    300.11   300.11     0  00:36        4.355        4.355
  A228                 JUNCTION    159.89   159.89     0  00:32        1.848        1.848
  NG014                JUNCTION      0.00  3255.17     0  01:03        0.000      101.062
  A230                 JUNCTION    390.38   390.38     0  00:36        5.788        5.788
  NG015                JUNCTION      0.00  3114.85     0  01:01        0.000       95.220
  A240                 JUNCTION    451.82   451.82     0  00:36        6.747        6.747
  NG016                JUNCTION      0.00  2951.90     0  00:58        0.000       88.390
  NG017                JUNCTION      0.00  1028.48     0  00:51        0.000       29.019
  A250                 JUNCTION    107.06   107.06     0  00:48        3.198        3.198
  A260                 JUNCTION    147.84   147.84     0  00:48        4.254        4.254
  NG018                JUNCTION      0.00   932.78     0  00:41        0.000       24.494
  A270                 JUNCTION    278.68   278.68     0  00:40        5.468        5.468
  NG019                JUNCTION      0.00   514.44     0  00:38        0.000       16.555
  NG119                JUNCTION      0.00   166.49     0  00:35        0.000        2.399
  NG020                JUNCTION      0.00   351.56     0  00:52        0.000       10.307
  A280                 JUNCTION    484.67   484.67     0  00:34        6.180        6.180
  NG021                JUNCTION      0.00   152.08     0  00:53        0.000        4.882
  A290                 JUNCTION    237.30   237.30     0  00:42        5.377        5.377
  A300                 JUNCTION    152.08   152.08     0  00:53        4.882        4.882
  ST000                JUNCTION      0.00  1427.17     0  00:52        0.000       39.204
  ST001                JUNCTION      0.00  1243.82     0  00:49        0.000       34.037
  J100                 JUNCTION    304.93   304.93     0  00:37        5.040        5.040
  J110                 JUNCTION    200.28   200.28     0  00:40        3.963        3.963
  ST002                JUNCTION      0.00   658.69     0  00:45        0.000       20.341
  ST101                JUNCTION      0.00   419.23     0  00:45        0.000        9.632
  J130                 JUNCTION    590.02   590.02     0  00:33        7.037        7.037
  ST003                JUNCTION      0.00   489.19     0  00:52        0.000       13.234
  J120                 JUNCTION    341.12   341.12     0  00:39        6.319        6.319
  A275                 JUNCTION    166.49   166.49     0  00:35        2.399        2.399
  J140                 JUNCTION    252.06   252.06     0  00:38        4.344        4.344
  ST004                JUNCTION      0.00   323.68     0  00:51        0.000        8.863
  ST005                JUNCTION      0.00   159.24     0  00:46        0.000        4.282
  J150                 JUNCTION    216.59   216.59     0  00:40        4.482        4.482
  J160                 JUNCTION    159.24   159.24     0  00:46        4.282        4.282
  ST102                JUNCTION      0.00   175.33     0  00:38        0.000        3.053
  J155                 JUNCTION    175.33   175.33     0  00:38        3.053        3.053
  RT000                JUNCTION      0.00   503.78     0  01:04        0.000       16.547
  RT001                JUNCTION      0.00   398.91     0  00:56        0.000       12.582
  I100                 JUNCTION    156.76   156.76     0  00:43        3.790        3.790
  I110                 JUNCTION    223.28   223.28     0  00:45        5.875        5.875
```

Table B-8

Sample SWMM Output

```
RT002                JUNCTION      0.00   207.96     0  00:51       0.000       6.590
I120                 JUNCTION     81.61    81.61     0  00:54       2.879       2.879
I115                 JUNCTION    127.87   127.87     0  00:49       3.711       3.711
SN000                JUNCTION      0.00  1706.64     0  01:18       0.000      74.023
F106                 JUNCTION    229.45   229.45     0  00:38       3.929       3.929
F102                 JUNCTION    119.38   119.38     0  00:40       2.305       2.305
F104                 JUNCTION    372.72   372.72     0  00:36       5.427       5.427
SN001                JUNCTION      0.00  1563.74     0  01:22       0.000      62.363
SN002                JUNCTION      0.00   963.43     0  01:20       0.000      37.142
F100                 JUNCTION    149.80   149.80     0  00:55       5.482       5.482
SN003                JUNCTION      0.00   882.21     0  01:16       0.000      31.995
F110                 JUNCTION    249.57   249.57     0  00:40       5.056       5.056
SN004                JUNCTION      0.00   778.48     0  01:10       0.000      25.934
F120                 JUNCTION    254.70   254.70     0  00:42       5.775       5.775
F125                 JUNCTION    132.84   132.84     0  00:45       3.522       3.522
F130                 JUNCTION    121.50   121.50     0  00:51       3.880       3.880
SN005                JUNCTION      0.00   598.37     0  01:01       0.000      18.349
F140                 JUNCTION    164.71   164.71     0  00:51       5.211       5.211
SN006                JUNCTION      0.00   465.11     0  00:51       0.000      12.958
F145                 JUNCTION    123.10   123.10     0  00:50       3.846       3.846
F150                 JUNCTION    127.15   127.15     0  00:51       4.036       4.036
SN007                JUNCTION      0.00   230.22     0  00:42       0.000       4.951
F155                 JUNCTION    230.22   230.22     0  00:42       4.951       4.951
MT000                JUNCTION      0.00   598.03     0  01:08       0.000      19.456
G100                 JUNCTION     97.94    97.94     0  00:47       2.859       2.859
MT001                JUNCTION      0.00   523.98     0  01:01       0.000      16.484
G110                 JUNCTION    147.91   147.91     0  00:45       3.852       3.852
MT002                JUNCTION      0.00   406.14     0  00:55       0.000      12.528
MT003                JUNCTION      0.00   165.31     0  00:48       0.000       4.701
G120                 JUNCTION    166.03   166.03     0  00:43       3.920       3.920
G115                 JUNCTION    125.09   125.09     0  00:48       3.751       3.751
G130                 JUNCTION    165.31   165.31     0  00:48       4.701       4.701
PW000                JUNCTION      0.00  1120.62     0  00:45       0.000      22.929
PW001                JUNCTION      0.00  1045.73     0  00:43       0.000      21.453
H100                 JUNCTION     93.49    93.49     0  00:36       1.460       1.460
H115                 JUNCTION    150.39   150.39     0  00:49       4.472       4.472
PW002                JUNCTION      0.00   665.78     0  00:38       0.000      11.774
H125                 JUNCTION    238.45   238.45     0  00:41       5.202       5.202
H120                 JUNCTION    444.02   444.02     0  00:36       6.573       6.573
H110                 JUNCTION    324.58   324.58     0  00:37       5.123       5.123
BW000                JUNCTION      0.00   953.48     0  00:45       0.000      22.905
BW001                JUNCTION      0.00   536.19     0  00:47       0.000      13.639
BW002                JUNCTION      0.00   322.61     0  00:47       0.000       8.887
E105                 JUNCTION    129.93   129.93     0  00:38       2.040       2.040
E115                 JUNCTION    125.88   125.88     0  00:37       1.888       1.888
E128                 JUNCTION    197.57   197.57     0  00:47       5.338       5.338
E100                 JUNCTION    172.68   172.68     0  00:41       3.714       3.714
```

Table B-8
Sample SWMM Output

```
E110                 JUNCTION     58.14    58.14     0  00:38       1.032       1.032
E120                 JUNCTION    231.00   231.00     0  00:43       5.620       5.620
E124                 JUNCTION     99.45    99.45     0  00:53       3.267       3.267
CT001                JUNCTION      0.00   313.00     0  00:45       0.000       8.233
CT000                JUNCTION      0.00   683.64     0  00:41       0.000      14.823
D110                 JUNCTION    160.58   160.58     0  00:50       5.064       5.064
D100                 JUNCTION    127.44   127.44     0  00:39       2.260       2.260
D105                 JUNCTION     38.60    38.60     0  00:43       0.909       0.909
D115                 JUNCTION     66.07    66.07     0  00:41       1.327       1.327
D120                 JUNCTION    213.49   213.49     0  00:38       3.519       3.519
D125                 JUNCTION    106.56   106.56     0  00:38       1.744       1.744
SP000                JUNCTION      0.00   781.96     0  00:58       0.000      23.251
SP001                JUNCTION      0.00   659.74     0  00:54       0.000      19.416
SP002                JUNCTION      0.00   275.78     0  00:52       0.000       9.197
C115                 JUNCTION    205.42   205.42     0  00:38       3.615       3.615
C120                 JUNCTION    194.70   194.70     0  00:51       6.279       6.279
C110                 JUNCTION    297.53   297.53     0  00:41       6.311       6.311
C100                 JUNCTION    183.89   183.89     0  00:41       3.731       3.731
B100                 JUNCTION    197.39   197.39     0  00:43       4.380       4.380
SJ001                JUNCTION      0.00   634.52     0  00:47       0.000      23.837
B110                 JUNCTION    292.68   292.68     0  00:42       6.190       6.190
SJ002                JUNCTION      0.00   376.27     0  00:45       0.000      17.588
B120                 JUNCTION    341.85   341.85     0  00:36       4.932       4.932
SJ003                JUNCTION      0.00   314.48     0  01:10       0.000      12.581
B135                 JUNCTION    345.96   345.96     0  00:37       5.358       5.358
B130                 JUNCTION    202.90   202.90     0  00:38       3.632       3.632
SJ004                JUNCTION      0.00   213.65     0  00:37       0.000       3.376
B140                 JUNCTION    213.65   213.65     0  00:37       3.376       3.376
A160                 JUNCTION     37.90    37.90     0  00:51       1.230       1.230
C125                 JUNCTION     82.11    82.11     0  00:55       2.918       2.918
NG-OUT               OUTFALL       0.00  3581.36     0  01:29       0.000     492.604
NG220                STORAGE       0.00 10381.17     0  01:03       0.000     345.672
SJ130                STORAGE       0.00   627.81     0  00:41       0.000      12.582
```

Table B-8
Sample SWMM Output

```
**********************
Node Surcharge Summary
**********************

Surcharging occurs when water rises above the top of the highest conduit.
---------------------------------------------------------------------
                                             Max. Height   Min. Depth
                                    Hours    Above Crown    Below Rim
Node                 Type      Surcharged           Feet         Feet
---------------------------------------------------------------------
A100                 JUNCTION      216.01          0.000        0.000
A104                 JUNCTION      216.01          0.000        0.000
A108                 JUNCTION      216.01          0.000        0.000
A110                 JUNCTION      216.01          0.000        0.000
A120                 JUNCTION      216.01          0.000        0.000
A130                 JUNCTION      216.01          0.000        0.000
A135                 JUNCTION      216.01          0.000        0.000
A140                 JUNCTION      216.01          0.000        0.000
A145                 JUNCTION      216.01          0.000        0.000
A155                 JUNCTION      216.01          0.000        0.000
A150                 JUNCTION      216.01          0.000        0.000
A165                 JUNCTION      216.01          0.000        0.000
A170                 JUNCTION      216.01          0.000        0.000
A175                 JUNCTION      216.01          0.000        0.000
A180                 JUNCTION      216.01          0.000        0.000
A200                 JUNCTION      216.01          0.000        0.000
A190                 JUNCTION      216.01          0.000        0.000
A210                 JUNCTION      216.01          0.000        0.000
A205                 JUNCTION      216.01          0.000        0.000
A220                 JUNCTION      216.01          0.000        0.000
NG013                JUNCTION      216.01          0.000        0.000
A221                 JUNCTION      216.01          0.000        0.000
A222                 JUNCTION      216.01          0.000        0.000
A223                 JUNCTION      216.01          0.000        0.000
A224                 JUNCTION      216.01          0.000        0.000
A225                 JUNCTION      216.01          0.000        0.000
A226                 JUNCTION      216.01          0.000        0.000
A227                 JUNCTION      216.01          0.000        0.000
A228                 JUNCTION      216.01          0.000        0.000
A230                 JUNCTION      216.01          0.000        0.000
A240                 JUNCTION      216.01          0.000        0.000
A250                 JUNCTION      216.01          0.000        0.000
A260                 JUNCTION      216.01          0.000        0.000
A270                 JUNCTION      216.01          0.000        0.000
A280                 JUNCTION      216.01          0.000        0.000
A290                 JUNCTION      216.01          0.000        0.000
A300                 JUNCTION      216.01          0.000        0.000
J100                 JUNCTION      216.01          0.000        0.000
J110                 JUNCTION      216.01          0.000        0.000
J130                 JUNCTION      216.01          0.000        0.000
J120                 JUNCTION      216.01          0.000        0.000
A275                 JUNCTION      216.01          0.000        0.000
J140                 JUNCTION      216.01          0.000        0.000
J150                 JUNCTION      216.01          0.000        0.000
J160                 JUNCTION      216.01          0.000        0.000
J155                 JUNCTION      216.01          0.000        0.000
I100                 JUNCTION      216.01          0.000        0.000
I110                 JUNCTION      216.01          0.000        0.000
I120                 JUNCTION      216.01          0.000        0.000
I115                 JUNCTION      216.01          0.000        0.000
SN000                JUNCTION      216.01          0.000        0.000
F106                 JUNCTION      216.01          0.000        0.000
F102                 JUNCTION      216.01          0.000        0.000
F104                 JUNCTION      216.01          0.000        0.000
F100                 JUNCTION      216.01          0.000        0.000
F110                 JUNCTION      216.01          0.000        0.000
F120                 JUNCTION      216.01          0.000        0.000
F125                 JUNCTION      216.01          0.000        0.000
F130                 JUNCTION      216.01          0.000        0.000
F140                 JUNCTION      216.01          0.000        0.000
F145                 JUNCTION      216.01          0.000        0.000
F150                 JUNCTION      216.01          0.000        0.000
F155                 JUNCTION      216.01          0.000        0.000
G100                 JUNCTION      216.01          0.000        0.000
G110                 JUNCTION      216.01          0.000        0.000
G120                 JUNCTION      216.01          0.000        0.000
G115                 JUNCTION      216.01          0.000        0.000
G130                 JUNCTION      216.01          0.000        0.000
H100                 JUNCTION      216.01          0.000        0.000
H115                 JUNCTION      216.01          0.000        0.000
H125                 JUNCTION      216.01          0.000        0.000
H120                 JUNCTION      216.01          0.000        0.000
H110                 JUNCTION      216.01          0.000        0.000
BW000                JUNCTION      216.01          0.000        0.000
E105                 JUNCTION      216.01          0.000        0.000
E115                 JUNCTION      216.01          0.000        0.000
E128                 JUNCTION      216.01          0.000        0.000
E100                 JUNCTION      216.01          0.000        0.000
E110                 JUNCTION      216.01          0.000        0.000
E120                 JUNCTION      216.01          0.000        0.000
E124                 JUNCTION      216.01          0.000        0.000
CT001                JUNCTION      216.01          0.000        0.000
CT000                JUNCTION      216.01          0.000        0.000
D110                 JUNCTION      216.01          0.000        0.000
```

Table B-8
Sample SWMM Output

```
  D100                 JUNCTION      216.01          0.000         0.000
  D105                 JUNCTION      216.01          0.000         0.000
  D115                 JUNCTION      216.01          0.000         0.000
  D120                 JUNCTION      216.01          0.000         0.000
  D125                 JUNCTION      216.01          0.000         0.000
  C120                 JUNCTION      216.01          0.000         0.000
  C110                 JUNCTION      216.01          0.000         0.000
  C100                 JUNCTION      216.01          0.000         0.000
  B100                 JUNCTION      216.01          0.000         0.000
  B110                 JUNCTION      216.01          0.000         0.000
  B120                 JUNCTION      216.01          0.000         0.000
  B135                 JUNCTION      216.01          0.000         0.000
  B130                 JUNCTION      216.01          0.000         0.000
  B140                 JUNCTION      216.01          0.000         0.000
  A160                 JUNCTION      216.01          0.000         0.000
  C125                 JUNCTION      216.01          0.000         0.000
  NG220                STORAGE       216.01          0.769         7.231


  *********************
  Node Flooding Summary
  *********************

  No nodes were flooded.


  **********************
  Storage Volume Summary
  **********************

  --------------------------------------------------------------------------------
------------
                         Average     Avg   E&I       Maximum     Max    Time of
Max    Maximum
                          Volume    Pcnt  Pcnt        Volume    Pcnt
Occurrence    Outflow
  Storage Unit          1000 ft3    Full  Loss      1000 ft3    Full    days
hr:min        CFS
  --------------------------------------------------------------------------------
------------
  NG220                 2944.988       1     0     39046.290       9       0
02:43     995.22
  SJ130                    3.943       0     0       695.974       0       0
01:09     314.48
```

```
***********************
 Outfall Loading Summary
 ***********************

 -----------------------------------------------------------
                       Flow       Avg.      Max.       Total
                       Freq.      Flow      Flow      Volume
 Outfall Node          Pcnt.       CFS       CFS    10^6 gal
 -----------------------------------------------------------
 NG-OUT                91.88      92.18   3581.36     492.604
 -----------------------------------------------------------
 System                91.88      92.18   3581.36     492.604


 ********************
 Link Flow Summary
 ********************

 ------------------------------------------------------------------------------
                                 Maximum  Time of Max   Maximum    Max/    Max/
                                  |Flow|   Occurrence   |Veloc|    Full    Full
 Link                 Type           CFS  days hr:min    ft/sec    Flow   Depth
 ------------------------------------------------------------------------------
 A10                  CONDUIT    3460.25     0  01:30      5.72    0.09    0.26
 A10.4                CONDUIT    3469.86     0  01:23      5.47    0.16    0.39
 A100-DF              DUMMY       167.97     0  00:45
 A104-DF              DUMMY        37.17     0  00:44
 A108-DF              DUMMY       148.87     0  00:45
 A11                  CONDUIT    2843.58     0  01:22      4.82    0.19    0.43
 A110-DF              DUMMY       235.91     0  00:35
 A115                 CONDUIT     211.02     0  00:43      3.91    0.04    0.25
 A12                  CONDUIT    2637.27     0  01:18      4.65    0.39    0.61
 A14                  CONDUIT    2282.70     0  01:10      5.42    0.14    0.34
 A14.5                CONDUIT    2252.47     0  01:04      4.91    0.16    0.36
 A120-DF              DUMMY       281.96     0  00:43
 A125                 CONDUIT     157.93     0  00:45      3.23    0.02    0.17
 A13                  CONDUIT    2507.06     0  01:11      4.37    0.23    0.44
 A130-DF              DUMMY       188.31     0  00:39
 A135-DF              DUMMY       303.03     0  00:40
 A140-DF              DUMMY       200.54     0  00:40
 A145-DF              DUMMY       180.47     0  00:35
 A15                  CONDUIT    2010.76     0  01:05      4.92    0.12    0.31
 A150-DF              DUMMY       230.43     0  00:46
 A155-DF              DUMMY       249.69     0  00:34
 A16                  CONDUIT    1789.38     0  01:02      4.03    0.09    0.29
 A160-DF              DUMMY        37.90     0  00:51
 A165-DF              DUMMY       579.09     0  00:37
```

Table B-8
Sample SWMM Output

```
A17                 CONDUIT   1024.52     0  02:41      4.30     0.06     0.21
A170-DF             DUMMY      231.08     0  00:41
A175-DF             DUMMY      199.21     0  00:38
A180-DF             DUMMY      301.64     0  00:41
A19                 CONDUIT   1022.91     0  02:41      4.48     0.09     0.25
A190-DF             DUMMY       94.03     0  00:51
A20                 CONDUIT   1010.20     0  02:52      3.54     0.03     0.15
A200-DF             DUMMY      204.70     0  00:46
A205-DF             DUMMY       84.61     0  00:55
A21                 CONDUIT    994.10     0  02:55      3.73     0.01     0.08
A210-DF             DUMMY      243.71     0  00:49
A22                 DUMMY     3255.17     0  01:03
A220-DF             DUMMY     2957.75     0  01:07
A221-DF             DUMMY       58.24     0  00:37
A222-DF             DUMMY      252.52     0  00:39
A223-DF             DUMMY      140.08     0  00:36
A224-DF             DUMMY       72.34     0  00:41
A225-DF             DUMMY      137.18     0  00:43
A226-DF             DUMMY      176.66     0  00:45
A227-DF             DUMMY      300.11     0  00:36
A228-DF             DUMMY      159.89     0  00:32
A23                 CONDUIT   3107.83     0  01:04      6.04     0.18     0.42
A230-DF             DUMMY      390.38     0  00:36
A24                 CONDUIT   2938.57     0  01:02      5.30     0.20     0.45
A240-DF             DUMMY      451.82     0  00:36
A25                 CONDUIT    988.39     0  01:01      4.36     0.08     0.29
A250-DF             DUMMY      107.06     0  00:48
A26                 CONDUIT    882.89     0  00:51      4.11     0.06     0.26
A260-DF             DUMMY      147.84     0  00:48
A27                 CONDUIT    506.11     0  00:51      4.48     0.04     0.21
A27.5               CONDUIT    157.47     0  00:40      4.30     0.01     0.12
A270-DF             DUMMY      278.68     0  00:40
A275-DF             DUMMY      166.49     0  00:35
A28                 CONDUIT    345.31     0  00:59      3.34     0.03     0.21
A280-DF             DUMMY      484.67     0  00:34
A29                 CONDUIT    149.51     0  00:59      2.94     0.01     0.10
A290-DF             DUMMY      237.30     0  00:42
A300-DF             DUMMY      152.08     0  00:53
B10                 CONDUIT    601.44     0  01:00      4.24     0.07     0.28
B100-DF             DUMMY      197.39     0  00:43
B11                 CONDUIT    372.82     0  00:54      2.26     0.05     0.25
B110-DF             DUMMY      292.68     0  00:42
B12                 CONDUIT    309.66     0  01:19      2.49     0.04     0.22
B120-DF             DUMMY      341.85     0  00:36
B13                 CONDUIT    169.64     0  00:51      3.29     0.03     0.17
B130-DF             DUMMY      202.90     0  00:38
B135-DF             DUMMY      345.96     0  00:37

B140-DF             DUMMY      213.65     0  00:37
BW-OUT              DUMMY      953.48     0  00:45
C10                 CONDUIT    651.83     0  01:00      4.48     0.12     0.34
C100-DF             DUMMY      183.89     0  00:41
C11                 CONDUIT    264.38     0  01:04      4.13     0.05     0.23
C11.5               CONDUIT    184.87     0  00:49      2.35     0.01     0.11
C110-DF             DUMMY      297.53     0  00:41
C120-DF             DUMMY      194.70     0  00:51
C125-DF             DUMMY       82.11     0  00:55
CT-OUT              DUMMY      683.64     0  00:41
D10                 DUMMY      313.00     0  00:45
D100-DF             DUMMY      127.44     0  00:39
D105-DF             DUMMY       38.60     0  00:43
D110-DF             DUMMY      160.58     0  00:50
D115-DF             DUMMY       66.07     0  00:41
D120-DF             DUMMY      213.49     0  00:38
D125-DF             DUMMY      106.56     0  00:38
E10.5               DUMMY      536.19     0  00:47
E100-DF             DUMMY      172.68     0  00:41
E105-DF             DUMMY      129.93     0  00:38
E11                 CONDUIT    321.56     0  00:50      3.08     0.03     0.19
E110-DF             DUMMY       58.14     0  00:38
E115-DF             DUMMY      125.88     0  00:37
E120-DF             DUMMY      231.00     0  00:43
E124-DF             DUMMY       99.45     0  00:53
E128-DF             DUMMY      197.57     0  00:47
F10                 CONDUIT    948.33     0  01:28      4.17     0.07     0.27
F10.2               DUMMY     1563.74     0  01:22
F100-DF             DUMMY      149.80     0  00:55
F102-DF             DUMMY      119.38     0  00:40
F104-DF             DUMMY      372.72     0  00:36
F106-DF             DUMMY      229.45     0  00:38
F11                 CONDUIT    875.35     0  01:22      4.21     0.08     0.31
F110-DF             DUMMY      249.57     0  00:40
F12                 CONDUIT    758.70     0  01:20      3.79     0.06     0.24
F120-DF             DUMMY      254.70     0  00:42
F125-DF             DUMMY      132.84     0  00:45
F13                 CONDUIT    576.93     0  01:13      3.81     0.06     0.29
F130-DF             DUMMY      121.50     0  00:51
F14                 CONDUIT    444.26     0  01:02      3.39     0.05     0.28
F140-DF             DUMMY      164.71     0  00:51
F145-DF             DUMMY      123.10     0  00:50
F15                 CONDUIT    215.89     0  00:52      3.21     0.02     0.18
F150-DF             DUMMY      127.15     0  00:51
F155-DF             DUMMY      230.22     0  00:42
G10                 CONDUIT    517.26     0  01:09      3.28     0.04     0.23
G100-DF             DUMMY       97.94     0  00:47
```

Table B-8
Sample SWMM Output

```
  G11                   CONDUIT    399.79     0  01:03      3.25     0.03     0.22
  G110-DF               DUMMY      147.91     0  00:45
  G115-DF               DUMMY      125.09     0  00:48
  G12                   CONDUIT    152.67     0  01:03      2.88     0.01     0.14
  G120-DF               DUMMY      166.03     0  00:43
  G130-DF               DUMMY      165.31     0  00:48
  H10                   CONDUIT   1041.42     0  00:45      4.18     0.07     0.26
  H100-DF               DUMMY       93.49     0  00:36
  H11                   CONDUIT    622.63     0  00:44      4.02     0.04     0.24
  H110-DF               DUMMY      324.58     0  00:37
  H115-DF               DUMMY      150.39     0  00:49
  H120-DF               DUMMY      444.02     0  00:36
  H125-DF               DUMMY      238.45     0  00:41
  I10                   CONDUIT    386.49     0  01:07      3.42     0.04     0.21
  I100-DF               DUMMY      156.76     0  00:43
  I11                   CONDUIT    200.89     0  01:01      3.17     0.02     0.14
  I110-DF               DUMMY      223.28     0  00:45
  I115-DF               DUMMY      127.87     0  00:49
  I120-DF               DUMMY       81.61     0  00:54
  J10                   CONDUIT   1230.95     0  00:55      5.76     0.09     0.32
  J100-DF               DUMMY      304.93     0  00:37
  J11                   CONDUIT    657.48     0  00:49      4.22     0.06     0.27
  J11.5                 CONDUIT    413.49     0  00:52      3.79     0.02     0.15
  J110-DF               DUMMY      200.28     0  00:40
  J12                   CONDUIT    139.30     0  00:55      2.51     0.01     0.09
  J120-DF               DUMMY      341.12     0  00:39
  J13                   CONDUIT    480.89     0  00:58      4.08     0.07     0.28
  J130-DF               DUMMY      590.02     0  00:33
  J14                   CONDUIT    319.45     0  00:57      3.25     0.03     0.21
  J140-DF               DUMMY      252.06     0  00:38
  J15                   CONDUIT    148.97     0  00:59      2.91     0.01     0.12
  J150-DF               DUMMY      216.59     0  00:40
  J155-DF               DUMMY      175.33     0  00:38
  J160-DF               DUMMY      159.24     0  00:46
  MT-OUT                DUMMY      598.03     0  01:08
  NG220-IN              DUMMY     7656.93     0  00:57
  NG-OUT                DUMMY     3581.36     0  01:29
  PW-OUT                DUMMY     1120.62     0  00:45
  RT-OUT                DUMMY      503.78     0  01:04
  SJ-OUT                DUMMY      755.24     0  00:58
  SN-OUT                DUMMY     1706.64     0  01:18
  SP-OUT                DUMMY      781.96     0  00:58
  ST-OUT                DUMMY     1427.17     0  00:52
  NG220-OUT             DUMMY      995.22     0  02:43
  SJ130-OUT             DUMMY      314.48     0  01:10
```

```
  *************************
  Conduit Surcharge Summary
  *************************

  ----------------------------------------------------------------------------
                                                                 Hours        Hours
                          --------- Hours Full --------   Above Full     Capacity
  Conduit                 Both Ends   Upstream   Dnstream  Normal Flow      Limited
  ----------------------------------------------------------------------------
  A100-DF                      0.01       0.01       0.01       216.01         0.01
  A104-DF                      0.01       0.01       0.01       216.01         0.01
  A108-DF                      0.01       0.01       0.01       216.01         0.01
  A110-DF                      0.01       0.01       0.01       216.01         0.01
  A120-DF                      0.01       0.01       0.01       216.01         0.01
  A130-DF                      0.01       0.01       0.01       216.01         0.01
  A135-DF                      0.01       0.01       0.01       216.01         0.01
  A140-DF                      0.01       0.01       0.01       216.01         0.01
  A145-DF                      0.01       0.01       0.01       216.01         0.01
  A150-DF                      0.01       0.01       0.01       216.01         0.01
  A155-DF                      0.01       0.01       0.01       216.01         0.01
  A160-DF                      0.01       0.01       0.01       216.01         0.01
  A165-DF                      0.01       0.01       0.01       216.01         0.01
  A170-DF                      0.01       0.01       0.01       216.01         0.01
  A175-DF                      0.01       0.01       0.01       216.01         0.01
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  A190-DF                      0.01       0.01       0.01       216.01         0.01
  A200-DF                      0.01       0.01       0.01       216.01         0.01
  A205-DF                      0.01       0.01       0.01       216.01         0.01
  A210-DF                      0.01       0.01       0.01       216.01         0.01
  A22                          0.01       0.01       0.01       216.01         0.01
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  A221-DF                      0.01       0.01       0.01       216.01         0.01
  A222-DF                      0.01       0.01       0.01       216.01         0.01
  A223-DF                      0.01       0.01       0.01       216.01         0.01
  A224-DF                      0.01       0.01       0.01       216.01         0.01
  A225-DF                      0.01       0.01       0.01       216.01         0.01
  A226-DF                      0.01       0.01       0.01       216.01         0.01
  A227-DF                      0.01       0.01       0.01       216.01         0.01
  A228-DF                      0.01       0.01       0.01       216.01         0.01
  A230-DF                      0.01       0.01       0.01       216.01         0.01
  A240-DF                      0.01       0.01       0.01       216.01         0.01
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  A260-DF                      0.01       0.01       0.01       216.01         0.01
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  A275-DF                      0.01       0.01       0.01       216.01         0.01
  A280-DF                      0.01       0.01       0.01       216.01         0.01
```

Table B-8
Sample SWMM Output

```
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  A300-DF                 0.01      0.01      0.01    216.01         0.01
  B100-DF                 0.01      0.01      0.01    216.01         0.01
  B110-DF                 0.01      0.01      0.01    216.01         0.01
  B120-DF                 0.01      0.01      0.01    216.01         0.01
  B130-DF                 0.01      0.01      0.01    216.01         0.01
  B135-DF                 0.01      0.01      0.01    216.01         0.01
  B140-DF                 0.01      0.01      0.01    216.01         0.01
  BW-OUT                  0.01      0.01      0.01    216.01         0.01
  C100-DF                 0.01      0.01      0.01    216.01         0.01
  C110-DF                 0.01      0.01      0.01    216.01         0.01
  C120-DF                 0.01      0.01      0.01    216.01         0.01
  C125-DF                 0.01      0.01      0.01    216.01         0.01
  CT-OUT                  0.01      0.01      0.01    216.01         0.01
  D10                     0.01      0.01      0.01    216.01         0.01
  D100-DF                 0.01      0.01      0.01    216.01         0.01
  D105-DF                 0.01      0.01      0.01    216.01         0.01
  D110-DF                 0.01      0.01      0.01    216.01         0.01
  D115-DF                 0.01      0.01      0.01    216.01         0.01
  D120-DF                 0.01      0.01      0.01    216.01         0.01
  D125-DF                 0.01      0.01      0.01    216.01         0.01
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  F110-DF                 0.01      0.01      0.01    216.01         0.01
  F120-DF                 0.01      0.01      0.01    216.01         0.01
  F125-DF                 0.01      0.01      0.01    216.01         0.01
  F130-DF                 0.01      0.01      0.01    216.01         0.01
  F140-DF                 0.01      0.01      0.01    216.01         0.01
  F145-DF                 0.01      0.01      0.01    216.01         0.01
  F150-DF                 0.01      0.01      0.01    216.01         0.01
  F155-DF                 0.01      0.01      0.01    216.01         0.01
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  G120-DF                 0.01      0.01      0.01    216.01         0.01
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  H110-DF                 0.01      0.01      0.01    216.01         0.01
  H115-DF                 0.01      0.01      0.01    216.01         0.01
  H120-DF                 0.01      0.01      0.01    216.01         0.01
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  I115-DF                 0.01      0.01      0.01    216.01         0.01
  I120-DF                 0.01      0.01      0.01    216.01         0.01
  J100-DF                 0.01      0.01      0.01    216.01         0.01
  J110-DF                 0.01      0.01      0.01    216.01         0.01
  J120-DF                 0.01      0.01      0.01    216.01         0.01
  J130-DF                 0.01      0.01      0.01    216.01         0.01
  J140-DF                 0.01      0.01      0.01    216.01         0.01
  J150-DF                 0.01      0.01      0.01    216.01         0.01
  J155-DF                 0.01      0.01      0.01    216.01         0.01
  J160-DF                 0.01      0.01      0.01    216.01         0.01
  MT-OUT                  0.01      0.01      0.01    216.01         0.01
  NG220-IN                0.01      0.01      0.01    216.01         0.01
  NG-OUT                  0.01      0.01      0.01    216.01         0.01
  PW-OUT                  0.01      0.01      0.01    216.01         0.01
  RT-OUT                  0.01      0.01      0.01    216.01         0.01
  SJ-OUT                  0.01      0.01      0.01    216.01         0.01
  SN-OUT                  0.01      0.01      0.01    216.01         0.01
  SP-OUT                  0.01      0.01      0.01    216.01         0.01
  ST-OUT                  0.01      0.01      0.01    216.01         0.01


  Analysis begun on:  Thu Jan 15 15:25:36 2015
  Analysis ended on:  Thu Jan 15 15:25:38 2015
  Total elapsed time: 00:00:02
```

Select tables from September 2012 draft of Chapter 4 – Rainfall, Urban Storm Drainage Criteria Manual Volume I

Table 4-1. Storm Duration and Area Adjustment for CUHP Modeling

Design Storm	Watershed Area (square miles)	Suggested Minimum Storm Duration	Apply DRF?
2-, 5-, and 10-Year	A ≤ 2.0	2 hours	No
	2.0 < A < 15.0	2 hours	Yes – Use Table 4-3
	A ≥ 15.0	6 hours	Yes – Use Table 4-3
25-, 50-, 100-, and 500-Year	A < 15.0	2 hours	No
	A ≥ 15.0	6 hours	Yes – Use Table 4-4

Table 4-3. DRFs for Design Rainfall Distributions 2-, 5-, and 10-Year Design Rainfall

Time (minutes)	Correction Factor by Watershed Area in Square Miles[1]								
	2	5	10	15	20	30	40	50	75
5	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
15	1.00	0.97	0.94	0.91	0.90	0.85	0.75	0.65	0.56
20	1.00	0.86	0.75	0.68	0.61	0.55	0.48	0.42	0.35
25	1.00	0.86	0.75	0.68	0.61	0.55	0.48	0.42	0.35
30	1.00	0.86	0.75	0.68	0.61	0.55	0.48	0.42	0.42
35	1.00	0.97	0.94	0.91	0.90	0.90	0.90	0.90	0.89
40	1.00	0.97	0.94	0.91	0.90	0.90	0.90	0.90	0.89
45	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
50	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
55	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
60	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
65	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
70	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
75	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
80	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
85	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
90	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
95	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
100	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
105	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
110	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
115	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
120	1.00	1.00	1.00	1.02	1.02	1.01	1.01	1.01	1.00
125-180	N/A	N/A	N/A	1.00	1.00	1.00	1.00	1.00	1.00
185-360	N/A	N/A	N/A	1.23	1.28	1.30	1.32	1.33	1.33

[1] For areas between the values listed in the table, correction factors can be obtained through linear interpolation between columns.

Table 4-4. DRFs for Design Rainfall Distributions 25-, 50-, 100-, and 500-Year Design Rainfall

Time (minutes)	Correction Factor by Watershed Area in Square Miles[1]					
	15	20	30	40	50	75
5	1.15	1.15	1.15	1.15	1.15	1.10
10	1.15	1.15	1.15	1.15	1.15	1.10
15	1.15	1.15	1.15	1.15	1.15	1.10
20	1.25	1.18	1.10	1.05	1.00	0.90
25	0.73	0.69	0.64	0.60	0.58	0.55
30	0.73	0.69	0.64	0.60	0.58	0.55
35	0.73	0.69	0.64	0.60	0.58	0.55
40	1.05	1.02	0.95	0.90	0.85	0.80
45	1.20	1.20	1.20	1.15	1.05	0.95
50	1.15	1.15	1.15	1.15	1.05	0.95
55	1.15	1.15	1.15	1.15	1.15	1.15
60	1.15	1.15	1.15	1.15	1.15	1.15
65	1.08	1.10	1.13	1.15	1.15	1.15
70	1.08	1.10	1.13	1.15	1.15	1.15
75	1.08	1.10	1.13	1.15	1.15	1.15
80	1.08	1.10	1.13	1.15	1.15	1.15
85	1.08	1.10	1.13	1.15	1.15	1.15
90	1.08	1.10	1.13	1.15	1.15	1.15
95	1.08	1.10	1.13	1.15	1.15	1.15
100	1.08	1.10	1.13	1.15	1.15	1.15
105	1.08	1.10	1.13	1.15	1.15	1.15
110	1.08	1.10	1.13	1.15	1.15	1.15
115	1.08	1.10	1.13	1.15	1.15	1.15
120	1.08	1.10	1.13	1.15	1.15	1.15
125-180	1.08	1.10	1.13	1.15	1.25	1.25
185-360	1.05	1.10	1.10	1.10	1.10	1.13

[1] For areas between the values listed in the table, correction factors can be obtained through linear interpolation between columns.

Appendix C

RUETER-HESS RESERVOIR ROUTING ANALYSIS

MEMORANDUM

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To: Shea Thomas and Bill DeGroot / UDFCD
Fred Koch and Brad Robenstein / Douglas County
Tom Williams and Jacob James / Town of Parker

From: Derek Johns / Muller Engineering Company
Jim Wulliman / Muller Engineering Company

Date: May 30, 2013

Project #: 12-050.01

Re: Newlin Gulch Major Drainageway Planning Study,
Rueter-Hess Reservoir Flood Control Benefits

Introduction

This memorandum documents the initial results of a baseline hydrology evaluation completed for the Newlin Gulch watershed located in Douglas County. This work was completed as one of the first components of the Major Drainageway Planning (MDP) study that is currently underway for the Newlin Gulch watershed. One of the key objectives of the MDP is to update hydrologic information provided in the previous Outfall Systems Planning (OSP) study completed in 1993 for the watershed. In addition, hydrologic results will be compared to the 1977 Flood Hazard Area Delineation (FHAD) study which is the basis for the current regulatory floodplain along Newlin Gulch.

The primary issues involved in updating the Newlin Gulch hydrology was to incorporate land use changes in the watershed and evaluate the impacts of Rueter-Hess Reservoir, a large water supply reservoir that was recently constructed on Newlin Gulch. The older OSP and FHAD studies were both completed prior to construction of Rueter-Hess Reservoir and don't recognize any flood detention benefits.

The following sections include a summary of land use changes in the watershed, describe key features of Rueter-Hess Reservoir, document the hydrologic evaluation, and summarize the impacts and flood detention benefits associated with Rueter-Hess Reservoir.

Land Use Changes

Since 1993, there have been significant changes in the existing land use and the projected future land use within the watershed. To-date, most of the development has occurred in the lower portion of the watershed in or near the Town of Parker. Existing imperviousness values in the watershed have been updated based on 2012 aerial photography and information provided in land development drainage reports. Based on this information, the composite watershed imperviousness for existing conditions is currently 22.5%. This value accounts for the Rueter-Hess Reservoir maximum normal pool being at 100% imperviousness. If the reservoir pool is excluded, the composite watershed imperviousness for existing conditions is 12%. In the 1993 OSP, the existing imperviousness was reported to be 4.9%.

The future land use conditions are projected to be much higher than the estimates in the 1993 OSP. In the 1993 OSP, future land use in the upper portion of the watershed was projected to consist primarily of open space and large lot residential development and the overall composite imperviousness cover was estimated to be 12.6%. Based on new land use information provided by the Town of Parker, Douglas County, and the City of Castle Pines, more land development is planned and at higher densities than what was estimated in 1993. As shown on the Future Land Use Map (Figure 1), there is a significant amount of development ranging from medium density residential areas (40% imperviousness) to business/commercial areas (85 to 90% imperviousness) that is planned in the upper portion of the watershed in Castle Pines. This includes the 3300-acre Canyons residential development that is planned immediately upstream of Rueter-Hess Reservoir along with Castle Pines Town Center and Lagae Ranch developments near I-25. In the lower portion of the watershed (below Rueter-Hess Reservoir), future developments that are planned include the Meridian Business Park (75% imperviousness) and several residential developments. Based on this new land use information, the composite watershed imperviousness for future conditions is estimated to be 35% (26% without Rueter-Hess) which is almost 3 times higher than the 12.6% imperviousness assumed in the 1993 OSP.

Rueter-Hess Reservoir

Rueter-Hess Reservoir is a water supply reservoir owned by Parker Water and Sanitation District (PWSD). It is located on the mainstem of Newlin Gulch in the central portion of the watershed. The construction of the reservoir was completed in 2012 and consists of a 170-foot tall earthen dam that is designed to store 72,000 acre-feet of water. Once it is filled to its maximum normal pool, the reservoir footprint will cover 1.8 square miles or approximately 12% of the entire Newlin Gulch watershed. The reservoir was built for water supply storage and not flood control.

Service Spillway. Outflows from Rueter-Hess reservoir are controlled through a multi-chambered tower that connects to two outlet conduits. The service spillway is comprised of two of the upper chambers on the outlet works tower, each approximately10-feet wide and 5-feet tall. The maximum normal pool elevation for the reservoir is elevation 6215.1 (NAVD88) which is equal to the crest of the service spillway. According to an evaluation conducted by the reservoir design engineer, the service spillway can convey both the 100-year and 500-year storm events.

Auxiliary Spillway. The auxiliary (or emergency) spillway consists of a large concrete labyrinth weir located on the west abutment of the dam. The auxiliary spillway crest is at elevation 6216.7 which is 1.6-feet above the service spillway crest. The auxiliary spillway is designed to convey extreme flood events (greater that the 500-year).

Hydrologic Evaluation

The hydrologic evaluation for the Newlin Gulch watershed was based on updated topographic mapping and land use information. A new subwatershed delineation was performed using the more current mapping and in accordance with UDFCD guidelines to keep the average subwatershed size to approximately 100-acres. The new delineation resulted in subdividing the 15.0 square mile watershed into 111 subwatersheds with an average subwatershed size of approximately 90-acres.

Percent imperviousness values for the subwatersheds were based on the most current land use information for both existing and future conditions. Hydrographs for the subwatersheds were generated using the Colorado Urban Hydrograph Procedure (CUHP). The hydrographs were then routed through the drainageway network using EPA's Storm Water Management Model (SWMM). The SWMM model was also used to evaluate the impacts of routing flood flows through Rueter-Hess Reservoir. Storage/discharge data for the reservoir was incorporated into the SWMM model based on rating curve tables shown on a record drawing provided by PWSD.

The hydrologic modeling was completed for the 100-year event based on future land use conditions. To evaluate the impacts of Rueter-Hess Reservoir, the modeling was performed for conditions with and without the reservoir. The assumptions for these two conditions are described below.

With Rueter-Hess Reservoir. This option accounts for the inherent flood detention/attenuation that the reservoir currently provides.

1. It was decided by the project sponsors to ignore the service spillway and route flows only through the auxiliary spillway. This is a more conservative approach. However, this option would allow some flexibility for future changes to the service spillway configuration.
2. The reservoir was assumed to be full to the auxiliary spillway crest (elevation 6216.7) prior to the storm event. The reservoir subwatershed was modeled at 100% imperviousness.
3. The resulting 100-year peak discharges for this option are presented in Figure 2 and show that discharges downstream of the reservoir would be lower than both the 1977 FHAD and the 1993 OSP discharges. The reservoir surcharge (rise in water level) for this option in the 100-year event would be approximately 0.8-feet.

With-Out Rueter-Hess Reservoir. This option assumes that Rueter-Hess Reservoir is not in place, so there is no reservoir pool or flood detention routing.

1. The reservoir subwatershed was modeled based on historic topographic conditions and 2% imperviousness.
2. The resulting 100-year peak discharges from this option are also shown on Figure 2 and indicate that peak flows are 250 to 750% higher than the "With Rueter-Hess Reservoir" option, 160% percent higher the 1993 OSP discharges, and 190% higher than the 1977 FHAD discharges.

Flood Control Benefits of Rueter-Hess Reservoir

This hydrologic evaluation shows that Rueter-Hess Reservoir provides substantial reductions in peak flood discharges in Newlin Gulch. The reduction in flood discharges is inherent because the reservoir surface area is so large relative to the upstream watershed. In addition, these flood detention benefits occur with the current reservoir configuration and no impacts to reservoir operations or water storage volume.

Recognizing the lower flood discharges from Rueter-Hess Reservoir would provide several benefits for the Newlin Gulch watershed. These benefits include:

1. Prevent Expansion of Regulatory Floodplain: Figure 3 shows a sample map of the 100-year regulatory floodplain in Stonegate Village located downstream of Rueter-Hess Reservoir. The map shows that the regulatory floodplain is in close proximity to the existing residential lots. Recognizing the flood peak reduction from Rueter-Hess Reservoir would maintain discharges below the current regulatory discharges and, therefore, prevent the expansion of the floodplain into residential and commercial properties. If the flood discharge reduction from RH reservoir is not recognized, then the 100-year regulatory discharges would increase by a factor of 2 as shown in the "Without RH Reservoir" option and result in a wider floodplain that would encroach onto numerous residential and commercial properties.
2. Avoid Increases to Flood Insurance Rates: If the floodplain were to expand, flood insurance premium rates for properties would likely increase. Recognizing the lower flood discharges would prevent this situation from occurring.
3. Avoid Lowering Property Values: If the floodplain were to expand, it is possible that property values would decrease. In addition, infrastructure improvements for properties within the expanded floodplain could be limited by floodplain regulations (i.e., it may be prohibited or more costly for a property owner to expand or modify a home or building). Recognizing the lower flood discharges would prevent this from occurring.

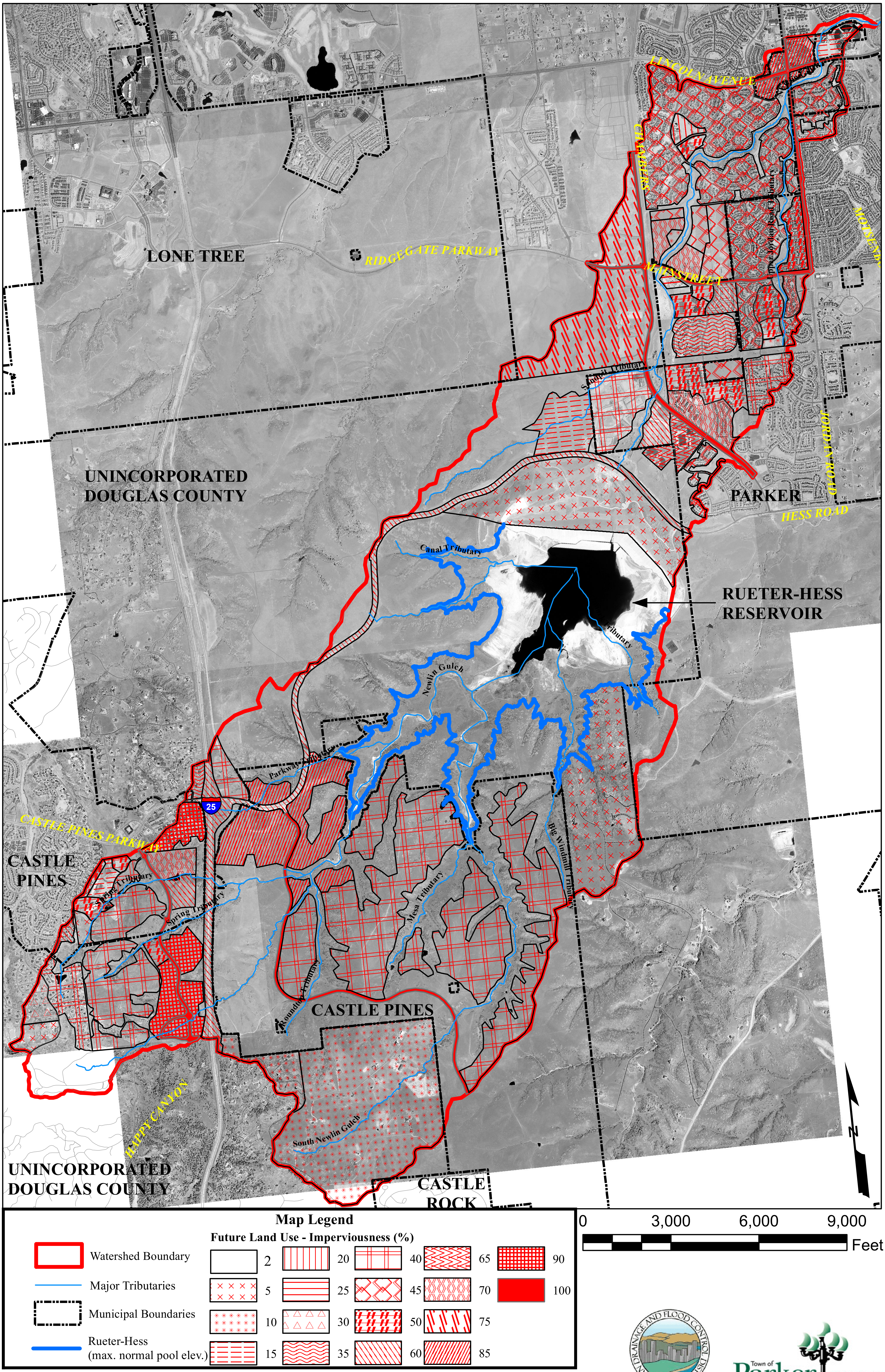
4. Reduce Costs for Roadway Crossings: Recognizing the flood peak reduction from Rueter-Hess Reservoir would also help to reduce costs for future roadway crossings or replacement of existing roadway crossings of Newlin Gulch. For example, if a new bridge crossing over Newlin Gulch needs to be replaced, the bridge span could be shorter using the lower flow rates and, therefore, less costly to construct.

5. Reduce Costs for Future Drainageway Improvements: Future drainageway infrastructure that will likely be needed along Newlin Gulch such as stream stabilization improvements will be more cost effective if they can be designed using the lower flood discharges.

Conclusion

In conclusion, Rueter-Hess Reservoir provides significant reduction in peak flood discharges for the Newlin Gulch drainageway downstream. Recognizing this would provide significant benefits for property owners downstream and would reduce costs for future infrastructure improvements within the Newlin Gulch drainageway.

In order for the flood peak reduction benefits from Rueter-Hess Reservoir to be officially recognized by regulatory agencies (i.e., UDFCD, FEMA, and the Colorado Water Conservation Board), an "adequate assurances" agreement would need to be executed with the reservoir owner, PWSD, ensuring no adverse changes would be made to the existing auxiliary spillway.



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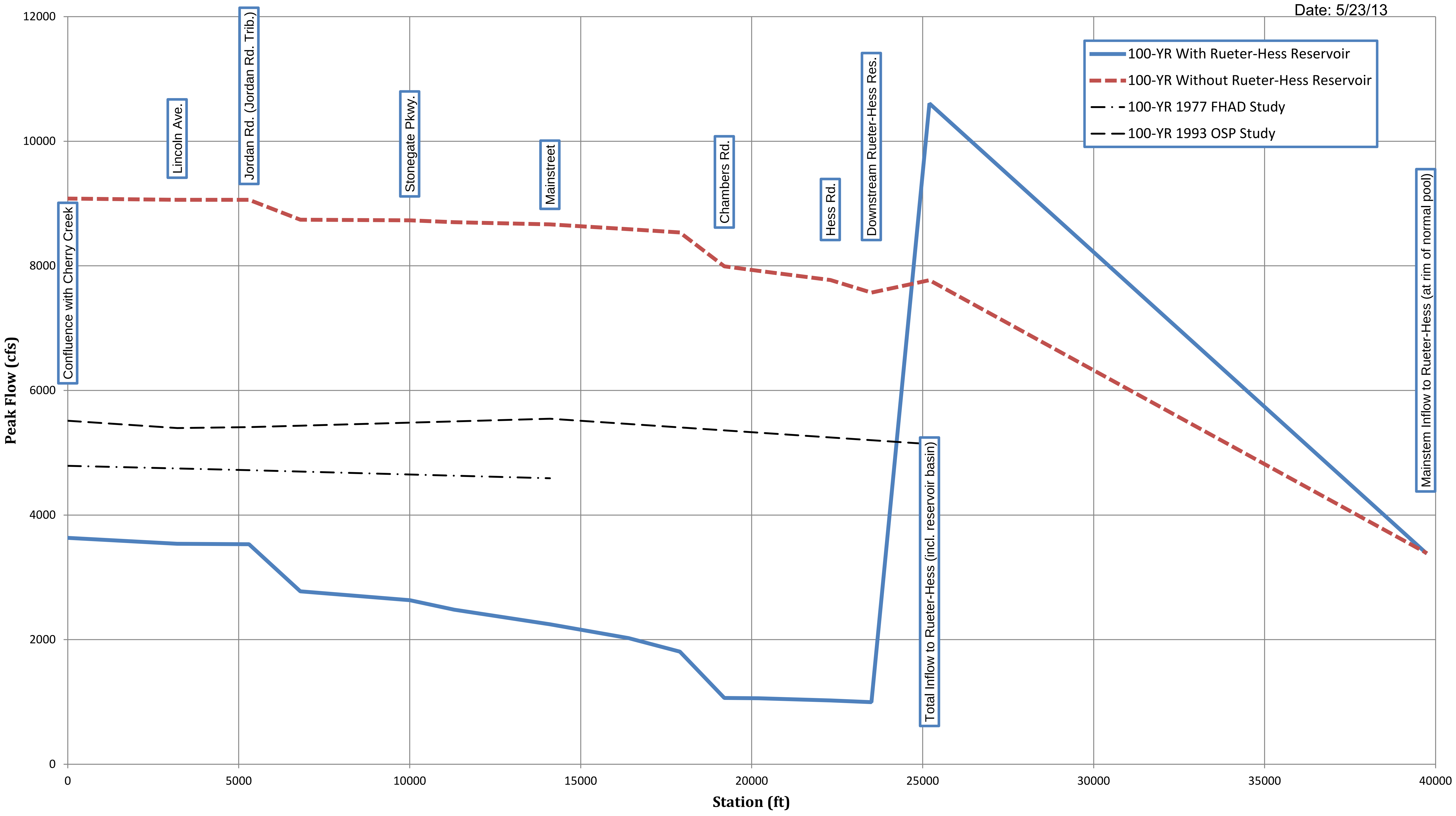
Newlin Gulch Major Drainageway Plan

Figure 1 - Future Land Use Map

(For Rueter-Hess Technical Memo)

May 20, 2013

Figure 2 - Newlin Gulch Peak Flow Profile - Future Development



DATE: 5/23/13

FIGURE 3

NEWLIN GULCH REGULATORY FLOODPLAIN

IN THE CENTRAL PORTION OF STONEGATE VILLAGE

NAME: P:\12-050.01 Newlin Gulch MDP - UDFCD\7 AUTOCAD FILES\Baseline Hydrology\12050-Stonegate Regulatory FP.dwg DATE: MAY 23, 2013 TIME: 11:04 AM

Table C-1
Rueter-Hess Reservoir Routing Alternatives

					1993 OSP **		**Current Study**							
							100-Yr (Existing Land Use)				**100-Yr (Future Land Use)**			
							With RH		**Without RH**		**With RH**		**Without RH**	
Location	**FHAD Cross Section**	**OSP Design Point**	**Current Design Point**	**1977 FHAD * 100-Yr (cfs)**	**100-Yr Existing (cfs)**	**100-Yr Future (cfs)**	**Service Spillway (cfs)**	**Auxiliary Spillway (cfs)†**	**I=100% (cfs)**	**I=2% (cfs)**	**Service Spillway (cfs)**	**Auxiliary Spillway (cfs)†**	**I=100% (cfs)**	**I=2% (cfs)**
Newlin Gulch														
Cherry Creek	28	180	NG000	4790	5357	5513	2843	**2843**	10968	6438	3581	**3581**	12882	8191
Lincoln Ave. (U/S)		177	NG001		5198	5396	2796	**2795**	10945	6430	3486	**3486**	12848	8174
Jordan Rd. (U/S)	23	176	NG002	4720	5220	5412	2793	**2793**	10951	6431	3478	**3478**	12855	8176
Stonegate Parkway (U/S)			NG004				2213	**2212**	10479	6122	2683	**2683**	12300	7839
Mainstreet (U/S)	16	166	NG006	4590	5330	5545	1945	**1945**	10301	6032	2253	**2253**	12092	7784
Chambers Rd. (U/S)			NG009				706	**905**	9306	5551	763	**1025**	10980	7192
Hess Rd.			NG011				325	**890**	9024	5431	325	**1010**	10626	7017
Rueter-Hess Reservoir Outflow			NG012				49	**880**	8822	5309	56	**995**	10381	6838
RH Total Inflow (Including Reservoir Subwatershed)			NG220				8822	**8822**	N/A	N/A	10381	**10381**	N/A	N/A
Mainstem and Tributary Inflow to RH		150	NG013		4969	5138	5871	**5871**	5871	4738	7657	**7657**	7657	6210
Mainstem Inflow to RH			NG014				2454	**2454**	3108	3108	3255	**3255**	4183	4183
I-25 (U/S)		103	NG019		321	311	426	**426**	426	426	514	**514**	514	514
Tributaries														
Jordan Rd. Tributary at Newlin Confluence		276	SJ000		545	785	690	**690**	690	690	755	**755**	755	755
South Newlin at Mesa Confluence		128	SN001		1106	1167	1388	**1388**	1388	1388	1564	**1564**	1564	1564
Mesa Tributary at South Newlin Confluence		224	MT000		420	470	493	**493**	493	493	598	**598**	598	598
Roundtop Tributary at Newlin Confluence		217	RT000		383	393	429	**429**	429	429	504	**504**	504	504
Spring Tributary at Newlin Confluence		219	ST000		773	840	1009	**1009**	1009	1009	1427	**1427**	1427	1427

Notes:

* 1977 FHAD flows based on 24-hour storm and WSP-2 and TR-20 models.

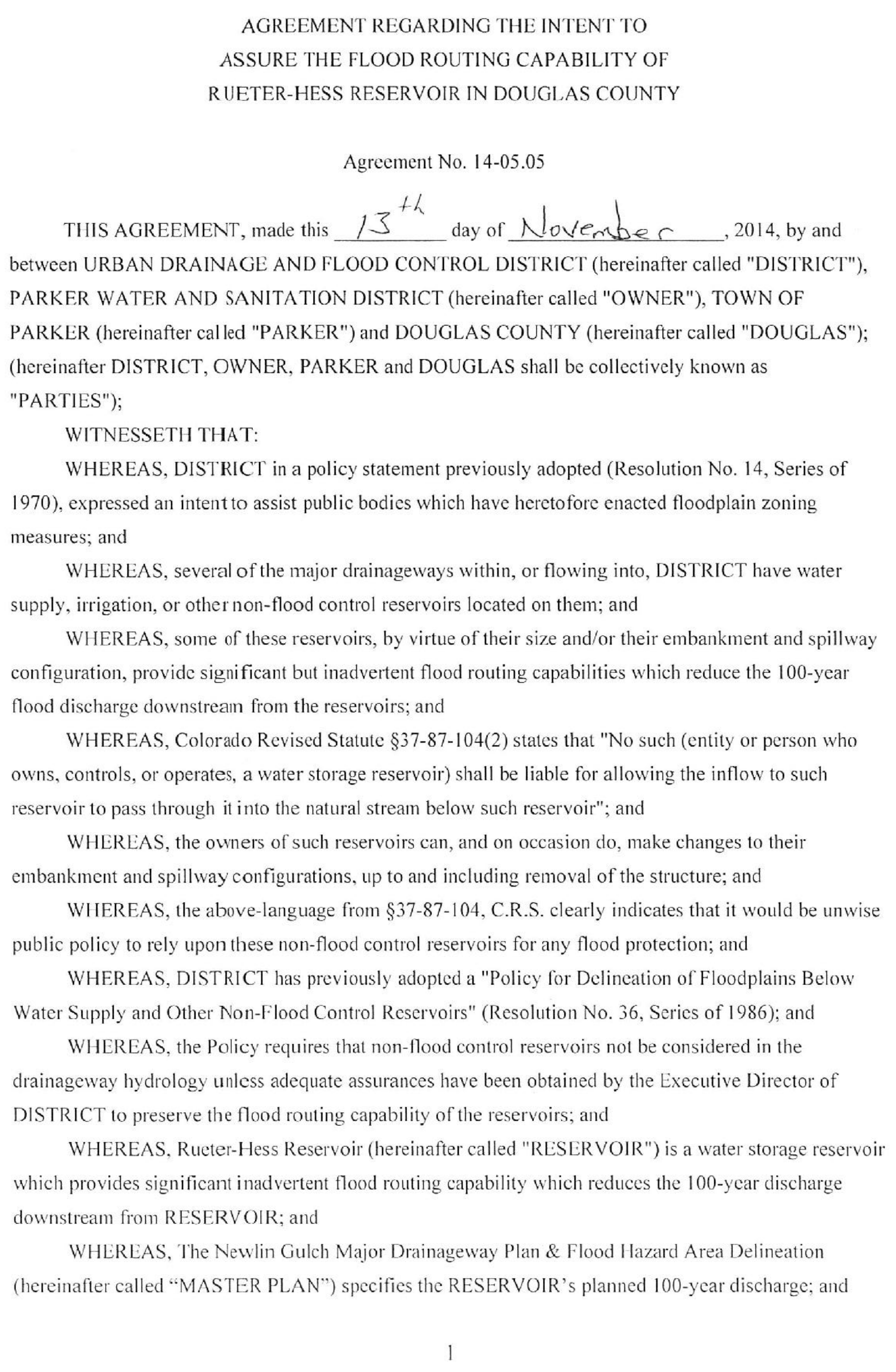
** 1993 OSP flows based on 3-hour storm and CUHP/UDSWMM models.

†Selected Alternative for Baseline Hydrology

Updated June 6, 2013

Appendix D

RUETER-HESS ADEQUATE ASSURANCES AGREEMENT



AGREEMENT REGARDING THE INTENT TO
ASSURE THE FLOOD ROUTING CAPABILITY OF
RUETER-HESS RESERVOIR IN DOUGLAS COUNTY

Agreement No. 14-05.05

THIS AGREEMENT, made this 13th day of November, 2014, by and between URBAN DRAINAGE AND FLOOD CONTROL DISTRICT (hereinafter called "DISTRICT"), PARKER WATER AND SANITATION DISTRICT (hereinafter called "OWNER"), TOWN OF PARKER (hereinafter called "PARKER") and DOUGLAS COUNTY (hereinafter called "DOUGLAS"); (hereinafter DISTRICT, OWNER, PARKER and DOUGLAS shall be collectively known as "PARTIES");

WITNESSETH THAT:

WHEREAS, DISTRICT in a policy statement previously adopted (Resolution No. 14, Series of 1970), expressed an intent to assist public bodies which have heretofore enacted floodplain zoning measures; and

WHEREAS, several of the major drainageways within, or flowing into, DISTRICT have water supply, irrigation, or other non-flood control reservoirs located on them; and

WHEREAS, some of these reservoirs, by virtue of their size and/or their embankment and spillway configuration, provide significant but inadvertent flood routing capabilities which reduce the 100-year flood discharge downstream from the reservoirs; and

WHEREAS, Colorado Revised Statute §37-87-104(2) states that "No such (entity or person who owns, controls, or operates, a water storage reservoir) shall be liable for allowing the inflow to such reservoir to pass through it into the natural stream below such reservoir"; and

WHEREAS, the owners of such reservoirs can, and on occasion do, make changes to their embankment and spillway configurations, up to and including removal of the structure; and

WHEREAS, the above-language from §37-87-104, C.R.S. clearly indicates that it would be unwise public policy to rely upon these non-flood control reservoirs for any flood protection; and

WHEREAS, DISTRICT has previously adopted a "Policy for Delineation of Floodplains Below Water Supply and Other Non-Flood Control Reservoirs" (Resolution No. 36, Series of 1986); and

WHEREAS, the Policy requires that non-flood control reservoirs not be considered in the drainageway hydrology unless adequate assurances have been obtained by the Executive Director of DISTRICT to preserve the flood routing capability of the reservoirs; and

WHEREAS, Rueter-Hess Reservoir (hereinafter called "RESERVOIR") is a water storage reservoir which provides significant inadvertent flood routing capability which reduces the 100-year discharge downstream from RESERVOIR; and

WHEREAS, The Newlin Gulch Major Drainageway Plan & Flood Hazard Area Delineation (hereinafter called "MASTER PLAN") specifies the RESERVOIR's planned 100-year discharge; and

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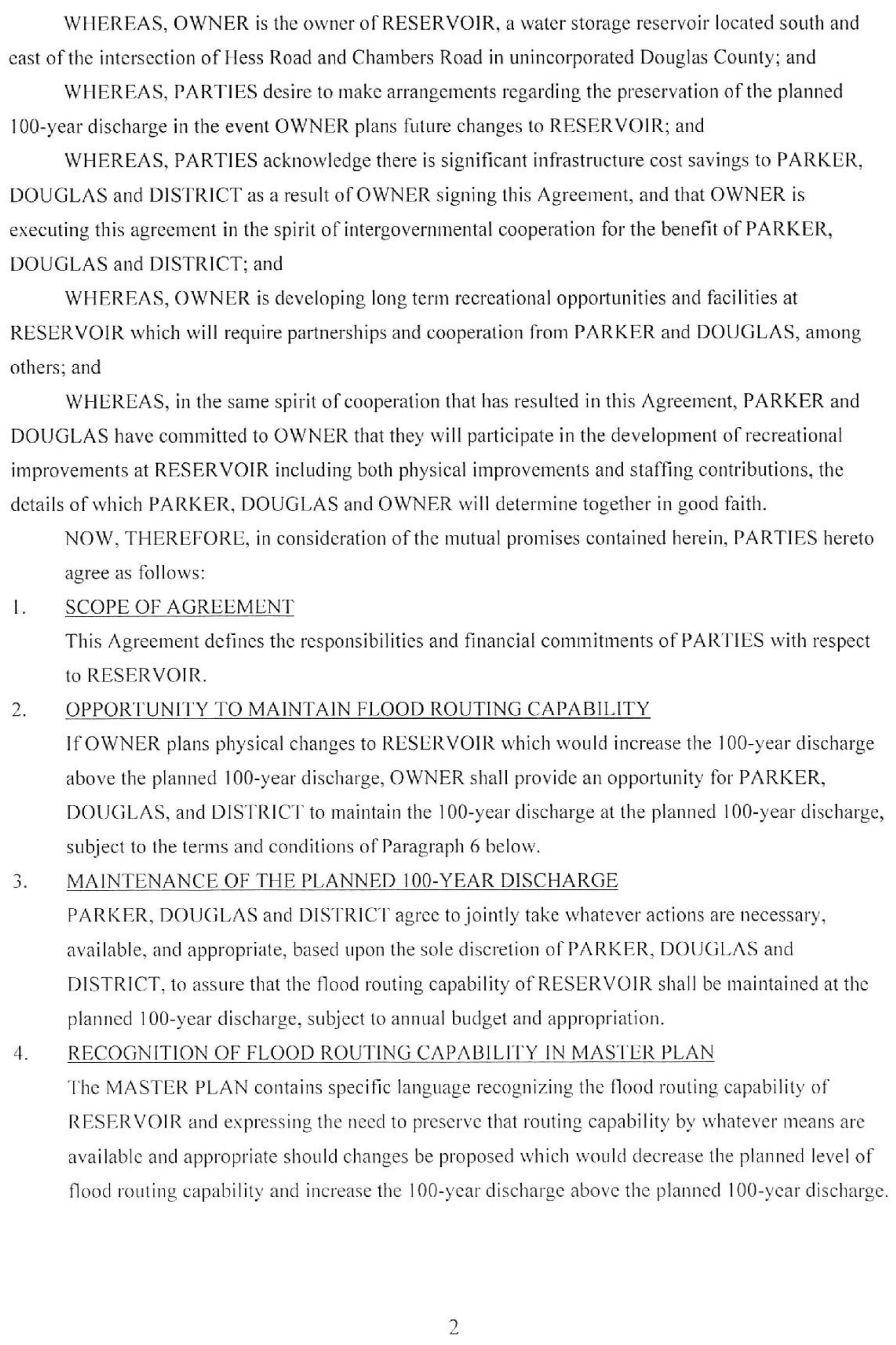


WHEREAS, OWNER is the owner of RESERVOIR, a water storage reservoir located south and east of the intersection of Hess Road and Chambers Road in unincorporated Douglas County; and

WHEREAS, PARTIES desire to make arrangements regarding the preservation of the planned 100-year discharge in the event OWNER plans future changes to RESERVOIR; and

WHEREAS, PARTIES acknowledge there is significant infrastructure cost savings to PARKER, DOUGLAS and DISTRICT as a result of OWNER signing this Agreement, and that OWNER is executing this agreement in the spirit of intergovernmental cooperation for the benefit of PARKER, DOUGLAS and DISTRICT; and

WHEREAS, OWNER is developing long term recreational opportunities and facilities at RESERVOIR which will require partnerships and cooperation from PARKER and DOUGLAS, among others; and

WHEREAS, in the same spirit of cooperation that has resulted in this Agreement, PARKER and DOUGLAS have committed to OWNER that they will participate in the development of recreational improvements at RESERVOIR including both physical improvements and staffing contributions, the details of which PARKER, DOUGLAS and OWNER will determine together in good faith.

NOW, THEREFORE, in consideration of the mutual promises contained herein, PARTIES hereto agree as follows:

1. SCOPE OF AGREEMENT

   This Agreement defines the responsibilities and financial commitments of PARTIES with respect to RESERVOIR.

2. OPPORTUNITY TO MAINTAIN FLOOD ROUTING CAPABILITY

   If OWNER plans physical changes to RESERVOIR which would increase the 100-year discharge above the planned 100-year discharge, OWNER shall provide an opportunity for PARKER, DOUGLAS, and DISTRICT to maintain the 100-year discharge at the planned 100-year discharge, subject to the terms and conditions of Paragraph 6 below.

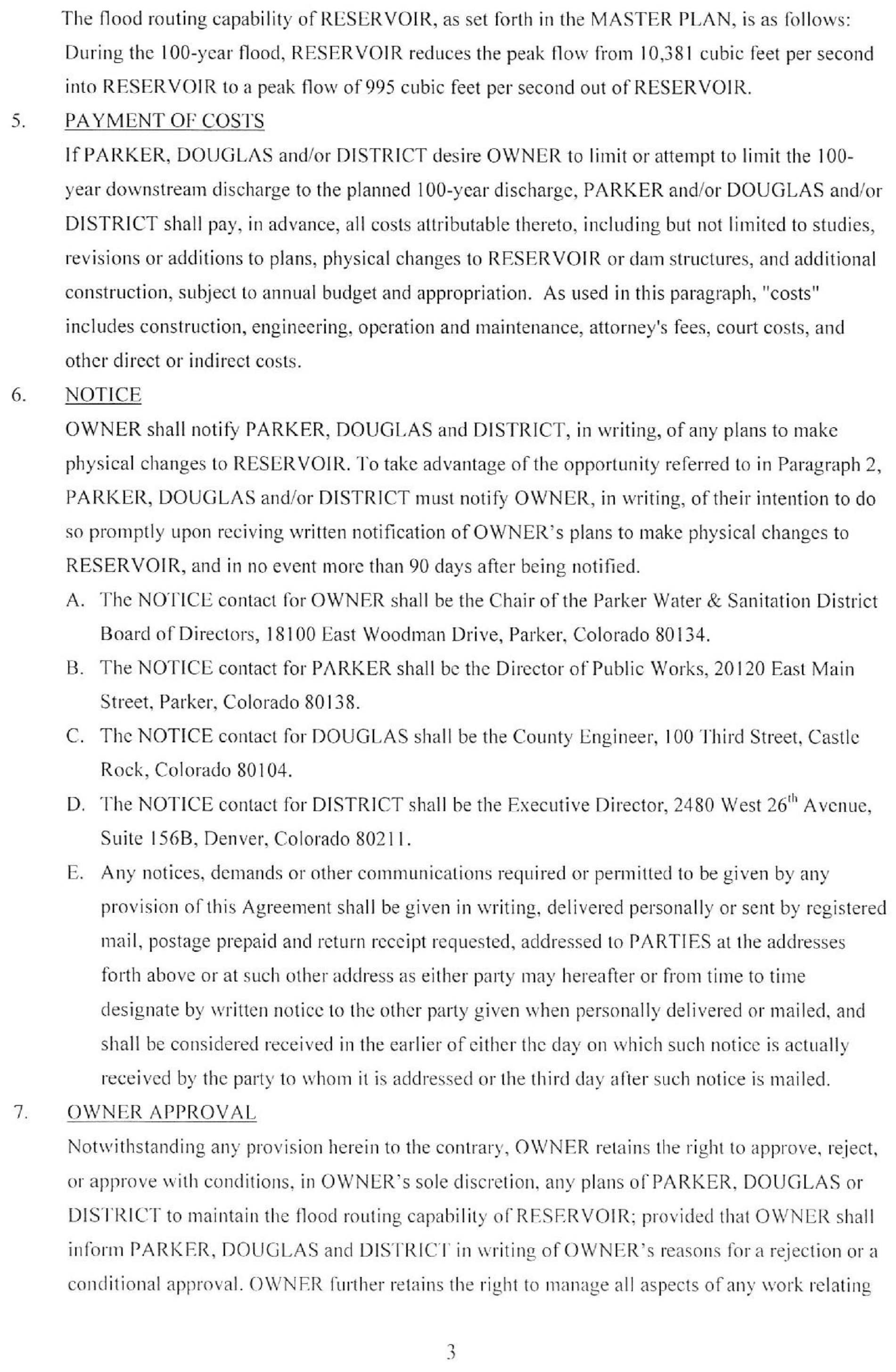
3. MAINTENANCE OF THE PLANNED 100-YEAR DISCHARGE

   PARKER, DOUGLAS and DISTRICT agree to jointly take whatever actions are necessary, available, and appropriate, based upon the sole discretion of PARKER, DOUGLAS and DISTRICT, to assure that the flood routing capability of RESERVOIR shall be maintained at the planned 100-year discharge, subject to annual budget and appropriation.

4. RECOGNITION OF FLOOD ROUTING CAPABILITY IN MASTER PLAN

   The MASTER PLAN contains specific language recognizing the flood routing capability of RESERVOIR and expressing the need to preserve that routing capability by whatever means are available and appropriate should changes be proposed which would decrease the planned level of flood routing capability and increase the 100-year discharge above the planned 100-year discharge.

2



The flood routing capability of RESERVOIR, as set forth in the MASTER PLAN, is as follows: During the 100-year flood, RESERVOIR reduces the peak flow from 10,381 cubic feet per second into RESERVOIR to a peak flow of 995 cubic feet per second out of RESERVOIR.

5. PAYMENT OF COSTS

If PARKER, DOUGLAS and/or DISTRICT desire OWNER to limit or attempt to limit the 100-year downstream discharge to the planned 100-year discharge, PARKER and/or DOUGLAS and/or DISTRICT shall pay, in advance, all costs attributable thereto, including but not limited to studies, revisions or additions to plans, physical changes to RESERVOIR or dam structures, and additional construction, subject to annual budget and appropriation. As used in this paragraph, "costs" includes construction, engineering, operation and maintenance, attorney's fees, court costs, and other direct or indirect costs.

6. NOTICE

OWNER shall notify PARKER, DOUGLAS and DISTRICT, in writing, of any plans to make physical changes to RESERVOIR. To take advantage of the opportunity referred to in Paragraph 2, PARKER, DOUGLAS and/or DISTRICT must notify OWNER, in writing, of their intention to do so promptly upon reciving written notification of OWNER's plans to make physical changes to RESERVOIR, and in no event more than 90 days after being notified.

A. The NOTICE contact for OWNER shall be the Chair of the Parker Water & Sanitation District Board of Directors, 18100 East Woodman Drive, Parker, Colorado 80134.

B. The NOTICE contact for PARKER shall be the Director of Public Works, 20120 East Main Street, Parker, Colorado 80138.

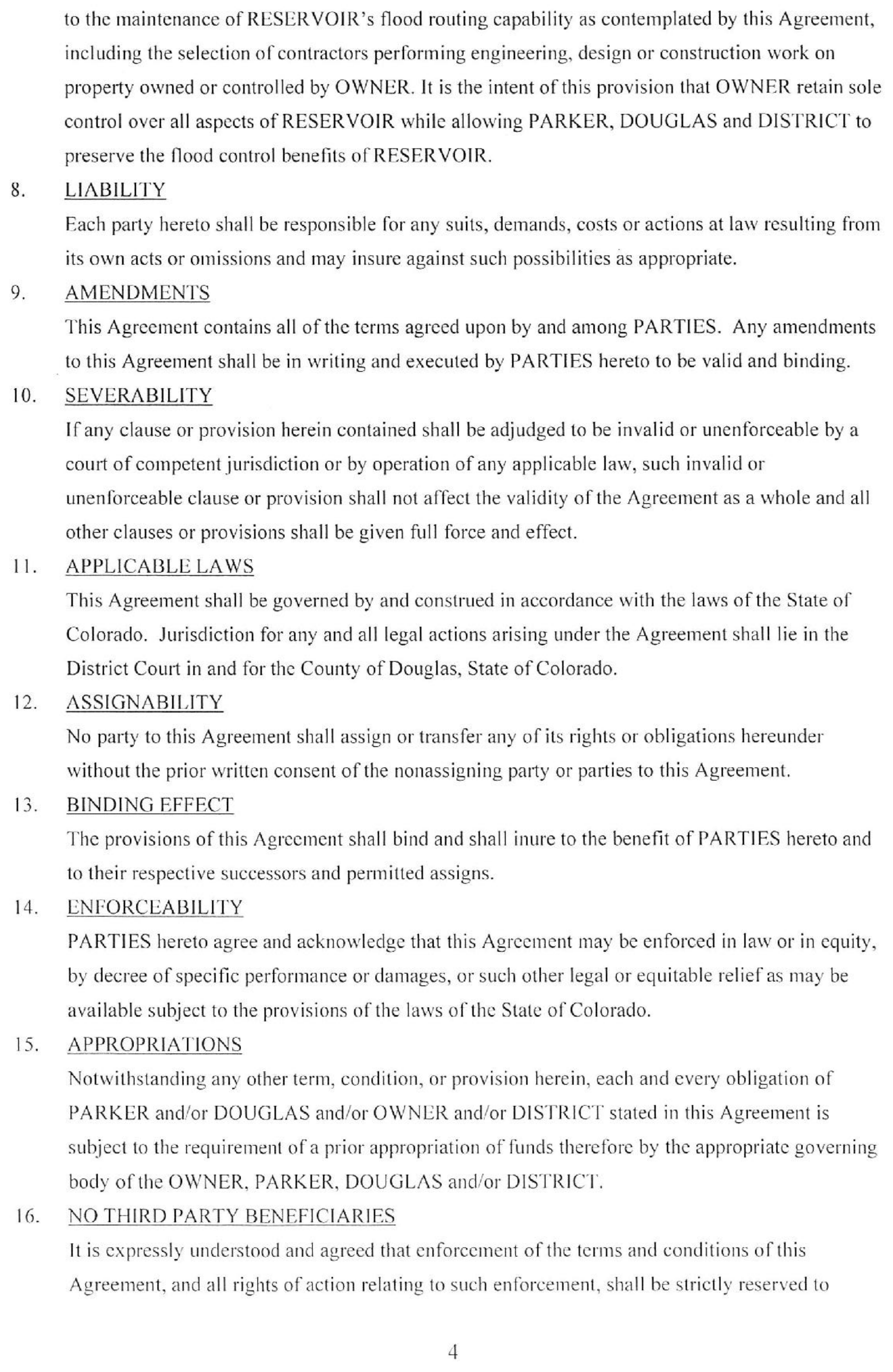
C. The NOTICE contact for DOUGLAS shall be the County Engineer, 100 Third Street, Castle Rock, Colorado 80104.

D. The NOTICE contact for DISTRICT shall be the Executive Director, 2480 West 26th Avenue, Suite 156B, Denver, Colorado 80211.

E. Any notices, demands or other communications required or permitted to be given by any provision of this Agreement shall be given in writing, delivered personally or sent by registered mail, postage prepaid and return receipt requested, addressed to PARTIES at the addresses forth above or at such other address as either party may hereafter or from time to time designate by written notice to the other party given when personally delivered or mailed, and shall be considered received in the earlier of either the day on which such notice is actually received by the party to whom it is addressed or the third day after such notice is mailed.

7. OWNER APPROVAL

Notwithstanding any provision herein to the contrary, OWNER retains the right to approve, reject, or approve with conditions, in OWNER's sole discretion, any plans of PARKER, DOUGLAS or DISTRICT to maintain the flood routing capability of RESERVOIR; provided that OWNER shall inform PARKER, DOUGLAS and DISTRICT in writing of OWNER's reasons for a rejection or a conditional approval. OWNER further retains the right to manage all aspects of any work relating to the maintenance of RESERVOIR's flood routing capability as contemplated by this Agreement, including the selection of contractors performing engineering, design or construction work on property owned or controlled by OWNER. It is the intent of this provision that OWNER retain sole control over all aspects of RESERVOIR while allowing PARKER, DOUGLAS and DISTRICT to preserve the flood control benefits of RESERVOIR.



8. LIABILITY

Each party hereto shall be responsible for any suits, demands, costs or actions at law resulting from its own acts or omissions and may insure against such possibilities as appropriate.

9. AMENDMENTS

This Agreement contains all of the terms agreed upon by and among PARTIES. Any amendments to this Agreement shall be in writing and executed by PARTIES hereto to be valid and binding.

10. SEVERABILITY

If any clause or provision herein contained shall be adjudged to be invalid or unenforceable by a court of competent jurisdiction or by operation of any applicable law, such invalid or unenforceable clause or provision shall not affect the validity of the Agreement as a whole and all other clauses or provisions shall be given full force and effect.

11. APPLICABLE LAWS

This Agreement shall be governed by and construed in accordance with the laws of the State of Colorado. Jurisdiction for any and all legal actions arising under the Agreement shall lie in the District Court in and for the County of Douglas, State of Colorado.

12. ASSIGNABILITY

No party to this Agreement shall assign or transfer any of its rights or obligations hereunder without the prior written consent of the nonassigning party or parties to this Agreement.

13. BINDING EFFECT

The provisions of this Agreement shall bind and shall inure to the benefit of PARTIES hereto and to their respective successors and permitted assigns.

14. ENFORCEABILITY

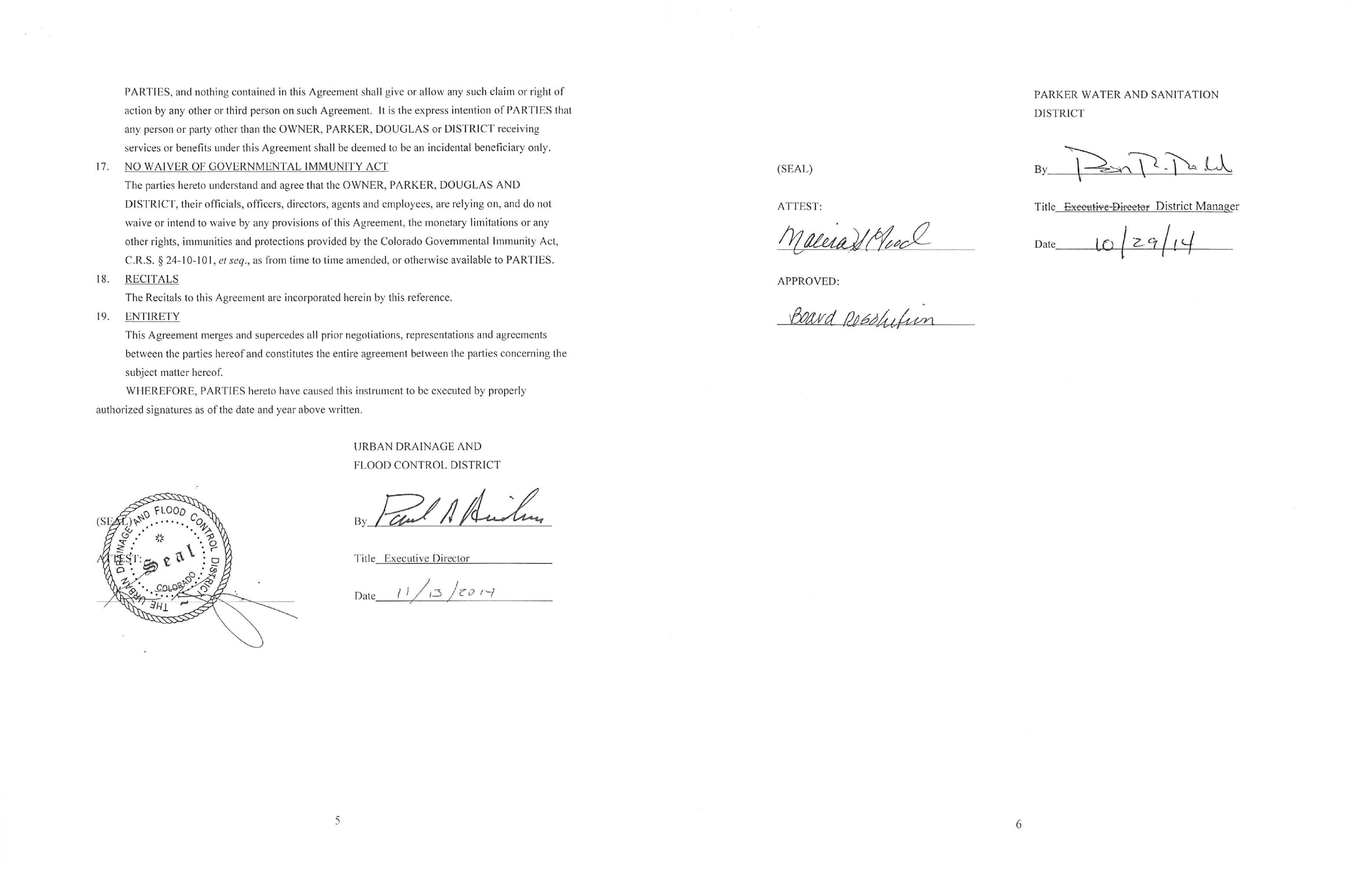
PARTIES hereto agree and acknowledge that this Agreement may be enforced in law or in equity, by decree of specific performance or damages, or such other legal or equitable relief as may be available subject to the provisions of the laws of the State of Colorado.

15. APPROPRIATIONS

Notwithstanding any other term, condition, or provision herein, each and every obligation of PARKER and/or DOUGLAS and/or OWNER and/or DISTRICT stated in this Agreement is subject to the requirement of a prior appropriation of funds therefore by the appropriate governing body of the OWNER, PARKER, DOUGLAS and/or DISTRICT.

16. NO THIRD PARTY BENEFICIARIES

It is expressly understood and agreed that enforcement of the terms and conditions of this Agreement, and all rights of action relating to such enforcement, shall be strictly reserved to



PARTIES, and nothing contained in this Agreement shall give or allow any such claim or right of action by any other or third person on such Agreement. It is the express intention of PARTIES that any person or party other than the OWNER, PARKER, DOUGLAS or DISTRICT receiving services or benefits under this Agreement shall be deemed to be an incidental beneficiary only.

17. NO WAIVER OF GOVERNMENTAL IMMUNITY ACT

The parties hereto understand and agree that the OWNER, PARKER, DOUGLAS AND DISTRICT, their officials, officers, directors, agents and employees, are relying on, and do not waive or intend to waive by any provisions of this Agreement, the monetary limitations or any other rights, immunities and protections provided by the Colorado Governmental Immunity Act, C.R.S. § 24-10-101, *et seq*., as from time to time amended, or otherwise available to PARTIES.

18. RECITALS

The Recitals to this Agreement are incorporated herein by this reference.

19. ENTIRETY

This Agreement merges and supercedes all prior negotiations, representations and agreements between the parties hereof and constitutes the entire agreement between the parties concerning the subject matter hereof.

WHEREFORE, PARTIES hereto have caused this instrument to be executed by properly authorized signatures as of the date and year above written.

URBAN DRAINAGE AND
FLOOD CONTROL DISTRICT

(SEAL)

By Paul A Hindman

ATTEST:

Title Executive Director

Date 11/13/2014

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PARKER WATER AND SANITATION
DISTRICT

(SEAL)

By Ron R. Redd

ATTEST:

Marcia Mead

Title ~~Executive Director~~ District Manager

Date 10/29/14

APPROVED:

Board Resolution

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TOWN OF PARKER

(SEAL)

By____________________
Mike Waid
Title__Mayor________________
Date 10/6/14

ATTEST:

Carol Baumgartner
Carol Baumgartner, Town Clerk

APPROVED:

James S. Maloney
James Maloney, Town Attorney

BOARD OF COUNTY COMMISSIONERS
OF THE COUNTY OF DOUGLAS

BY: ____________________
DOUGLAS J. DEBORD, County Manager

APPROVED AS TO FISCAL CONTENT:

Andrew Copland
ANDREW COPLAND, Finance Director

APPROVED AS TO LEGAL FORM:

Kristin Decker
KRISTIN DECKER, Asst. County Attorney

AGREEMENT REGARDING THE INTENT TO
ASSURE THE FLOOD ROUTING CAPABILITY OF
RUETER-HESS RESERVOIR IN DOUGLAS COUNTY

Agreement No. 13-

<u>EXHIBIT A: LOCATION</u>