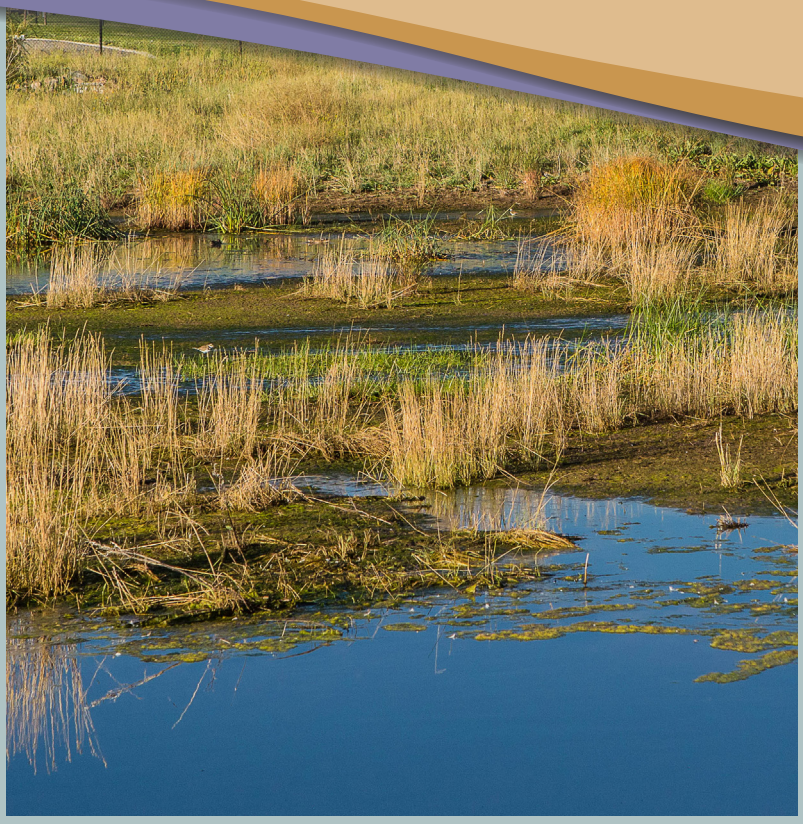
CONSULTING ENGINEERS

Town of Mead
Stormwater Master Plan

February 2019



Prepared For:

Town of MEAD

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EXECUTIVE SUMMARY

The Town of Mead (Town) is located in Weld County, CO approximately 35 miles north of Denver along Interstate 25 (I-25). The Town is a small, but growing community, with a current population of approximately 4,400 people and a developed area of approximately 2,230 acres. The current Town limits encompass a 12.4 square-mile area situated south of CR42, west of CR17, north of CR26 and St. Vrain Creek, and east of E County Line Road. The Stormwater Master Plan (Plan) study area was established based on the Town's Planning Influence Area Boundary and JVA's analysis of the watershed boundaries in the area. The study area is 38.1 square-miles and is located within the same roadway boundaries as the existing Town limits. The existing Town limits, the Plan's study area, and the thirteen major drainage basins are shown in Figure 1.

The purpose of the Stormwater Master Plan is to provide the Town with a comprehensive analysis of the designated study area that will allow for the Town and developers to understand the existing drainage patterns, 100-year runoff flows, and infrastructure capacity for the watershed tributary areas impacting the Town and its future expansion areas. Major drainage basins and their subbasins are defined by the topography of the land and are only interrupted by man-made infrastructure that require stormwater conveyances to transport flow downstream. The Plan will provide the Town with a starting point for the development process to provide guidance and knowledge to developers and land owners on the current stormwater flows, infrastructure conditions, and future requirements. Currently, the Town's storm system is not a regulated Municipal Separate Storm Sewer System (MS4) due to the Town's population. However, as concern for water quality in water bodies continues to increase, regulations may change, and the Town's system could be designated as an MS4 and be required to obtain a National Pollutant Discharge Elimination System (NPDES) permit. The NPDES permit requires the Town to establish a program to monitor, control, and treat stormwater runoff as well as educate and engage the community in the Town's efforts. As regulations change, the stormwater standards for the Town and this Plan will need to be updated.

The data compiled to complete the report will provide the Town with a database in ESRI Geographic Information Software (GIS) of the identified storm infrastructure and the delineated basin hydrology. The knowledge provided in the Plan and database will be used to create maintenance and capital improvement budgets to help facilitate the proactive mitigation of stormwater needs. A near term capital improvement plan (CIP) was created to mitigate existing major stormwater concerns within the Town along with cost estimates to maintain the existing system and provide future improvements as development occurs.

The Plans goals are to provide the Town with a document that will allow the Town to make informed decisions on drainage outfall locations and sizing requirements. The focus of the study is to:

- Document and quantify historic runoff peaks for the delineated subbasin within the study area
- Inventory and analyze the performance of existing public infrastructure at design points for each subbasin

- Define drainage development criteria for each subbasin to be used for design consideration and development within the subbasin
- Identify and prioritize infrastructure improvements for the CIP

The Plan, associated models, and mapping system should be viewed as a changeable working document that is reviewed and updated as areas are developed, infrastructure is updated, and flooding issues are reported to record the improvements that have been made to the drainage systems.

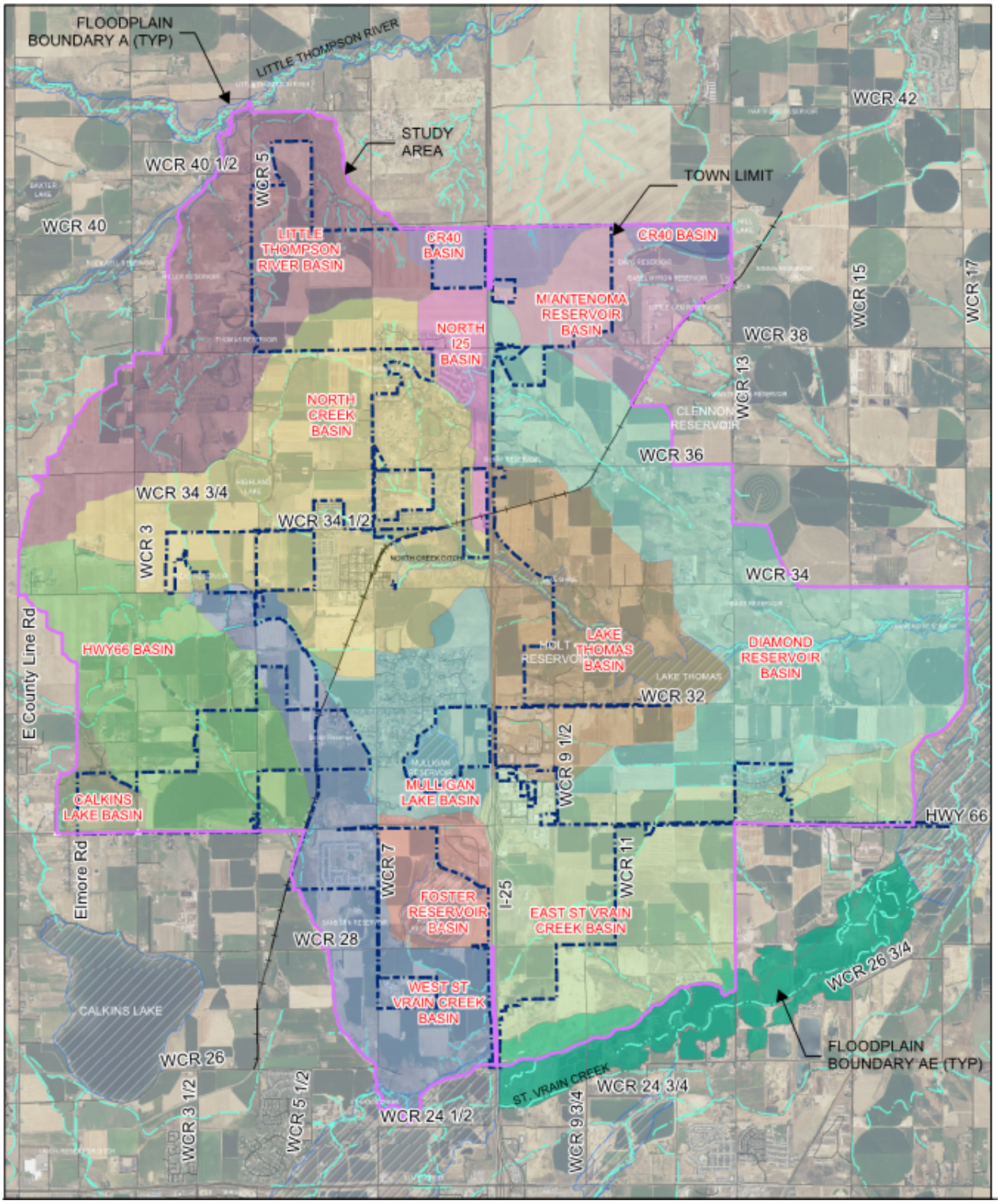

FIGURE 1. TOWN OF MEAD STORMWATER MASTER PLAN STUDY AREA AND MAJOR BASINS

SECTION 1 – INTRODUCTION

AUTHORIZATION

This report was authorized by the Town of Mead Board of Trustees under the April 2017 letter agreement regarding "Town of Mead Stormwater Master Plan Update". Notice to proceed was provided verbally by the Town of Mead Public Works Director in September 2017.

PROJECT INTENT AND SCOPE

The Plan's purpose was to update existing information in the Town's 1998 Drainage Master Plan by the Sear-Brown Group and its 2007 Addendum by JR Engineering to the current Town standards and design practices and to extend the study area to encompass the watershed tributaries that have potential to be within the Town limits in the future. The Plan will be used as an evolving document for the Town and developers to understand the drainage patterns within the study area, the capacity of the subbasin outlet infrastructure, and the condition and constraints of the analyzed stormwater infrastructure. The Plan will allow the Town to make informed decisions on drainage discharge locations and sizing requirements. The focus of the study is to:

- Document and quantify historic runoff peaks for the delineated subbasins within the study area
- Inventory and analyze the performance of existing public infrastructure at design points for each subbasin
- Define drainage development criteria for each subbasin to be used for design consideration and development within the subbasin
- Identify and prioritize infrastructure improvements for the CIP

The Plan will use the 1998 Master Plan and the 2007 addendum as a starting point with the understanding that the basic engineering means and methods for calculating stormwater runoff and the rainfall data for the area have changed. The available information on culvert and pipe inverts, sizes and materials from previous documents were used in the Plan when updated data was not available. The adjustments to the subbasin boundaries and the advances in the calculation methodology restricted the comparison analysis between the reports to a perfunctory analysis. The Plan utilizes LiDAR data, aerial imagery, survey data, property data, and field observation data from 2013 through 2018. The Town's 2018 Standards and Specifications were followed for the existing system hydrologic calculations and the developed peak runoff requirements.

During the winter of 2017-2018, Flatirons Inc. and Town staff completed an inventory of the culverts under major roadways throughout the proposed study area to better delineate the subbasins. While only the design point outlet infrastructure is being hydraulically analyzed, the available storm infrastructure from the study survey and observation reports, subdivision construction documents, and the original master plans will be used to create a complete GIS

database to retain the gathered information for use in the future. The tributary basin and subbasin data, the hydrologic inputs, and results, will also be housed in this database.

MAPPING AND SURVEY

Data was compiled on the study area's topographic conditions, land use, and storm conveyance elements to complete the Plan. All the acquired data is being documented in GIS and/or AutoCAD for future use. The data includes LiDAR data for contours and surface elevations, aerial imagery and Google Earth Pro's street view, survey data and site observations, existing construction documents, drainage reports and the original master plan and its addendum. The coordinate system used in GIS and AutoCAD mapping is NAD83, Colorado North and NAVD88.

The main source of topographic data was the 2013 LiDAR data. The files were downloaded from the Colorado Geological Survey website that has since moved to The Colorado Water Conservation Board Colorado Hazard Mapping & Risk MAP Portal. The contours from the LiDAR data were used to delineate the study area boundary, major basin and subbasin boundaries, the basin drainage pathways, and the project mapping, and hydrologic and hydraulic analysis. When there was no outlet information available for subbasin design points, the LiDAR data was also used to assume invert elevations.

The Weld County 2015 aerial imagery and 2016 aerial data in ArcMap's basemap data from DigitalGlobe and the AutoCAD live Map Data, which uses the Microsoft Bing Maps Platform, were all used for the land use and imperviousness analysis for existing conditions once the subbasins were delineated. The aerial imagery was also used to determine the drainage pathways based on visual analysis in conjunction with the LiDAR data. The GIS aerial imagery was also used for mapping purposes. Google Earth Pro's street view was used when more data was necessary to complete the hydraulic analysis of the subbasins outlet structures, to locate an outlet, provide more information on the outlet, confirm site observations, and/or determine pipe material.

Survey data was completed by Flatirons Inc. in December of 2017 and January of 2018 at identified basin outfall locations to obtain pipe diameters, inverts, and ditch cross-sections. Staff measurements were completed upon request during the spring of 2018 to acquire outfall information as the study area increased. The collected data was imperative for the hydraulic analysis and in determining the capacity and flooding potential within the drainageways at outfalls of the subbasins. An inventory of the pipes that were surveyed and identified for the study are included in the Town's GIS database with notes on how the information was gathered.

Development records including construction documents and drainage reports were used when available to determine the drainage patterns and storm infrastructure within a subbasin. Most of the drainage reports for the developed subdivisions were not available and updated information on how the subdivision systems are functioning should be completed in the future. The storm infrastructure data available in the original master plan and addendum were used to confirm assumptions and provide infrastructure information as needed.

DATA COLLECTION

The storm infrastructure data available from the Town was collected and analyzed for the Plan. There are missing records for several of the developed subdivisions and downtown area drainage. The Plan is focused on major drainage systems. Available data for detention and pipe infrastructure will be included in the GIS database for future reference and will continue to be populated. The primary references used for this study include:

- Town of Mead Drainage Master Plan, 1998, Sear-Brown Group
- Town of Mead Addendum to the Drainage Master Plan, 2007, JR Engineering
- Town of Mead GIS Mapping Data including parcel data, subdivisions, zoning and planning area map, floodplain mapping, and hydrology, 2015-Present, FEMA.gov, Weldgov.com, Town of Mead
- Town of Mead Standards and Construction Specifications, 2018
- Urban Drainage Flood Control District (UDFCD) Criteria Manual, 2018

Acknowledgements

This report was prepared with the cooperation of the Town of Mead. The representatives who were involved in this study are listed in the following table:

Table 1. Project Participants

Name	Representing	Title
Erika Rasmussen, P.E.	Town of Mead	Town Engineer and Public Works Director
Chris Larmon (Former Employee)	Town of Mead	Operations Manager
Helen Migchelbrink, P.E.	Town of Mead	Town Manager
Kenneth Clifford, P.E.	JVA, INC	Town of Mead Engineer
Kevin Tone, P.E.	JVA, INC	President
Brian Campbell, P.E.	JVA, INC	Senior Project Manager
Laurie Trifone	JVA, INC	Project Engineer
Matt Gardner	JVA, INC	Design Engineer

SECTION 2 – STUDY AREA DESCRIPTION

PLANNING AND STUDY AREA

The study area was defined by natural watersheds that fit within the area that the Town outlined as their designated boundary. The boundary was determined based on the area that could potentially be within the Town limits in the future or influence the Town's drainage. The 38.1 square-mile study area includes basins that are tributary to St. Vrain Creek and Little Thompson River. The area falls between E County Line Road to the west, Weld County Road 42 to the north, Weld County Road 17 to the east, and St. Vrain Creek to the south. The study area was defined using ridges, valleys, drainage channels, streams, ditches, and roads and is shown in Appendix D and Figure 1.

Existing public and private drainageways in the Town and surrounding areas are comprised of open channel ditches, culverts at road and drive crossings, and underground storm sewer systems. The concentrated flows in ditches and open channels are more characteristically in rural areas and the underground infrastructure tends to be in more urban areas. Observations and information from the Town indicates that there are several locations where the drainage conveyance systems need to be maintained and are possibly undersized for larger storm events. Most of the existing conveyance infrastructure is undersized to transport the 100-year peak flows and peak routed flows. With only approximately 2,230 acres of the Town and study area currently developed, there is opportunity to mitigate the subbasin outfall capacity issues as development occurs.

LAND USES AND FUTURE DEVELOPMENT

The study area watersheds are composed of the hydrologic soil groups (HSG), A, B, C, and D as classified by the Natural Resources Conservation Service, and is attached as Appendix D. The HSG's are spread throughout the area with most of the study area having HSG B at 54% and HSG C at 31%. HSG A and HSG D comprise only 6% and 5% of the study area, respectively. HSG A and D are located mostly at the banks and around the floodplain areas of the drainage channels. The existing developed Town limits and other developed areas including the region along I-25 are mostly located in HSG B. HSG C is found more in the farm lands and open rural space areas. Overall, all the soil groups are intermixed throughout the study area. The study encompasses a large area, and to provide a comprehensive analysis without requiring averaging the HSG in each subbasin, it was assumed all subbasins were HSG C. The assumption provides a conservative approach to the runoff analysis. More specific drainage analyses with averaged HSG's should be used at individual sites as development occurs.

The Town's Official Zoning map and potential 10-year growth areas establish land use categories for undeveloped land within the town limits and urban growth area. The current land use in developed areas is low density residential with most being estate lots or one dwelling per acre lots. The Town proper is a relatively small area of small business and high density residential areas. There is also a small area of light industrial located to the east of the Town. Commercial development is mainly located to the east of I-25, between CR32 and CR28 and west of CR9 1/2. The rural land use is mainly farmland or grazing with homesteads and gravel access roads.

Most zoned areas in the Town's 12.4 square mile area are residential with 4 lots per acre and 1 lot per acre with pockets of commercial and light industrial areas. The other 25.7 square miles of study area do not have zoning or planned use. Town design standards require the developed peak 100-year runoff rate be decreased to 90% of the calculated existing 100-year peak runoff rate. Since there is a large area with unknown zoning, and zoning can be changed dependent on the developers and Town's desires, the Plan does not calculate developed runoff based on the zoned use, but on the existing capacity of the subbasins outfall pipe, available ponding volume at the subbasin outfall from LiDAR data, and the Town design standards.

Outfall Description and Receiving Waters

There are twelve major outfalls identified within the study boundary which are broken down further into subbasins and discussed in Section 4 of the report. The thirteen major basins and outfalls are the Little Thompson River Basin, CR40 Basin, North Creek Basin, HWY66 Basin, Foster Reservoir Basin, Mulligan Lake Basin, North I-25 Basin, West St. Vrain Creek Basin, Calkins Lake Basin, Diamond Reservoir Basin, Lake Thomas Basin, East St. Vrain Creek Basin, and Miantenoma Reservoir Basin. Watershed boundaries were established and defined by the area draining to a major outfall, which was generally a receiving water, a reservoir or lake, or a major roadway (I-25, Highway 66, or CR40). As most of the study area is undeveloped farmland and open space, runoff is generally conveyed via overland flow to unnamed drainage channels. Within the developed areas, most runoff is transported through roadside swales, curb and gutter, and storm conveyances.

There are two major receiving waters for the study area, Little Thompson River to the north and St. Vrain Creek to the south, with both ultimately draining to the South Platte River. Runoff from the Little Thompson River Basin and the CR40 Basin drains to the North into the Little Thompson River.

The North Creek Basin, North I-25 Basin, Mulligan Lake Basin and Foster Reservoir Basin all have outfalls at I-25 that transport flows to the east into other basins where runoff is eventually transported to the St. Vrain Creek, which is a tributary to the South Platte River.

The HWY66 Basin, Calkins Lake Basin, and West St. Vrain Basins all drain to the south, either directly into the St. Vrain Creek, or into drainage systems that ultimately reach the St. Vrain Creek. Highway 66 was determined to be the southeastern boundary for the study area and defined the southern boundary for the HWY66 Basin. The West St. Vrain Basin was bound by an unnamed drainage channel that defines its boundary and a portion of the study areas western boundary. The entire tributary for the West St. Vrain Basin is therefore not analyzed in this study.

On the east side of I-25, the Miantenoma Reservoir Basin only contains a portion of the entire watershed tributary area that drains to the Reservoir because the basin is bound by the Great Western Railroad. The railroad was chosen as a western boundary because of its ability to create a distinct eastern boundary for the study area that conformed to the Town's desires. There are four outfalls that transport flows under the railroad tracks that drain into channels which discharge into the Miantenoma Reservoir.

The Lake Thomas Basin collects flows from the North Creek Basin, North I-25 Basin, and the Mulligan Reservoir Basin. The Lake Thomas Basin outfalls into the Diamond Reservoir Basin, which in turn discharges into the St. Vrain Creek via a drainage channel and culvert under CR17.

The East St. Vrain Creek Basin collects flows from the Foster Reservoir Basin and drains to the south. The basin has multiple outfalls that discharge into the St. Vrain Creek. CR13 and HWY66 were determined to be boundary limits for the study areas southeast corner by the Town, and the remaining basin area was excluded from the analysis.

FEMA Floodplains and Flood History

Investigation of the floodplains within the Town and the Plan study area was completed for the Plan. The water features identified by FEMA with floodplain boundaries include the North Creek Ditch floodplain, Big Hallow, Little Thompson River, St. Vrain Creek, Mulligan Reservoir, Foster Reservoir, Lake Thomas, and Diamond Reservoir. The identified floodplain for all but St. Vrain Creek are designated Flood Zone A, special flood hazard areas subject to inundation by the 1% annual flood with no base flood elevation (BFE) determined. St. Vrain Creek is designated Flood Zone AE. The floodway is a channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights. Zone A signifies that the 100-year floodplain elevation is not defined, but there is flooding that discharges outside of the drainage channels banks. Most of the major drainage systems within the Plan area are unnamed channels that are not denoted with a Flood Zone by FEMA. The available FEMA floodplain maps for the area are attached in Appendix D.

There has been reported flooding at nineteen different locations throughout the Town. Town staff provided the locations of the flooding, mainly along roadside ditches, but did not include detailed information on the extent and source of the flooding. Investigation indicated that most of the flooding occurred due to poorly maintained culvert and roadside ditches. As part of the CIP analysis, each of the reported flood areas was explored and funding is included in the maintenance estimate, improvements estimate, or CIP project estimate. A map of the reported flood areas and flood hazard areas is included in Appendix D, called Floodplain and Reported Flooding Areas.

SECTION 3 – HYDROLOGIC APPROACH

OVERVIEW

The Plan updates the Town's previous drainage master plan study areas and hydrology calculations based on updated land use characteristics, design standards, and calculation techniques. In Section 4 of this report, a description of hydrologic characteristics, and results are provided for the delineated major basins and subbasins including figures of the subbasin delineations and routing assumptions. The Colorado Urban Hydrograph Procedure (CUHP) version 2.0.0, released September 9, 2016, was used to develop 100-year event runoff hydrographs for each subbasin and determine the peak runoff rate and time for each subbasins. The EPA Stormwater Management Model (SWMM) was used to model the hydrologic conditions at the outfall locations. Microsoft Excel was used to calculate the routed hydrograph at each subbasin outfall location.

The Plan's purpose was to delineate the watershed tributary areas and their subbasins, determine the routing through the subbasins, identify the outfall locations and infrastructure, analyze how the 100-year event functions at the outfalls, and determine what the developed design rates for each subbasin can be based on the existing condition analysis. Of the 38.1 square miles, only 12.4 square miles are within the Town limits and are required to follow the Town Standards and Design Specifications. However, when development does occur outside of the Town limits the areas will most likely be annexed into the Town and be required to follow Town stormwater standards.

The study area was split into 13 major basins that follow seven major drainage pathways through the basins. There are 178 subbasins included in the hydrologic analysis. The average watershed area is 137 acres with the smallest subbasin at 2.3 acres and the largest subbasin at 1,011.2 acres. Following Urban Drainage Flood Control District criteria manual recommendations, a 5-minute hydrograph was used in CUHP based on the average size of the subbasins.

DESIGN RAINFALL

The Town Standards and Design Specifications used the depth-duration frequency information provided in the Precipitation-Frequency Atlas of the Western United States (Volume 2 - Colorado), published by National Oceanic and Atmospheric Administration (NOAA), to determine the precipitation depths for the Town. The UDFCD Criteria Manual does include rainfall data for the Town of Mead. The NOAA Atlas can be accessed on the NOAA website. The one-hour rainfall depth for the 100-year storm event is 2.78-inches.

SUBBASIN CHARACTERISTICS

The subbasin characteristics were determined using LiDAR and aerial information from GIS and AutoCAD provided mapping. Areas outside of the major basin tributaries defined by the study area were not included in the analysis. There are instances where the subbasin boundary and study area boundary is a drainage channel. The entirety of the tributary flows to the drainage channels were not calculated and should not be used as the channel's total peak flows. All canals and

irrigation ditches were assumed to be flowing full during the analysis and have no influence on the stormwater drainage.

The 2013 LiDAR 1-foot contours were used to delineate the subbasin boundaries and determine the flow paths and slopes of each subbasin. The required CUHP input, the distance from the centroid of the basin to the outfall via the flow path, was also determined using AutoCAD. CUHP was run to calculate the existing subbasin runoff peaks, time to peak, and storm hydrographs for the 100-year events. Recommended values from the Urban Storm Drainage Criteria Manual (USDCM) were used for the average infiltration rates and depression storage values depending on the observed land use.

Imperviousness for the subbasins was calculated using aerial imagery from GIS and AutoCAD, which reference imagery from DigitalGlobe and Microsoft Bing Maps Platform, respectively. The land use percent imperviousness was taken from the Town of Mead Standards, which uses the UDFCD Criteria Manual suggested values. The developed percent imperviousness was not calculated based on zoned land use because the Town of Mead Standards required the developed peak 100-year runoff rate to be 90% of the existing peak 100-year runoff rate. Therefore, the developed percent imperviousness will not affect the required discharge rate from the site. The input parameters to the CUHP model are provided in Appendix B.

Hydraulic Methodology and Hydrograph Routing

The CUHP program was used to create storm hydrographs for each of the 178 subbasins within the study area. The resulting storm hydrographs and time to peak values were used to determine routed flows at the design point of each subbasin. The subbasin routing was completed in Microsoft Excel. The routed peak flow hydrographs to each design point is a summation of all contributing upstream subbasin storm hydrographs. The time to peak for each subbasin was used as the travel time from design point to design point. Therefore, the routed start time for each subbasins hydrograph is the accumulation of time to peaks through each upstream subbasin that contributes flow to the design point being analyzed. This methodology of routing flows via peak travel times assumes a consistent travel time for any given flow path through each subbasin. Furthermore, the approach assumes that the storm hydrographs are not attenuated downstream and the peaks are not decreased due to undersized infrastructure and ponding. It is believed that this approach to routing stormwater flows will overestimate the routed flows throughout the study area. The routed flows may be used as conservative peak flow rates to the subbasin outfalls. As development occurs, more detailed modeling and analysis should be completed for individual storm reaches within the impacted subbasins.

EPA-SWMM was used to analyze the ponding area and outfall capacity of the subbasin outfalls at each design point. The stage-storage curves for individual ponding areas entered into the SWMM models were taken from the recent LiDAR data. It is assumed that the water surface area of reservoirs or lakes are the elevation of the lowest contour of the LiDAR data. This assumption could under or over-estimate the available volume in the analyzed reservoirs and lakes. Therefore, it was also assumed that all Reservoirs, Lakes and ponding areas at outfalls will discharge downstream and the downstream infrastructure is required to transport the peak routed flows. Culvert invert elevations and dimensions were determined by survey, site observations, the 1998 master plan and addendum reports, and LiDAR data.

SECTION 4 – FUTURE DESIGN CRITERIA

The Plan provides the allowable developed design 100-year peak flow rate for each of the subbasins. The flow rates were calculated based on the design capacity of the subbasin outfalls. The subbasin drainage analysis in the next section will provide the calculation method used and the required developed 100-year peak flow rate. The following outlines the possible design flow rate calculation methods based on the outfall capacity:

- If the outfall is adequately sized, the developed peak flow rate was calculated using the Town design standard of 90% of the calculated existing 100-year peak flow rate.

- If the outfall is not adequately sized to convey and store the peak stormwater flows from the subbasin, developers will be required to reduce the 100-year peak discharge rate to the allowable cfs/subbasin area.

- If the outfall is sized sufficiently for the subbasins existing 100-year peak runoff, but the routed peak flows are larger than the outfall capacity, the developed design flows for the subbasin will follow Town design standards of 90% of the calculated existing 100-year peak flow rate, but it will be required for any development in any subbasin upstream of the outfall to upsize the outfall to transport the calculated peak routed flow rate. The developer will work with the Town on the design and construction.

As development occurs within a subbasin, analysis of the effects to the downstream subbasin outfalls will be required to ensure there is available capacity in all the downstream outfalls and volume in any storage areas for the development flows. Many of the reservoirs, lakes, retention ponds, and ponding areas will likely require US Army Corp permits and upstream design impacts will need to be assessed before increased stormwater runoff volumes can be discharged into them.

The Plan does not address water quality requirements within the subbasins. It is the responsibility of the developer to meet Town water quality standards and coordinate with the Town on acceptable water quality treatment facilities. Currently, the Town's storm system is not a regulated MS4 due to the Town's population. However, as concern for water quality in water bodies continues to increase, regulations may change, and the Town's system could be designated as an MS4. The Town would then be required to obtain a NPDES permit and establish programs to monitor, control, and treat stormwater runoff for new and existing systems. As regulations change, the stormwater standards for the Town and the Plan will be updated to meet the increased regulations.

SECTION 5 – DRAINAGE ANALYSIS AND RESULTS

The drainage analysis includes a description and flow analysis of each subbasin by calculating the existing and developed 100-year rainfall event peak runoff flow rates and routed peak runoff flow rates at the outfall locations of the subbasins. The results include the evaluation of the capacity of the outfalls for the 100-year event and required developed 100-year flow rates based on that capacity. As most of the study area is outside of the Town boundary and zoning limits the developed analysis will specify what the developed peak flow rate can be using the Town standards and the capacity of the outfall system.

Major Basins

The major basins within the study area were delineated by natural and unnatural boundaries provided by roads, streams, creeks, ditches, reservoirs, and ridgelines. There is a total of thirteen (13) major basins delineated based on major outfall locations. Four of the major basins have been previously delineated and analyzed in both the original drainage master plan and its addendum. These include the North Creek Basin (NCB), Mulligan Lake Basin (MLB), North I-25 Basin (NI25B), and Foster Reservoir Basin (FRB). The other nine basins are CR40 Basin (CR40B), Diamond Reservoir Basin (DRB), East St .Vrain Creek Basin (ESVCB), West St. Vrain Creek Basin (WSVCB), HWY66 Basin (H66B), Lake Thomas Basin (LTB), Little Thompson River Basin (LTRB), Calkins Lake Basin (CLB), and Maintenoma Reservoir Basin (MRB). Each major basin was delineated based on its outfall location and encompasses as much of the watershed tributary area while maintaining the Town's identified study area limits.

SUBBASINS

The subbasins within each major basin were determined based on the location of the smaller outfalls within the major basin. The outfalls were either a road crossing with or without a culvert, a confluence of a stream or ditch, a detention pond, a dam/retention area, a reservoir, or a lake. The subbasin analysis will characterize in more detail the flows at crossings and key locations within the major basins. This examination will provide an analysis of the overall performance of drainage throughout the major basin. Since the study area and subbasin areas are extensive, it is still recommended that more in depth analysis, than the entire subbasin evaluation, occurs during development review to determine the effects of the existing and increased runoff volume and flows at the design point outfall locations and within the subbasins. Developed runoff flows for a subbasin can be reduced with regional and/or on-site detention basins. However, the developed runoff volumes can only be reduced with infiltration methods that might not be implemented or possible within the development area or downstream. Therefore, being cognizant of the increased volumes and the effects they have on the downstream systems should be a priority with new developments and planned improvements within the study area.

NORTH CREEK BASIN

The North Creek Basin (NCB) contains 29 subbasins that all drain to an outfall on the west side of I-25 located north of CR34. NCB is located to the west of I-25, east of E. County Line Road,

north of CR32 and south of CR42. The basin boundary is mostly defined by the natural topography of the land with only a few areas where a road or irrigation ditch defines the boundary. There are two main watershed branches within the basin. The southeastern watershed drains mostly west to east into the North Creek Ditch, while the northern watershed drains generally from north to south into an unnamed drainage channel. The two branches combine at the basins outfall where flows are transported to the east under I-25 into the Lake Thomas Basin and ultimately drains into Lake Thomas. There are several locations within the NCB where reports of flooding have been provided to the Town due to several of the outfalls being undersized for larger storm events. The Supply Ditch, Mead Lateral, Farmers Extension Canal, Upper Highland Ditch, and several unnamed drainage channels are within the basin. CIP project 2 is within the NCB basin and is described in detail in Section 6. The NCB drainage map and schematic flow routing figures are provided below.

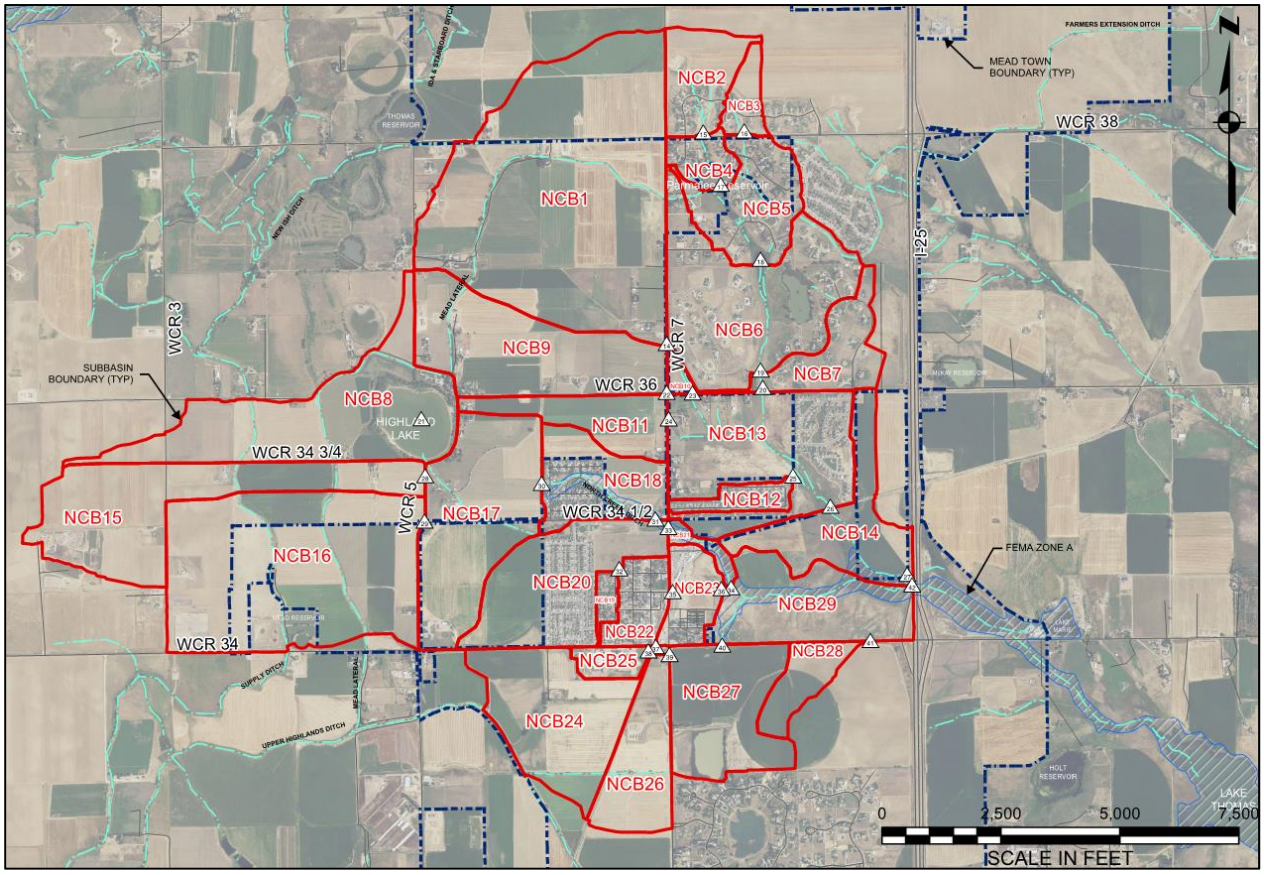

Figure 2. North Creek Basin Subbasin Map

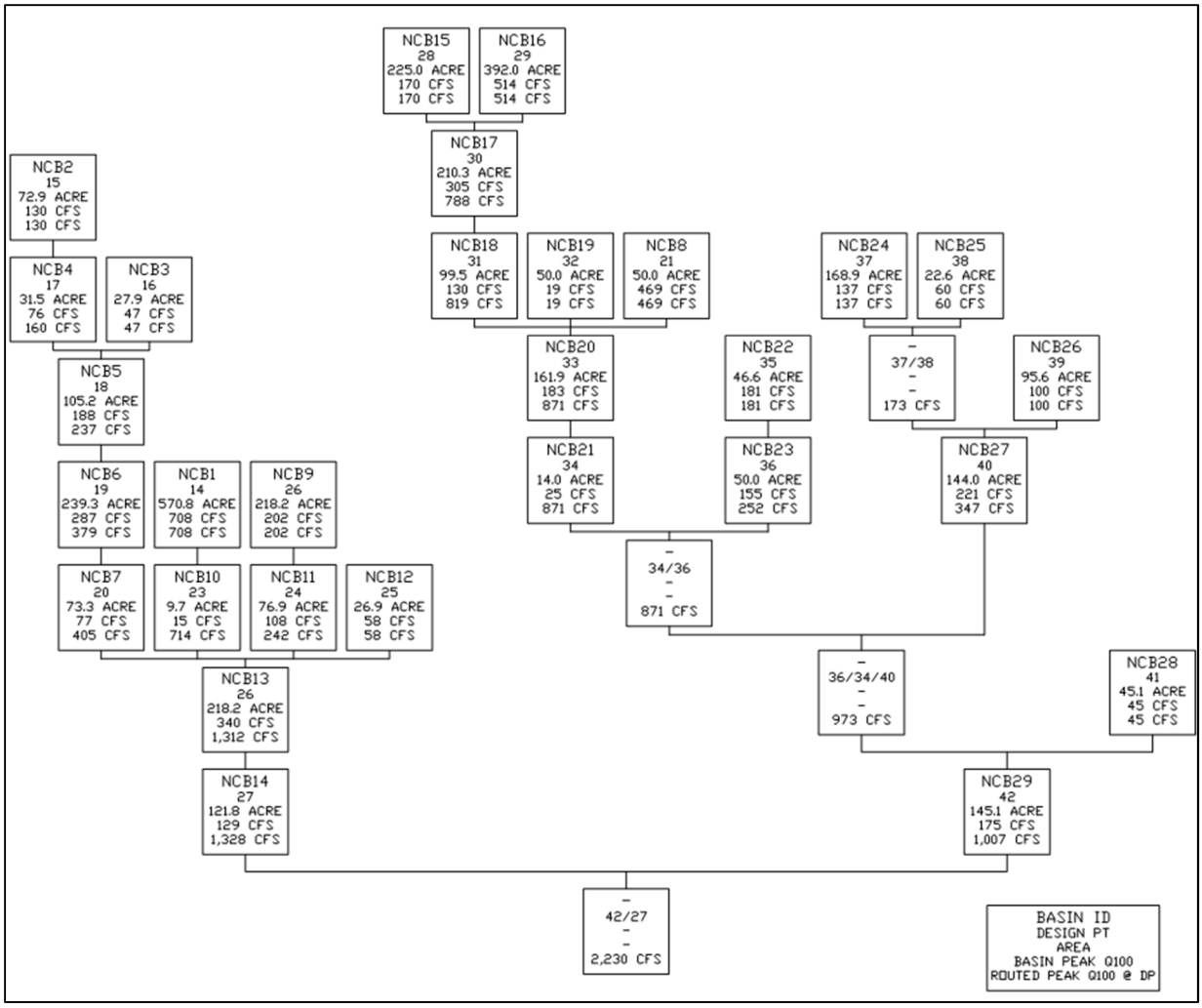

Figure 3. North Creek Basin Schematic Flow Routing

NORTH CREEK BASIN 1

Subbasin NCB1 is a 570.8 acre basin located between CR5 and CR7, north of CR36, and crosses CR38 where there has been reported flooding. The basin consists of mostly farmland with a few rural residential lots and farmsteads. NCB1 is bisected by the Mead Lateral, New Ish Ditch, and Farmers Extension Canal as well as CR38. There is an 18"x12" CMP pipe at a low spot along CR38 that could be utilized as a crossing for CR38 and break up the basin, but the drainage ditch along the north side of the basin needs to be better defined to be able to transport flows from the basin north of CR38 to the crossing. There is flooding occurring along CR38 due to the lack of a defined ditch which could be mitigated by defining the swale to drain to the existing pipe crossing.

According to the 1998 drainage report, the basins discharge pipe is a 60"x42" elliptical CMP crossing of CR7 north of CR36 into subbasin NCB10. Using dynamic wave modeling in SWMM, the pipe can only transport approximately 170 cfs, which is significantly less than the basin peak 100-year runoff of 708 cfs. There are two overflows at the outfall, to the south along the western roadside swale into subbasin NCB9 and to the west over the road into subbasin NCB10. All of the excess flow does drain to the south into NCB9 and perpetuates the flooding at the outfall of

NCB9. In order to transport the developed 100-year runoff at the basins outlet, the developed 100-year runoff rate is calculated at 0.28 cfs/acre. By reducing the flows from the basin as development occurs, flooding can be mitigated downstream. The basin outlet, overflow and downstream systems should be modeled to better understand the drainage system. The 1998 plan outlined that the discharge pipe for basin LTRB9 could be increased to mitigate the larger storm event flows from both NRC1 and NCB9. If the system downstream is upsized to transport effectively the upstream flows, the basins developed release rate could be increased to 90% of the existing developed runoff rate, 637 cfs, but further analysis and upsizing of system would need to occur before adjusting the recommended developed rate.

NORTH CREEK BASIN 2

Subbasin NCB2 is a 72.9 acre basin located north of CR38 and west of CR7 and contains a portion of Margil Farms Subdivision consisting of residential estate lots, farmland, and an oil and gas well station. Runoff drains to the south toward CR38 into drainage channels, and the northern roadside swale, which direct flows to a ponding area and the 24-inch RCP pipe outlet at CR38 that discharges flow downstream into subbasin NCB4. The 100-year runoff rate was calculated at 104 cfs. The outlet pipe can transport 45 cfs. According to the SWMM model, the ponding area and outlet are sized to capture and convey the peak 100-year runoff rates and should not flood CR38 during the 100-year event. The ponding area has a water surface elevation of 4979.0 feet and a top of pond elevation of approximately 4980.0 feet. The developed 100-year peak runoff rate for the entire basin was calculated at 130 cfs and the undeveloped areas should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 90% of the peak runoff rate. There has been flooding reported along the north roadside drainage swale of CR38 and the west roadside drainage swale of CR7 in the basin. This is the result of lack of maintenance of the swales and culverts under roads in the swale, including those in NCB1 along CR38 and CR7 which is largely contributing to the flooding at the intersection of CR38 and CR7.

NORTH CREEK BASIN 3

Subbasin NCB3 is a 27.9 acre basin located north of CR38 and contains a portion of Margil Farms Subdivision consisting of residential estate lots and farmland. Runoff drains to the south toward CR38 into drainage channels, and the northern roadside swale which direct flows to a ponding area and the 24-inch RCP outlet pipe at CR38 that discharges flow downstream into subbasin NCB4. The 100-year runoff rate was calculated at 47 cfs. The outlet pipe can transport 32 cfs. According to the SWMM model, the ponding area and outlet are sized to capture and convey the peak 100-year runoff rates and should not flood CR38 during the 100-year event. The ponding area has a water surface elevation of 4986.8 feet with a top of pond elevation of approximately 4989.0 feet. The developed 100-year peak runoff rate for the entire basin was calculated at 42 cfs and the undeveloped areas should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 90% of the peak runoff rate.

NORTH CREEK BASIN 4

Subbasin NCB4 is a 31.5 acre basin that located south of CR38 and east of CR7. The basin contains a portion of Highland Estates and is almost fully developed except for approximately 3 acres that is undeveloped land south of the subdivision. A drainage channel starting from the outlet pipe of NCB2 to Parmalee Reservoir collects runoff from NCB2 and NCB4 and drains to the south. The Farmers Extension Ditch is located to the north of the reservoir and runoff from the subbasin is assumed to bypass the ditch and drain into the reservoir by overtopping the ditch. The 100-year

subbasin peak runoff rate was calculated at 76 cfs and the routed flow rate was calculated at 160 cfs at the basin outlet. According to the SWMM model results and LiDAR data, the reservoir should not flood during the 100-year storm event. The reservoir's water surface elevation is 4947.4 feet and the top of the reservoir embankment is approximately 4950.0 feet. If the remaining undeveloped areas are developed, the peak runoff rate will be calculated at 90% of the existing 100-year peak runoff rate for the areas, with the total runoff from the subbasin calculated at 68 cfs. As the undeveloped areas and upstream basin develops, the reservoir will need to be reanalyzed to confirm it can store the increased runoff volume.

NORTH CREEK BASIN 5

Subbasin NCB5 is a 105.2 acre basin that is located downstream of NCB4 and NCB3 and contains a portion of Lake Hallow Estates and Highland Estates. NCB5 is fully developed with residential estate lots. The subbasin generally drains to the south and has two retention ponds within the drainage channel that collects runoff from the subbasin. The most southern retention pond acts as the outfall for the subbasin. There was no found outlet pipe for the retention pond, suggesting the embankment is the overflow and outlet for the pond, which is directed into subbasin NCB6. The peak runoff rate for the subbasin was calculated at 188 cfs and the routed peak runoff rates for the subbasin was calculated at 237 cfs. The SWMM model of the retention pond showed that the retention pond floods during the 100-year event and flows continue downstream into the defined drainage channel. If the basin were to be redeveloped, the developed peak 100-year runoff rate was calculated at 169 cfs and it is assumed the retention pond is supposed to flood downstream during larger storm events.

NORTH CREEK BASIN 6

Subbasin NCB6 is a 239.3 acre basin that is located downstream of basin NCB5. The basin contains part of Lake Hallow Estates, Vale View, and Margil Farms and is fully developed. Runoff from the basin is directed into the Lake located on Vale View property and the drainage channel located within the basin. A ponding area and the 103"x71" CMP Arch pipe at crossing of the drainage channel at Vale View Lane acts as the outlet for the basin. The pipe discharges into subbasin NCB7. The peak runoff rate for the subbasin is 287 cfs and the routed 100-year peak flow rate was calculated at 379 cfs at the outlet location. The outlet pipe can easily transport the routed flows and has a maximum discharge of approximately 550 cfs. If the basin were to be redeveloped the peak flow rate is calculated at 208 cfs, 90% of the existing peak runoff rate.

NORTH CREEK BASIN 7

Subbasin NCB7 is a 73.3 acre basin that contain part of the Vale View Subdivision and is fully developed. According to the construction plans the outlet for the basin is two 54-inch RCP pipes under CR36 into subbasin NCB13. Flow from basin NCB6 and its upstream basins are directed into the existing detention pond constructed for the Vale View development. The subbasin peak runoff was calculated at 77 cfs and has a calculated routed peak 100-year runoff rate of 405 cfs. The routed flow storm hydrograph and detention area were modeled in SWMM and the model showed there is adequate volume in the pond for existing conditions. The model results for the 100-year routed storm events indicate the water surface elevation is 4973.6 feet and the top of pond elevation at approximately 4980.9 feet. If the fully developed basin is ever redeveloped the 100-year peak runoff rate should be designed to 69 cfs, 90% the existing runoff rate.

NORTH CREEK BASIN 8

Subbasin NCB8 is a 255.1 acre basin of farmland, undeveloped areas, and a few developed lots that drain into Highland Lake which has an 20" RCP outlet into a channel that drains to the Western Meadows detention area after crossing CR34 ½ via a 21"x15" elliptical pipe. The drainage channel bisects basin NCB17 and it is assumed flows from NCB17, or any upstream basins discharging into NCB17, will not contribute to the drainage channel during larger storm events. The peak 100-year runoff rate for basin NCB8 is 469 cfs. The 10" RCP pipe can transport 40.6 cfs. The Lake and outlet was modeled in SWMM and according to the LiDAR contour data the Lake can retain the entire existing 100-year runoff volume without discharging to the drainage channel and is at a water surface elevation of 5060.1 feet and a top of pond elevation of approximately 5067.0 feet. Therefore, the 100-year developed peak runoff rate was calculated at 422 cfs, 90% of the existing peak runoff rate. As the basin is developed, the volume of runoff will increase to the Lake and a more in-depth analysis of the available volume and possible permitted influent volume to the Lake should be completed to confirm the Lake will not flood and the outlet is still adequate to handle to basins runoff if the Lake receives enough volume to cause it to discharge. It is assumed that flows will be transported downstream to meet drainage requirements and that developed flows may not be accepted into the Lake. Further investigation into the Highland Lake and its discharge ditch is required to understand the capacity and allowable discharge rates and volumes.

NORTH CREEK BASIN 9

Subbasin NCB9 is a 203 acre basin of farmland, undeveloped areas, oil and gas well stations, rural residents, and residential lots located to the north of CR36 and west of CR7. Runoff generally flows to the east toward CR7. There are roadside swales along the north side of CR36 and west side of CR7 that transport flow to the northwest corner of the intersection of the two roads where there is an 18-inch CMP pipe that can transport 11.1 cfs of flow to the south into basin NCB11. Subbasin NCB9 receives overflows from basin NCB1 that are not transported under CR7 into subbasin NCB10. In this study the flow from NCB1 is assumed to all flow to the east under or over CR7 based on the Plans assumptions that all flow will be transported downstream at the subbasins outlet. However, a more in-depth analysis of basin's NBC1, NCB9, NCB10, and NCB11 should be performed to optimize the existing system and determine what is required for upsizing or detention areas in the subbasins. The calculated peak 100-year runoff rate for NCB9 is 202 cfs. Currently, the outlet pipe is extremely undersized and has no ponding area upstream to provide detention. Therefore, the developed 100-year release rate is calculated at 0.05 cfs/acre. Until the outlet pipe can be resized, and the downstream system is analyzed to confirm there will be no adverse effects to increasing the diameter, the developed release rate must be reduced to the capacity of the existing culvert. NCB9's peak runoff rate of 202 cfs does not account for the overflow runoff from subbasin NCB1 which has a peak 100-year runoff rate of 708 cfs. Furthermore, there is reported flooding along CR36 near the basins outlet which is the product of the undersized outlet pipe and undersized swales that are also not maintained.

NORTH CREEK BASIN 10

Subbasin NCB10 is a 9.7 acre basin that consists of a small corner of undeveloped land northeast of CR36 and CR7. The subbasin mainly serves as a drainage channel for upstream flows and has a rural lot. The basin transports flow from NCB1 to the 22-inch CMP outlet pipe crossing CR36. The outlet can transport 10.8 cfs based on staff measurements and LiDAR data. The peak runoff rate for the subbasin is 15 cfs and the routed 100-year peak runoff was calculated at 714 cfs. However, the entirety of NCB1's flow is not being transported to NCB10 due to under sizing of

the NCB1's outlet pipe and the grading at the outlet. The developed 100-year runoff rate was calculated at 14 cfs, 90% of the existing peak runoff rate. As mentioned in NCB9's section, the drainage for NCB1, NCB9, NCB10, and NCB11 needs to be investigated to optimize the runoff routing for the basin outlets and the appropriate sizing for the outlet pipes and ponding areas. When development occurs in subbasin NCB1, the flows will need to be reduced to accommodate the downstream culvert capacities or the culverts will need to be upsized to transport the routed peak flows.

NORTH CREEK BASIN 11

Subbasin NCB11 is a 76.9 acre basin that is located to the south of CR36 and west of CR7. The subbasin generally drains to the east overland or within the CR36's southern roadside swale. Once flows reach CR7's roadside swale the flows are is directed to the north or south to the subbasins 22-inch CMP outlet pipe under CR7 that has a release rate of 27.9 cfs. There is a ponding area upstream of the crossing that will detain some of the flow. NCB9 discharges into the basin near the basins outlet. The basins peak runoff rate was calculated at 108 cfs and the routed flow was calculated at 242 cfs. The developed peak runoff rate was calculated at 0.36 cfs/acre. With the additional flows from NCB1 into basin NCB9 and the shortened drainage path from the NCB9's outlet to NCB11's outlet, there will most likely be a larger peak routed runoff at NCB11's outlet than was calculated based on the Plans methodology. As mentioned in NCB9's description the drainage for NCB1, NCB9, NCB10, and NCB11 needs to be investigated to optimize the runoff routing for the basin outlets and identify the appropriate sizing for the outlet pipes and ponding areas to reduce the flooding in the area.

NORTH CREEK BASIN 12

Subbasin NCB12 is a 26.9 acre basin that contains most of Feather Ridge Estates Subdivision. The subbasin drains east and north to the subdivision's detention pond located in the northeast corner of the subbasin. The 100-year runoff rate was calculated at 58 cfs. According to the subdivision plans, the outlet pipe for the detention pond is a 33" RCP that has a release rate of 35.1 cfs. The detention pond and outlet structure were modeled in SWMM and the results showed the pond and outlet were adequate to detain the basins runoff. The pond has a water surface elevation of 4948.7 feet with the top of the ponding area at approximately 4951.25 feet. If the basin were to be redeveloped the 100-year runoff rate is calculated at 52 cfs, 90% of the existing peak runoff rate.

NORTH CREEK BASIN 13

Subbasin NCB13 is a 218.2 acre basin that contains Coyote Run Subdivision, an undeveloped area to the south of Feather Ridge Estates Subdivision, the backyards of several lots in Feather Ridge Estates, rural residences, undeveloped areas, and an unnamed drainage channel that collects all the runoff from the basin and runoff from basin's NCB1-NCB7, NCB9-NCB12. The outlet of the basin, taken from the original drainage master plan, is a 70-foot-long 9'x6' box culvert under the Great Western Railway. The railway acts as the basins southern boundary. The peak runoff rate for the basin is 340 cfs with the routed peak 100-year runoff rate for NCB13 at the outlet pipes of 1,312 cfs. The ponding area upstream of the railway crossing and the outlet pipe was modeled in SWMM to determine the ponding depth and potential of overtopping of the railroad. According to the SWMM model the water surface elevation upstream for the 100-year event is at approximately 4939.0 feet with the top of the pond at approximately 4951.0 feet. A portion of the basin is developed, but if there is redevelopment, or the rest of the subbasin is developed the

developed runoff rate was calculated at 306 cfs for the entire basin, 90% of the existing 100-year peak runoff rate. If any development occurs upstream of the outlet to the basin, the outlet and ponding area need to be analyzed to determine the effects of the development including the increased volume effects on the ponding area and downstream system.

NORTH CREEK BASIN 14

Subbasin NCB14 is a 121.8 acre basin that collects the flows from the northern portion of the NCB basin and is downstream of the crossing of the Great Western Railway. A portion of the basin also contains a small area to the east of Coyote Run Subdivision that drains to the south and sheets flows over the railroad and into the drainage channel. Runoff drains from the east and west into the unnamed drainage channel that flows to the south and eventually combines with the North Creek ditch in subbasin NCB29. The subbasin consists of mostly undeveloped land and farmland with the drainage channel and surrounding vegetation. Subbasin NCB14 has a peak flow of 129 cfs and a routed peak flow of 1,328 cfs. The combined routed flows from NCB29 and NCB14, 2,230 cfs, discharge through the two 10'x6' box culverts which cross under I-25 to the east and into subbasin LTB1. The routed flows, detention ponding area, and outlets were modeled in SWMM to analyze the ponding depth at the outlet. The ponding area has a 100-year water surface elevation of 4924.95 feet. The developed 100-year flow rate for NCB14 was calculated at 158 cfs, 90% of the existing peak runoff rate.

NORTH CREEK BASIN 15

Subbasin NCB15 is a 225 acre basin that drains to the east towards CR5 and is located to the south of CR34 ¾. The subbasin contains a rural residence with farmland and undeveloped area that is bisected by the Mead Lateral and Supply Ditch. The outlet for the basin is a 24-inch CMP culvert under CR5 into basin NCB17 which is clogged with debris and possibly crushed. The swale the pipe discharges into is directed towards the Highland Lake discharge ditch, but is cut off by a berm along the ditch. It is unknown at this time if the ditch is active for irrigation flows and it is assumed that the runoff from NCB15 will bypass the ditch and continue to the east in basin NCB17. The 100-year existing peak flow is calculated at 170 cfs. Using the available information, the outlet pipe has a release rate of 17 cfs. The excess flow will overflow CR5 when the pipes capacity and the minor ponding areas volume is exceeded. The calculated developed 100-year runoff rate for the basin is 0.08 cfs/acre to reduce the overflows to CR5 by reducing the runoff rate to the pipes capacity. The pipe should be cleaned out, replaced if needed, and the flow calculations rerun to update the allowable developed discharge rate for the subbasin. If the pipe crossing is enlarged to accommodate the calculated 100-year runoff rate, then the outflow rate can be updated to match Town standards. However, an analysis of the downstream systems should also be completed to determine the effects of increased flows and ensure there are no adverse effects downstream.

NORTH CREEK BASIN 16

Subbasin NCB16 is a 392 acre basin that is located to the south of Subbasin NCB15 and is contained between CR3 and CR5. The basin generally drains to the east to CR5 where flow is captured in the western roadside swale and directed along the road until reaching CR34 ½ and two culverts that transport flow to the north and south sides of CR34 ½ and into basin NCB17. Both Mead Lateral and Supply Ditch bisect the subbasin. The two culverts are 21"x15" elliptical CMP pipes and can transport a maximum peak of approximately 20.7 cfs. NCB16 has a peak 100-year runoff rate of 514 cfs. There is a ponding area upstream of the culvert crossings that will detain some of the runoff, but most of the flow will overflow CR5 to the east directing flow to the north

and south sides of CR34 1/2. Therefore, the developed 100-year runoff rate was calculated at 0.05 cfs/acre to reduce the probability of flooding at the intersection of CR5 and CR34 ½. If the culvert capacities are increased, the peak flow rate for the developed basin can be increased, but an analysis needs to be completed to determine the downstream effects of the increased release rate based on the increased outlet capacity. The decrease in peak flows from the basin as development occurs will improve the flooding issues downstream.

NORTH CREEK BASIN 17

Subbasin NCB17 is a 210.3 acre basin that is bound by CR34 to the South and CR5 to the west with North Creek Subdivision acting as the eastern boundary. Its northern boundary is a ridge south of CR36. The basin is mainly comprised of farmland, with a few rural residences and undeveloped areas. Flow from the southern portion of the basin drains to the north to CR34 ½ where flow is transported along the southern drainage ditch until the ditch becomes undefined and runoff sheet flows across the road to the north into the neighboring field. The concentrated flows all drain to the outlet of the subbasin, the North Creek Ditch within North Creek Subdivision. There has been reported flooding along CR34 ½ and the undefined southern roadside swale is the main reason for the flooding. The concentrated flows all drain to the outlet of the subbasin, the North Creek Ditch within North Creek Subdivision. Both NCB15 and NCB16 discharge into NCB17. The subbasin has a peak 100-year runoff rate of 305 cfs with a routed 100-year peak runoff rate calculated at 788 cfs. There is no pipe or embankment acting as the outfall, but there is a road crossing directly downstream of the subbasins outfall, W. View Drive, that has two (2) 22”x34” elliptical RCP culverts to transport the upstream flows. The pipes have a capacity of approximately 153 cfs and runoff will overtop the road during the larger storm events. To mitigate the flooding of W. View Drive the developed 100-year runoff rate was calculated at 0.73 cfs/acre. CIP project 2, discussed in Section 6 of the report, proposes to analyze the drainage patterns in this subbasin and those contributing to the North Creek Ditch Floodway in order to determine a method to provide relief to the flows entering North Creek Subdivision and model the ditches floodplain. Until improvements are constructed in the contributing subbasins, the flows from NCB17 will be required to be reduced to the capacity of the existing culverts.

NORTH CREEK BASIN 18

Subbasin NCB18 is a 99.5 acre basin that contains the North Creek Subdivision, undeveloped farmland and open space to the east and north of the subdivision, and a few rural residences. Runoff is directed to the North Creek Ditch that flows to the southeast towards the intersection of CR34 ½ and CR3. The subbasin has a peak 100-year runoff rate of 130 cfs with a routed 100-year peak runoff rate of 819 cfs. The two (2) 36-inch RCP culverts under CR34 ½ act as the outfall for the subbasin. There is a secondary 18-inch CMP culvert crossing to the east of the North Creek Ditch, but according to the LiDAR data there is not a significant amount of flow draining to that culvert. The two 36-inch culverts and upstream detention area were modeled in SWMM, the results showed that the culverts can transport approximately 247 cfs. The road acts as an overflow for the excess flows that cannot be transported through the culverts. The pipes can transport the subbasin flows, but not the calculated routed peak flows. Therefore, the subbasin developed 100-year runoff rate was calculated at 117 cfs, 90% of the existing peak runoff rate. When development occurs in the subbasins contributing flows to the outfall, improvements should made to reduce flooding occurring at the outfall due to routed peak flows.

NORTH CREEK BASIN 19

Subbasin NCB19 is a 11.9 acre basin that contains a small portion of the fully developed downtown Mead area between 6th and 7th Streets north of Dillingham Avenue. Subbasin runoff flows to the north via curb and gutter until crossing Palmer Avenue in two valley gutters and draining into a grass swale which is a part of subbasin NCB20. The subbasin has a peak 100-year runoff rate of 19 cfs. There is no actual outfall restricting flows into NCB20. If the subbasin is ever redeveloped it has a developed 100-year peak runoff rate of 17 cfs, 90% of the existing peak runoff rate.

NORTH CREEK BASIN 20

Subbasin NCB20 is a 161.9 acre basin that contains the fully developed Mead Western Meadows subdivision, a portion of the open space and undeveloped farmland to the west of the subdivision, undeveloped open space to the east of the subdivision, and the regional storm system and park located south of CR34 ½ and west of 3rd Street. The basin drains to three (3) 6'x8' box culverts under 3rd street approximately 100 feet south of the intersection of 3rd Street and CR34 ½. The subbasin has a peak 100-year runoff rate of 183 cfs with a routed peak runoff rate of 871 cfs. The box culverts and ponding area at the inlet can transport the entirety of the routed peak flow having a maximum depth of approximately 3.1 feet in the culverts. Therefore, as the rest of the basin develops the developed runoff rate is calculated at 165 cfs, 90% of the existing runoff rate.

NORTH CREEK BASIN 21

Subbasin NCB21 is a 14.0 acre basin that is located downstream of basin NCB20 and contains the North Creek Ditch up to the confluence with basin NCB23 and NCB29. The basin is defined by ridgelines and is bisected by the Great Western Railroad. Along with floodplain and undeveloped areas, a part of the Boulder Scientific Company (BSC) property is within the subbasin boundary. There is no outfall for the subbasin, but the railroad crossing has a 22-inch steel pipe and upstream ponding area to detain and transport the North Creek Ditch flow. The subbasin has a peak 100-year runoff rate of 25 cfs with a routed peak flow rate of 871 cfs. The railroad crossing culvert has a maximum capacity of 86.4 cfs. Once the upstream ponding area is filled, runoff will spill across the railroad tracks and continue to the southeast along the North Creek Ditch. The steel pipe is not adequate to transport the Ditch's peak routed flows, but can transport the subbasin flows. Therefore, if the subbasin is developed further the peak developed 100-year runoff rate needs to be reduced to 23 cfs, 90% of the existing peak runoff rate. While the routing method is very conservative and there is probably peak reduction upstream of the railroad crossing, it would be beneficial to complete a more in-depth analysis of the drainage system and install a pipe and/or increase the upstream ponding area at the railroad crossing to reduce the risk of damage to the railroad tracks during larger storm events.

NORTH CREEK BASIN 22

Subbasin NCB22 is a 46.6 acre basin that contains a large part of downtown Mead and is fully developed. There is storm inlet and pipe infrastructure in place within the subbasin that was not evaluated in this Plan because the existing detailed networks were not analyzed as a part of this Plan. Flows are directed to the eastern edge of the subbasin along the west side of CR7 where there are inlets to collect runoff and discharge both the eastern and western sides of the railroad. A low spot in CR7 is currently the ultimate outfall for the subbasin and is located at the intersection of the railroad tracks and CR7. Inlets were found during a site visit near the low spot, but not at the low spot, that should capture a portion of the runoff if they were well maintained. Flows that are not captured in the storm system will overflow CR7 to the east into a swale along the east side of the railroad. Two 24-inch culverts are in place to discharge runoff from the swales under the

railroad. The peak 100-year runoff rate for the site was calculated at 181 cfs. Since the subbasin is fully developed, any redevelopment of the subbasin needs to reduce the peak runoff rate for the entire subbasin to 163 cfs, 90% of the existing peak runoff rate. If there is reported flooding at the outfall or within the basin an analysis of the storm system should be performed to optimize the existing system and determine where improvements can be made.

NORTH CREEK BASIN 23

Subbasin NCB23 is a 50.0 acre basin that contains a portion of the Boulder Scientific Company property, commercial properties, the future location of the Lighthouse Storage Facilities that is currently undeveloped land, and residential properties. Runoff is directed to the northeast corner of the subbasin via swales to discharge into the North Creek Ditch which flows to the southeast within the subbasin. Flows from subbasin NCB20 discharge into NCB21. The 100-year peak runoff rate for the subbasin is 155 cfs and the routed 100-year peak runoff rate was calculated at 252 cfs. There is no direct outfall for the subbasin. As development or redevelopment occurs in the subbasin the peak runoff rate needs to be reduced to 140 cfs, 90% of the existing peak runoff rate.

NORTH CREEK BASIN 24

Subbasin NCB24 is a 168.9 acre basin that contains farmland and undeveloped areas to the south of CR34, west of the Great Western Railroad and southwest of Mead Elementary School. The subbasin drains to the northeast to CR34's southern roadside swale, and a swale along the west and southern edge of the school property. The swale combines with the railroads swale on the west side of the railroad tracks that flows to the northeast. The outfall is a 36-inch RCP culvert located at the southwestern corner of the intersection of the railroad and CR34. Flows combine with NCB25 at the culvert to be discharged to the east under the railroad and CR7 into NCB27 along the swale on the south side of CR34 continuing to the east. The peak 100-year runoff rate for NCB24 is 137 cfs. The routed peak flow into the outfall is 173 cfs. There is very little ponding upstream of the culvert, and when modeled in SWMM the 36-inch culvert has a capacity of 102 cfs and does not have the capacity to transport the peaked routed flows. Runoff that is not captured and transported via the culvert will overflow the railroad tracks to the east along CR34's southern roadside swale. The developed 100-year peak flow rate for the site was calculated to be 0.60 cfs/acre.

NORTH CREEK BASIN 25

Subbasin NCB25 is a 22.6 acre basin that contains Mead Elementary School. Flow is transported through the site from west to east until reaching the Great Western Railroad where it discharges into the railroads drainage swale before entering the 36" storm system combining with NCB24 flows. The storm system discharges to the east into CR34's southern roadside swale east of 3rd Street. The site has a calculated 100-year runoff rate of 60 cfs with a routed peak flow rate of 173 cfs. If more development occurs on the school site it will be important for detention to be implemented to reduce the runoff flows entering the undersized storm system. The site has a developed peak runoff rate of 54 cfs, 90% of the existing peak runoff rate.

NORTH CREEK BASIN 26

Subbasin NCB26 is a 95.6 acre basin that contains mostly farmland with an oil and gas station located in the middle of the basin and a residential property on the northern edge. The site is located to the east of the Great Western Railroad, west of CR7, south of CR34 and north of

subbasin MLB2. The basin drains overland to the east and once captured in CR7's western roadside swale, the concentrated flow is directed to the north. There is an 18" CMP culvert located approximately 170 feet north of the intersection of CR34 and CR7 that transports the runoff from NCB26 under CR7 to the northeast. Sediment has buried most of the culvert inlet and the ponding area at the culvert. Maintenance is required to restore the culvert to its maximum capacity of 5.5 cfs. The subbasin has a peak 100-year runoff rate of 100 cfs. Overflow at the outfall will be directed to the north and east across CR7 and into CR34's southern roadside swale. The developed 100-year runoff rate was calculated at 0.06 cfs/acre to reduce the flooding occurring at the subbasin outfall. If improvements are made at the outfall, the runoff rate could be increased to match Town design standards or the capacity of the new storm system.

NORTH CREEK BASIN 27

Subbasin NCB27 is a 144.0 acre basin that contains mostly farmland with a large retention area located on the southern portion of the subbasin. The basin is located to the east of CR7 and north of CR34 and extends to the south to Mulligan Lake Estates. Most of the runoff overland flows to the north until reaching a swale south of CR34. The swale is south of CR34's roadside swale and directs flow to a ponding area before overflowing into the roadside swale where flow is directed to two 36-inch RCP culverts under CR34 that have a capacity of approximately 365 cfs. The ponding areas and culverts were modeled in SWMM and the routed peak flows of 347 cfs can be detained and transported without flooding CR34 to the north. The subbasin has a peak 100-year runoff rate of 221 cfs. The developed runoff rate was calculated at 199 cfs, 90% of the existing peak runoff rate. As development occurs the ponding detention area south of the culverts cannot be removed without analysis and possible replacement of the area within the development.

NORTH CREEK BASIN 28

Subbasin NCB28 is a 45.1 acre basin that contains farmland and is located to the east of NCB26 and south of CR34. The subbasin overland flows to the north until reaching CR34 where flow is directed to the east in the roadside swale. At approximately 2,300 feet west of I-25, the roadside swale is no longer defined and sheet flows from NCB28 to the north across CR34 and into basin NCB29. Therefore, there is no structural outfall for the subbasin. The peak 100-year runoff rate was calculated at 45 cfs and the peak 100-year developed runoff rate was calculated at 41 cfs, 90% of the existing peak runoff rate. As development occurs in the subbasin, or reports of flooding at the outfall location are received, a culvert should be installed to transport the runoff flows under CR34.

NORTH CREEK BASIN 29

Subbasin NCB29 is a 145.1 acre basin that contains the North Creek Ditch and its floodplain as defined by FEMA, a park, undeveloped open space, and wetlands. The subbasin is located to the north of CR34 and west of I-25, and collects the flows from the eastern and southern portion of the NCB basin. Runoff generally overland flows to the north until draining into the North Creek Ditch that is flowing to the east and I-25. Subbasin NCB29 has a peak 100-year runoff rate of 175 cfs and a routed peak flow of 1,007 cfs. The combined routed flows from NCB29 and NCB14, 2,230 cfs, discharge through the two 10'x6' box culverts which cross under I-25 to the east and into subbasin LTB1. The routed flows, detention ponding area, and outlets were modeled in SWMM to analyze the ponding depth at the outlet. The ponding area has a 100-year water surface elevation of 4924.95 feet. The developed 100-year flow rate for NCB14 was calculated at 158 cfs, 90% of the existing peak runoff rate.

Table 2. North Creek Basin Discharge Summary

Subbasin ID	Design Point ID	Area (acre)	Existing Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
NCB1	14	570.8	4.2%	708	708	0.15 cfs/acre	N
NCB2	15	72.9	10.5%	130	130	117 cfs	Y
NCB3	16	27.9	13.4%	47	47	42 cfs	Y
NCB4	17	31.5	30.8%	76	160	68 cfs	Y
NCB5	18	105.2	20.9%	188	237	169 cfs	Y
NCB6	19	239.3	24.7%	287	379	258 cfs	Y
NCB7	20	73.3	21.8%	77	405	69 cfs	Y
NCB8	21	255.1	24.8%	469	469	422 cfs	Y
NCB9	22	203.0	6.4%	202	202	0.05 cfs/acre	N
NCB10	23	9.7	16.8%	15	714	14 cfs	N
NCB11	24	76.9	5.2%	108	242	0.36 cfs/acre	N
NCB12	25	26.9	52.7%	58	58	52 cfs	Y
NCB13	26	218.2	17.4%	340	1,312	306 cfs	Y
NCB14	27	121.8	4.1%	129	2,230	116 cfs	Y
NCB15	28	225.0	7.3%	170	170	0.08 cfs/acre	N
NCB16	29	392.0	6.9%	514	514	0.06 cfs/acre	N
NCB17	30	210.3	7.2%	305	788	0.73 cfs/acre	N
NCB18	31	99.5	22.6%	130	819	117 cfs	N
NCB19	32	11.9	45.8%	19	19	17 cfs	Y
NCB20	33	161.9	23.7%	183	871	165 cfs	Y
NCB21	34	14.0	36.9%	25	871	23 cfs	N
NCB22	35	46.6	57.0%	181	181	165 cfs	Y
NCB23	36	50.0	46.8%	155	252	140 cfs	Y
NCB24	37	168.9	3.2%	137	137	0.60 cfs/acre	N
NCB25	38	22.6	55.0%	60	60	54 cfs	N
NCB26	39	95.6	7.9%	100	100	0.06 cfs/acre	N
NCB27	40	144.0	3.9%	221	347	199 cfs	Y
NCB28	41	45.1	4.0%	45	45	41 cfs	N
NCB29	42	145.1	4.8%	175	2,230	158 cfs	Y

*Adequate capacity is based on routed 100-year peak flow rate

North I-25 Basin

The North I-25 Basin (NI25B) is a 405.8 acre basin consisting of 4 subbasins that is located west of I-25. The basin is split into two major watersheds, the northern watershed collects flows into a ditch that flows under I-25 and into the Diamond Reservoir Basin. The southern watershed collects flows into a ditch along I-25 that drains from north to south. The flows from the southern watershed flow from north to south through subbasin NI25B4 and under I-25 into the Lake Thomas Basin. The subbasin NI25B4 is located north of CR34 and west of I-25. All the outfalls in the basin are sufficient for the 100-year runoff rate and are not undersized. The NI25B drainage map and schematic flow routing figures are provided below.

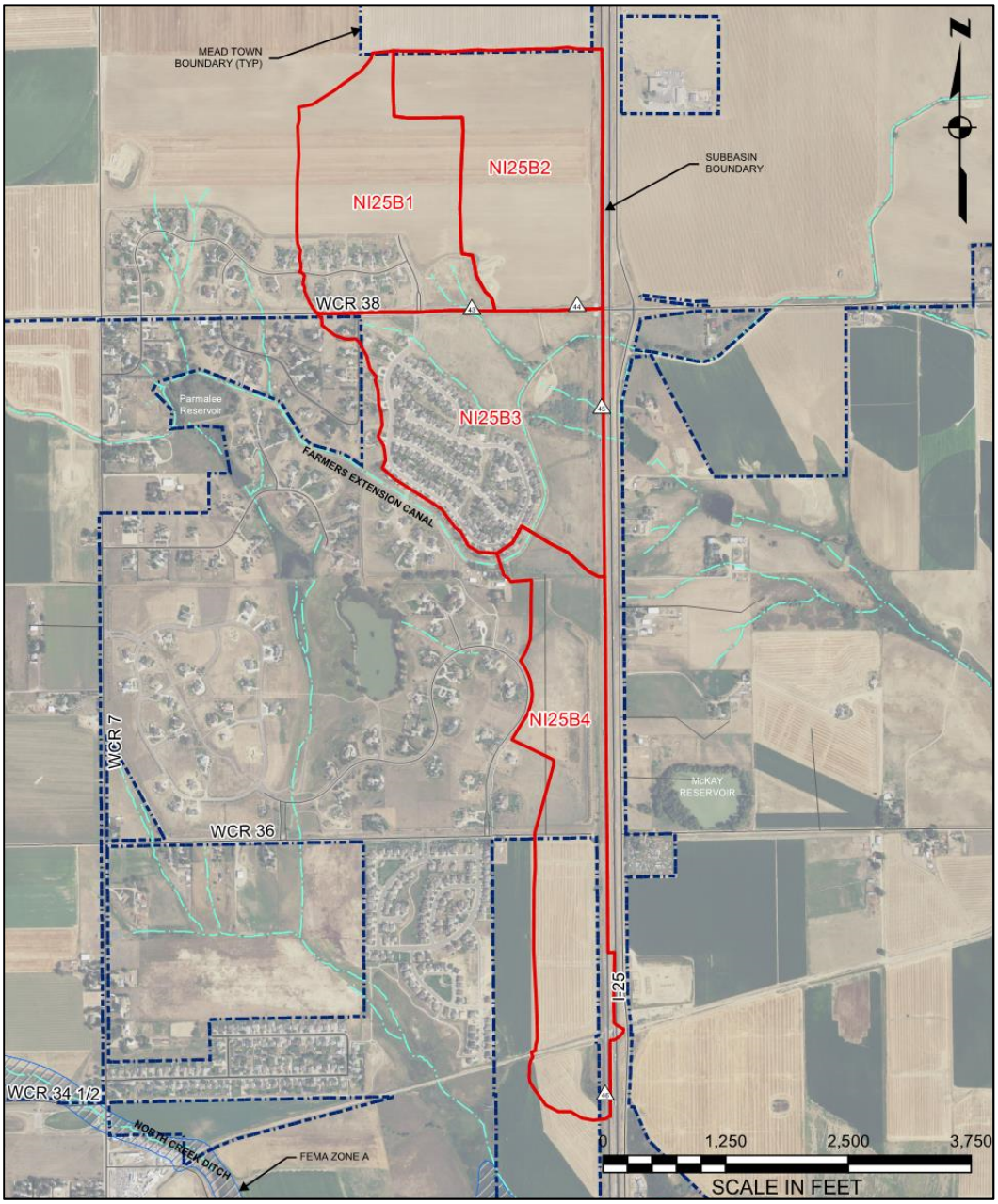

Figure 4. North I-25 Basin Map

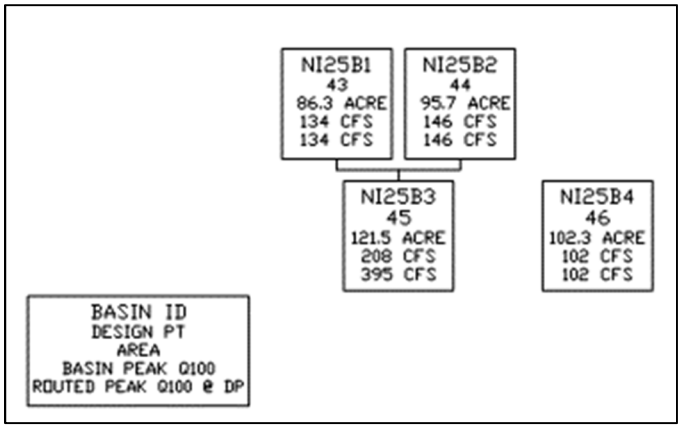

Figure 5. North I-25 Basin Flow Routing Schematic

NORTH I-25 BASIN 1

Subbasin NI25B1 is an 86.3 acre basin that is located to the north of CR36 and to the west of NI25B2. The basin is comprised farm land with 16.1 acres of residential development in the south-west corner. The 100-year runoff rate for the basin was calculated to be 134 cfs. The runoff sheet flows from the northwest corner of the basin until reaching the residential development where it is conveyed through curb and gutter until it reaches a swale at the south end of the basin that runs along CR a detention pond. The detention ponds outfall is at the southeast corner of the site where water is conveyed under CR36 through a 24-inch RCP. The water outfalls into basin NI25B3. With the four-foot-deep ponding area upstream of the outlet the runoff can be stored transported without flooding. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 121 cfs, 90% of the existing peak runoff rate.

NORTH I-25 BASIN 2

Subbasin NI25B2 is a 95.7 acre basin that is located to the north of CR36 and west of I-25. The subbasin is comprised of farm land and the eastern half of I-25 for half a mile. The runoff sheet flows from the northwest corner of the site until it reaches the east side of the basin where there is a road side swale that transports the water along I-25 into basin NI25B3. Any runoff that is not collected by the swale overflows three pipes, two 24-inch CMP and one 12-inch CMP, at the southeast corner of the site that convey the water under CR36 into basin NI25B3. The 100-year peak runoff rate for this subbasin was calculated to be 146 cfs. The SWMM model of the outfall system indicates that the peak 100-year runoff flows can be transport under CR36 into NI25B3 without flooding CR36. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 131 cfs, 90% of the existing peak runoff rate.

NORTH I-25 BASIN 3

Subbasin NI25B3 is a 121.5 acre basin located to the south of CR36 and west of I-25 and contains a portion of Margil Farm Subdivision. The subbasin consists of undeveloped land, 51 acres of residential development, and the eastern half of I-25 for half a mile. Runoff from subbasins NI25B1 and NI25B2 discharge into subbasin NI25B3. The subbasin also contains a section of the Farmers Extension Canal which conveys flows from the south end of the basin to the northeast corner then under I-25 though a 6'x16' box culvert. Runoff typically drains from the northwest

corner of the subbasin flowing through curb and gutter in the subdivision until it reaches a swale that transports the runoff to a ponding area at the east side of the subbasin. This swale is directed under two roads in the subdivision and then under the Farmer Extension Canal first passing through two 30-inch RCP, a 48-inch RCP, and then a 5-inch CMP. The runoff is conveyed from the detention area under I-25 through a 60-inch RCP into subbasin DRB4. The peak 100-year runoff rate was calculated at 208 cfs with the routed existing 100-year peak flow was calculated to be 395 cfs. The SWMM model of the detention pond and outfall with the routed flow hydrograph using dynamic wave indicate that the outfall system is adequate to store and transport the runoff flows from the subbasins. As development or redevelopment occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 187 cfs, 90% of the existing peak runoff rate.

NORTH I-25 BASIN 4

Subbasin NI25B4 is 102.3 acre basin located to the east of I-25 and south of NI25B3. The subbasin is comprised mainly of farm land and the eastern half of I-25 for a mile. The runoff sheet flows from the north end of the site to the southeast corner where it is conveyed to a wetland detention area before crossing under I-25 by a 9'x4' box culvert. The 100-year runoff rate for the subbasin is 102 cfs. The SWMM model of the detention pond and outfall with the routed flow hydrograph using dynamic wave indicate that the outfall system is adequate to store and transport the runoff flows from the subbasins. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 92 cfs, 90% of the existing peak runoff rate.

Table 3. NI25B Discharge Summary

Basin ID	Design Point ID	Area (acre)	Existing Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
NI25B1	43	86.3	8.9%	134	134	121 cfs	Y
NI25B2	44	95.7	6.1%	146	146	131 cfs	Y
NI25B3	45	121.5	25.8%	208	395	187 cfs	Y
NI25B4	46	102.3	10.4%	102	102	92 cfs	Y

*Adequate capacity is based on routed 100-year peak flow rate

MULLIGAN LAKE BASIN

The Mulligan Lake Basin (MLB) is a 1,121.9 acre basin consisting of 10 subbasins that is located west of I-25 and drains from west to east into the Mulligan Reservoir then under I-25 into the Lake Thomas Basin. The Reservoir is located north of Highway 66 and west of I-25. Outflows from the Reservoir will continue to the east under I-25 and into the Lake Thomas Basin and eventually drains into Lake Thomas. The basin is split into two major watersheds, one of the watersheds collects flows and drains north to south into Mulligan Reservoir then drains west to east under I-25. The other main watershed is bounded on the west side by the Upper Highland Ditch and flows west to northeast. These subbasins generally flow in the ditch along CR32 from west to east into MLB5 then drains under I-25 into the Lake Thomas Basin. There are several locations within the MLB where reports of flooding have been provided to the Town due to several of the outfall being undersized for larger storm events. The MLB drainage map and schematic flow routing figures are provided below.

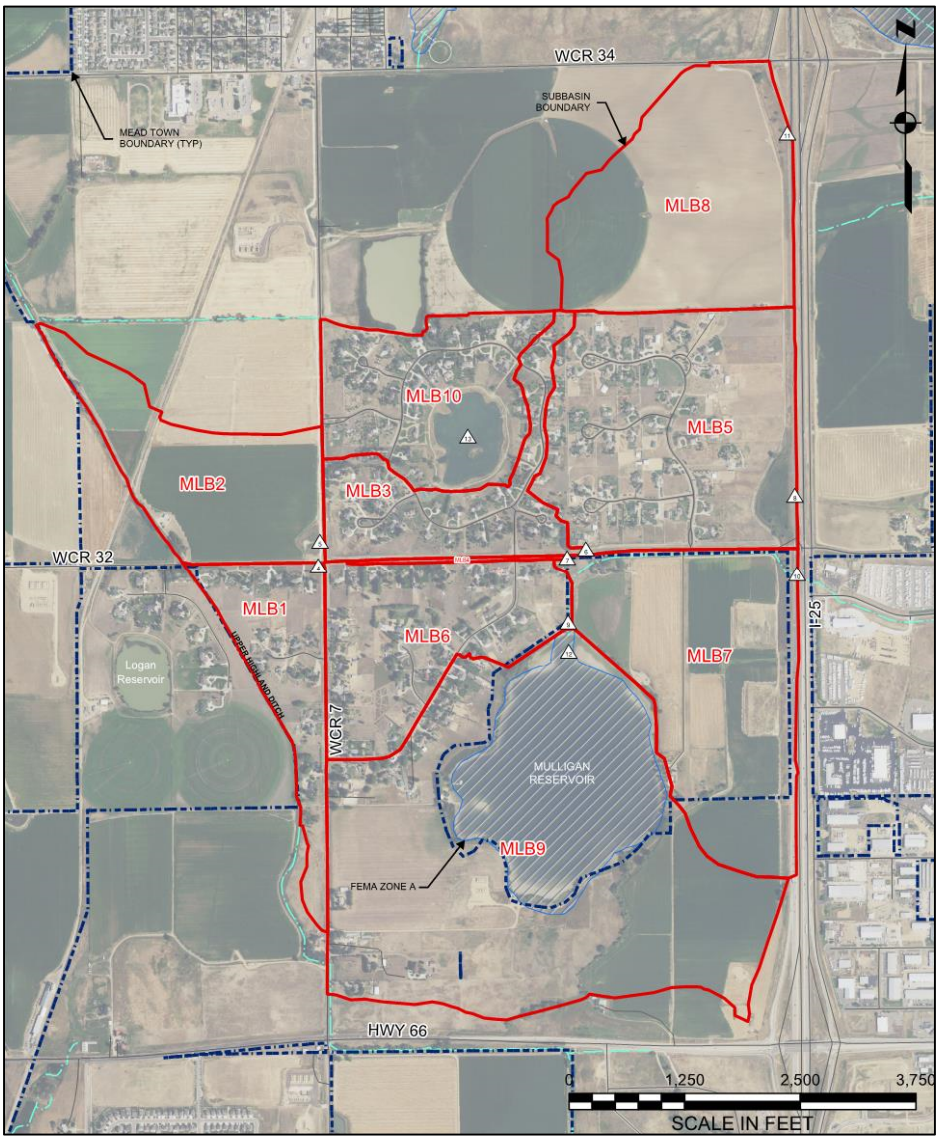

Figure 6. Mulligan Lake Basin Map

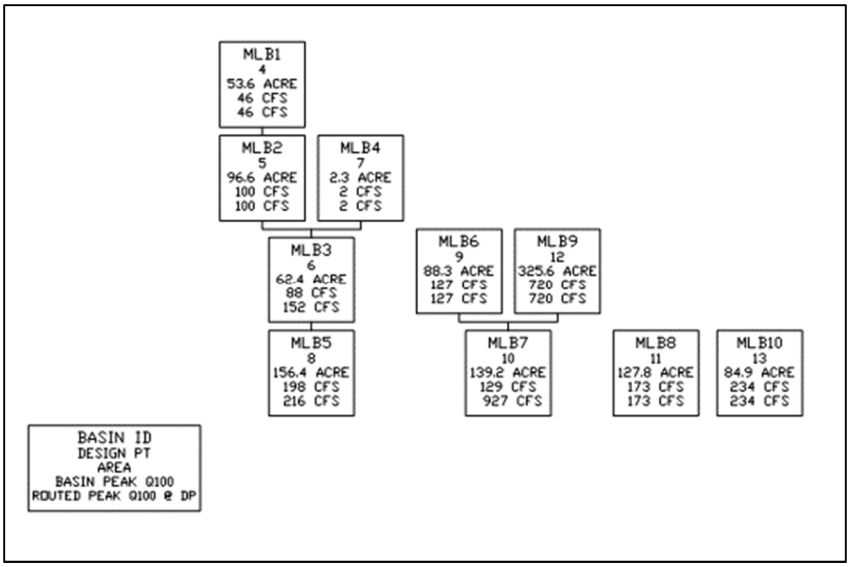

Figure 7. Mulligan Lake Basin Flow Routing Schematic

MULLIGAN LAKE BASIN 1

Subbasin MLB1 is a 53.6 acre basin that is located to the south of CR32 and a to the east of CR7. The subbasin is comprised of 22.2 acres of rural residence and the rest of the land is undeveloped area. The west side of the basin is constrained by the Upper Highland Ditch that conveys water from the north end to the south end of the basin. There are two swales following the north and the west sides of the basin that convey water to the northeast corner where it discharges into a 19"x30" RCP culvert under CR32 where it then changes to a 24-inch RCP and empties into a detention pond in subbasin MLB2. The 19"x30" RCP and the 24-inch RCP are elliptical equivalents and can convey 18.2 cfs. The 100-year runoff rate for the subbasin was calculated to be 46 cfs. The outfall floods to the north over CR32 and into subbasin MLB2. In order to mitigate flooding at the discharge point the developed outflow rate is calculated to be 0.34 cfs/acre.

MULLIGAN LAKE BASIN 2

Subbasin MLB2 is an 81.3 acre basin that is located to the north of CR32 and to the east of CR7. The basin is comprised of farm land with a couple of dirt road cutting through it. The west side of the basin is constrained by the Upper Highland Ditch that conveys water from the north end to the south end of the basin. Runoff sheet flows from the west side to the east side of the basin where approximately half of the water collects in a small ponding area while the other half flows onto CR7. At the outfall of the detention pond there is an 18-inch CMP that conveys the water under the side walk into a 24-inch CMP that conveys the water under CR7. There is also an 18-inch CMP just north of the detention area to convey any runoff that overflows the pond or is not captured in the pond in an attempt to prevent flooding of CR7. The two 18-inch CMP's can convey a total of 30.5 cfs and the 100-year routed runoff rate for this basin was calculated to be 100 cfs. According to the SWMM model, the detention pond and outlet pipes are not large enough to keep CR7 from flooding during the 100-year runoff event. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins developed runoff rate was calculated to be 0.38 cfs/acre. Further analysis and survey of the detention pond and existing culvert should be completed before development of the area to confirm the design assumptions. There should also be adjustments made to the basin to direct all of the flow to the detention pond to allow for detention before discharge under CR7.

MULLIGAN LAKE BASIN 3

Subbasin MLB3 is a 62.4 acre basin that is located to the north of CR32 and to the east of CR7. The subbasin is comprised of large lot residential homes in the Mulligan Lakes Estates development. The runoff flows through roadside swales in the housing development until reaching a swale at the south side of the site along CR32. MLB2 discharges into MLB3 where flows travel along the northern roadside swale of CR32 to the east. MLB4 also discharges into MLB3. The developed 100-year runoff rate for the subbasin was calculated at 88 cfs. The 100-year routed runoff rate for the subbasin was calculated to be 152 cfs. The outfall from the basin is a 42-inch RCP under a driveway into subbasin MLB5. There are several culverts under driveways and roads that have collected debris and need to be cleaned to transport the design flows including the 42-inch pipe. The 42-inch RCP has a small ponding area upstream of the culvert before the water continues down the swale. A SWMM model was run to analyze the capacity of the pipe with the ponding area. The 42-inch RCP with the ponding area has the capacity to transport the peak flows when clear of debris. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 79 cfs, 90% of the existing peak runoff rate.

MULLIGAN LAKE BASIN 4

Subbasin MLB4 is a 2.3 acre basin that is located to the south of CR32 and to the north of basin MLB6. The subbasin contains the southern half of CR32 for a half a mile section and a small piece of the Hunters Cove neighborhood. There is a swale that runs along CR32 from the west side of the subbasin to the east side of the basin. The swale runs under five driveways through 18-inch RCP and under Hunters Cove Rd through a 24-inch RCP. The swale ultimately crosses under CR32 through a 24-inch RCP with a capacity of 17.5 cfs. The subbasin has a 100-year peak runoff rate of 2.0 cfs. The 24-inch RCP is sufficient to prevent flooding of CR32 along its south side with the subbasin. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 1.8 cfs, 90% of the existing peak runoff rate.

MULLIGAN LAKE BASIN 5

Subbasin MLB5 is a 156.4 acre basin that is located to the north of CR32 and to the west of I-25. The subbasin is comprised mainly of large lot residential homes in the Singletree Estates Development and farm land. A roadside swale that runs along CR32 in subbasin MLB3 continues to the southeast corner of MLB5 where there is a detention area. The runoff from the neighborhood follows a swale along the side of the road until flowing into the swale along CR32. The rest of the runoff sheet flows to the southeast corner of the subbasin into the detention area. The detention area has two outfalls a 32-inch RCP and a 24-inch RCP outfall under I-25 into LTB9. The pipes have a combined capacity of approximately 89 cfs. The subbasin has a peak 100-year runoff rate of 198 cfs with a routed peak runoff rate of 216 cfs. According to the SWMM model, the detention area and outlet pipe are not adequately sized to detain the runoff and keep CR32 from flooding and runoff from flowing along CR32 to the east under I-25 via the underpass during the 100-year runoff event. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins developed runoff rate was calculated to be 0.57 cfs/acre. Further analysis and survey of the ponding area and existing culverts should be completed before development of the area to confirm the design assumptions.

MULLIGAN LAKE BASIN 6

Subbasin MLB6 is an 88.3 acre basin that is located to the south of CR32 and to the east of CR7. The subbasin is comprised mainly of large lot residential homes in the Hunters Cove development and the eastern half of CR7 for a half a mile stretch. The runoff in the subbasin sheet flows until reaching roadside swales throughout the neighborhood. These swales transport the runoff to subdivisions detention pond located directly north of the Mulligan Lake Reservoir. The subbasin has a peak 100-year existing runoff rate of approximately 127 cfs. The detention pond discharges into the Lakes overflow swale that drains to the north into a pipe and eventually into CR32's southern roadside swale and subbasin MLB7. The outfall for the detention pond was not surveyed during the site investigation. However, since the subdivision is completely buildout it is assumed the detention pond is sized correctly. If the subdivision is ever redeveloped the peak runoff flows shall be reduced to 114 cfs, 90% of the existing peak runoff rate.

MULLIGAN LAKE BASIN 7

Subbasin MLB7 is a 139.2 acre basin that is located to the south of CR32 and to the west of I-25. The subbasin is comprised mainly of farm land with a few rural developments totaling 20 acres. The runoff sheet flows to the north and east side of the subbasin where there are two swales, one along I-25 and one along CR32 that capture and transport the flows to outfall. The 4'x9' box culvert outfall is located in the northeast corner of the subbasin where it conveys the runoff under I-25 into subbasin LTB7. Both MLB6 and MLB9 are routed into MLB7. While Mulligan Lake Reservoir will not likely reach capacity, it is assumed as a part of this study that the reservoir is at capacity and the peak 100-year runoff flows will be transported downstream into MLB7. The subbasin has a peak 100-year runoff rate of 129 cfs and a routed 100-year peak runoff rate of 927 cfs. The box culvert can transport 313 cfs with four feet of ponding area. If the reservoir does contribute flows downstream the outfall system is not adequate, and the outfall area will flood to the north onto CR32 and travel to the east. Without the flows from the reservoir the outfall system is adequate to transport the peak routed flows from MLB7 and MLB6, 206 cfs. Therefore, it is assumed that the reservoir will contain the runoff flows from the MLB9 and the developed peak runoff rate from MLB7 was calculated at 116 cfs. Further research and discussion with the reservoir owners should be completed before development to confirm possible discharge rates from the reservoir downstream. There are two other culverts under I-25 in the subbasin that could be utilized to transport flow as development occurs, currently the LiDAR data shows the subbasin does not drain to the culverts.

MULLIGAN LAKE BASIN 8

Subbasin MLB8 is a 127.8 acre basin that is located to the south of CR34 and to the west of I-25. The basin is comprised mainly of farm land with some gravel roads and the east half of I-25. The water sheet flows over the farmland until it reaches the north or east end of the basin where there are drainage ditches that convey the water to a ponding area before it crosses under I-25 into basin LTB17. The pipe that conveys the runoff under I-25 is a 24-inch with a capacity of 32.2 cfs. The peak flow to the basin during the 100-year event is calculated to be 173 cfs. The SWMM model of the ponding area with the routed flow hydrograph indicate that the ponding area is flooding, and the outlet pipe is undersized. The developed 100-year peak runoff rate has been calculated to be 0.25 cfs/acre to account for the existing capacity of the 24-inch culvert.

MULLIGAN LAKE BASIN 9

Subbasin MLB9 is a 325.6 acre basin that is located to the north of FRB1, west of I-25, and east of CR7. The basin is comprised mainly of farm land with a few rural developments and a small

section of the Hunters Cove development. The main feature of the subbasin is that it contains the Mulligan Lake Reservoir. All runoff from the subbasin drains into the Lake. The peak 100-year runoff flow rate was calculated to be 720 cfs. The Lake was modeled in SWMM and according to the LiDAR contour date the reservoir can retain the entire 100-year runoff flows without flooding the surrounding areas. Therefore, the developed peak 100-year runoff is 648 cfs. As the subbasin is developed the volume of runoff will increase to the reservoir and a more in-depth analysis of the available volume and possible permitted influent volume to the reservoir should be completed to confirm the reservoir will not flood. Any state or local permits for the reservoir will need to be investigated to determine if the influent volume and runoff rates can be increased. As part of the major drainage analysis it will be assumed that the reservoir is full, and the peak 100-year runoff will discharge downstream into subbasin MLB7.

MULLIGAN LAKE BASIN 10

Subbasin MLB10 is an 84.9 acre basin that is located to the east of CR7 and to the north of MLB3. The basin is comprised mainly of large lot residential homes in the Mulligan Lakes Estates development and subdivisions retention pond. All runoff from the subbasin is transported via sheet flow either directly into the retention pond or into swales that discharge into the pond. The pond was modeled in SWMM and according to the LiDAR contour date the reservoir can retain the entire 100-year runoff flow without flooding of the surrounding areas. The peak 100-year runoff rate was calculated at 234 cfs. If the subbasin is ever redeveloped the developed runoff rate will be required to be 211 cfs, 90% of the existing calculated runoff rate. Furthermore, the volume of the retention pond will be required it be analyzed in further detail to confirm it has the capacity for any redevelopment.

Table 4. Mulligan Lake Basin Discharge Summary

Basin ID	Design Point ID	Area (acre)	Existing Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
MLB1	4	53.6	21.1%	46	46	0.34 cfs/acre	N
MLB2	5	81.3	8.0%	100	100	0.25 cfs/acre	N
MLB3	6	62.4	28.2%	88	152	79 cfs	Y
MLB4	7	2.3	32.4%	2	2	1.8 cfs	Y
MLB5	8	156.4	23.7%	198	216	0.57 cfs/acre	N
MLB6	9	88.3	23.3%	127	127	114 cfs	Y
MLB7	10	139.2	10.3%	129	927	116 cfs	N
MLB8	11	127.8	6.2%	173	173	0.25 cfs/acre	N
MLB9	12	325.6	34.4%	720	720	648 cfs	Y
MLB10	13	84.9	36.1%	234	234	211 cfs	Y

*Adequate capacity is based on routed 100-year peak flow rate

FOSTER RESERVOIR BASIN

The Foster Reservoir Basin (FRB) is a 616 acre basin comprised of three subbasins defined originally in the 1998 Mead Drainage Master Plan and adjusted based upon updated contours. The basin contains the Foster Reservoir and the Upper Highland Ditch. Most of the basin drains into the Reservoir where runoff is retained. Subbasin FRB3 drains under I-25 into the East Saint Vrain Creek Basin. The basin is defined on the East side by 125 and on the south side by CR28. There are currently no flooding issues in the basin.

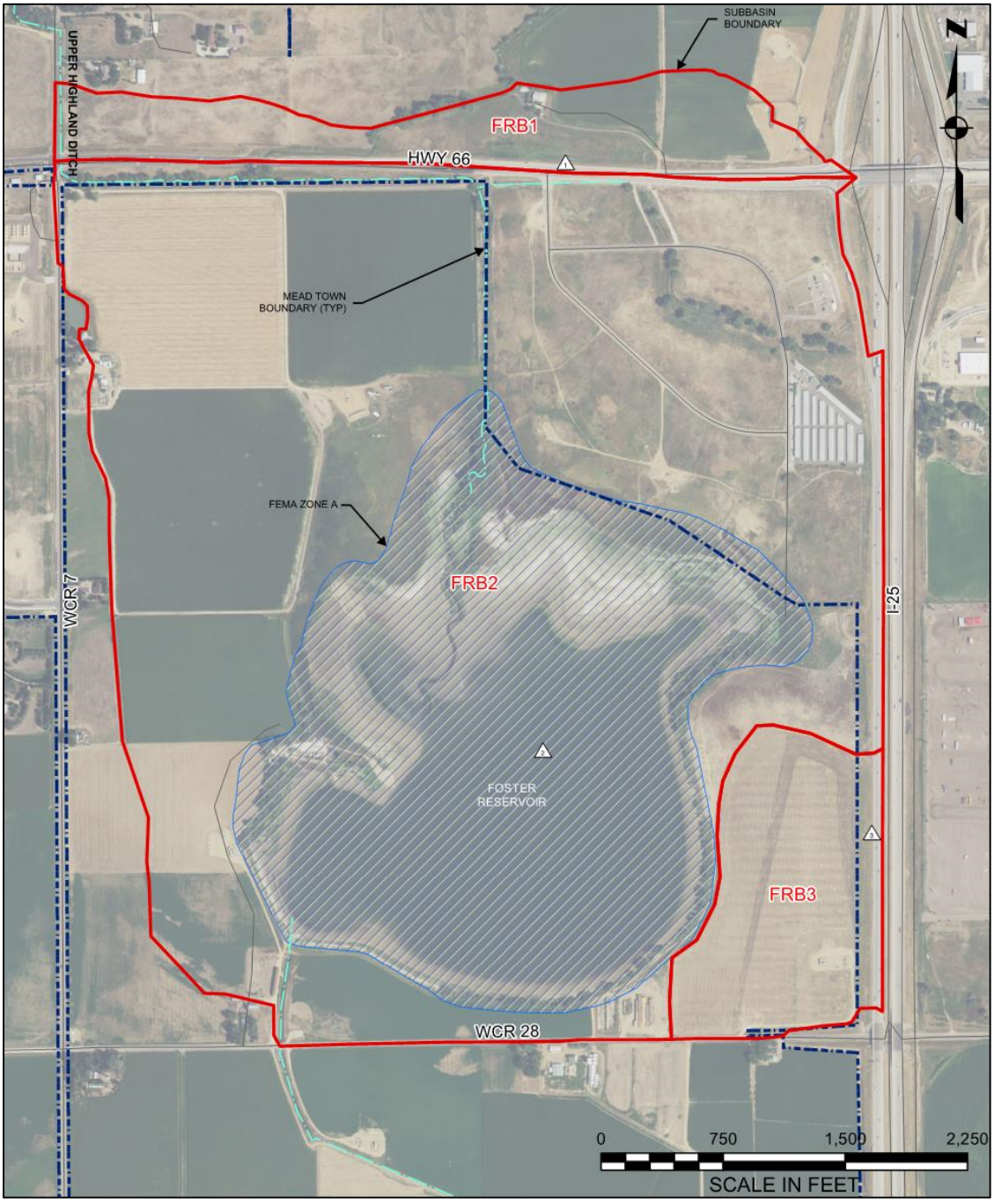

Figure 8. Foster Reservoir Basin Map

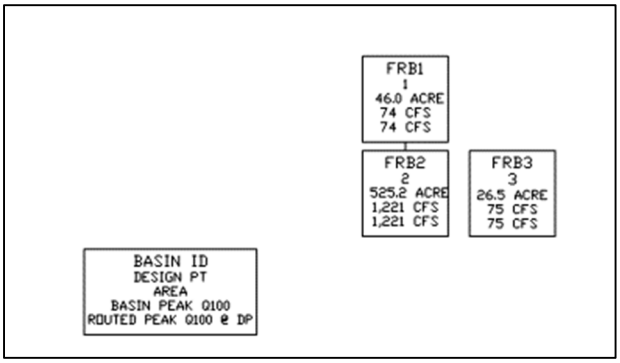

Figure 9. Foster Reservoir Basin Flow Routing Schematic

FOSTER RESERVOIR BASIN 1

Subbasin FRB1 is a 46.0 acre basin that is located to the north of Highway 66 and to the east of CR7. The subbasin is comprised of farm land, undeveloped land and the northern half of Hwy 66 for a one-mile section. Runoff sheet flows from the northwest corner of the subbasin into a swale that runs along Highway 66 to the outfall, a ponding area on the southcentral edge of the subbasin with a 24-inch RCP culvert under Highway 66 into subbasin FRB2. The 100-year runoff rate for the subbasin was calculated at 74 cfs. A SWMM model was run for the ponding area, culvert, and the subbasins flow hydrograph using dynamic wave. The model indicated that the outfall system is sufficient to prevent flooding of Highway 66 during the 100-year runoff event. The developed runoff rate is calculated at 54 cfs, 90% of the exiting peak runoff rate.

FOSTER RESERVOIR BASIN 2

Subbasin FRB2 is a 525.2 acre basin that contains the Foster Reservoir and is located to the south of Highway 66 and the west of I-25. The subbasin is comprised of farmland, developed land at the northeast corner of the subbasin, and the eastern half of I-25. The Upper Highland Ditch is located along the north end of the subbasin. The Ditch captures the runoff transported under Highway 66 through the box culvert from subbasin FRB1 and conveys the runoff along the north end of the subbasin before turning to the south and into the Foster Reservoir. The rest of the runoff in the subbasin sheet flows directly into the Reservoir. The 100-year runoff rate for the subbasin was calculated to be 1,221 cfs. The routed 100-year peak runoff rate was calculated at 1,221 cfs. The Reservoir was modeled in SWMM and according to the LiDAR contour date the Reservoir can retain the entire existing routed 100-year runoff volume. As the subbasin is developed the volume of runoff will increase to the Reservoir and a more in-depth analysis of the available volume and possible permitted influent volume to the Reservoir should be completed. The developed runoff rate is calculated at 1,098 cfs, 90% of the exiting peak runoff rate.

FOSTER RESERVOIR BASIN 3

Subbasin FRB3 is a 44.8 acre basin to the north of CR28 and the west of I-25. The subbasin is comprised mainly of farmland and contains the north half of I-25 for a third of a mile. The runoff sheet flows to the east to the outfall, a ponding area and 36-inch RCP culvert under I-25 in ESVCB6. The 100-year runoff rate for the basin was calculated to be 75 cfs. A SWMM model was run for the ponding area, culvert, and the subbasins flow hydrograph using dynamic wave. The results indicated that the outfall system is sufficient to detain and discharge the subbasin flows without causing flooding during the 100-year runoff event. The developed runoff rate is calculated at 68 cfs, 90% of the exiting peak runoff rate.

Table 5. FRB Discharge Summary

Subbasin ID	Design Point ID	Area (acre)	Existing Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
FRB1	1	46.0	24.3%	74	74	67 cfs	Y
FRB2	2	525.2	28.9%	1,221	1,221	1,098 cfs	Y
FRB3	3	44.8	9.6%	75	75	68 cfs	Y

*Adequate capacity is based on routed 100-year peak flow rate

LITTLE THOMPSON RIVER BASIN

The Little Thomas River Basin (LTRB) is comprised of 26 subbasins that generally drain to the north in drainage channels that ultimately connect to the Little Thompson River. There are several dammed channels and retentions areas that collect concentrated flows and are the outfall locations for several of the subbasins. The retention areas and dams are possibly registered with the State and have an associated volume and discharge rate. As the subbasins become developed investigation should be completed to determine the design volume, influent rates, and discharge rates of the dams and retention areas to ensure no adverse effects result from development. For the most part it is assumed that decreasing the developed 100-year runoff rate to 90% of the existing peak runoff rate will be adequate for the subbasins that do not have culverts or piped outfalls. However, the effects of the increased volumes in the subbasins will not be investigated in this report and should be included in future detailed studies or during development review.

Little Thompson River Basin is located to the west of I-25 and northwest of downtown Mead in the northwest corner of the study area. The tributary area is a total of 2967.5 acres with no existing residential subdivisions and only farmstead homes and large acreage properties with mainly farmland and undeveloped open space and waterbodies. The Supply Ditch, New Ish Ditch and Ide and Starboard Ditch all cross through the basin. The basin drains to west and north into unnamed drainage channels or Holmes Draw before entering Big Hallow Draw and ultimately Little Thompson River. The main outfall for the basin is a bridge crossing under CR5 north of CR42.

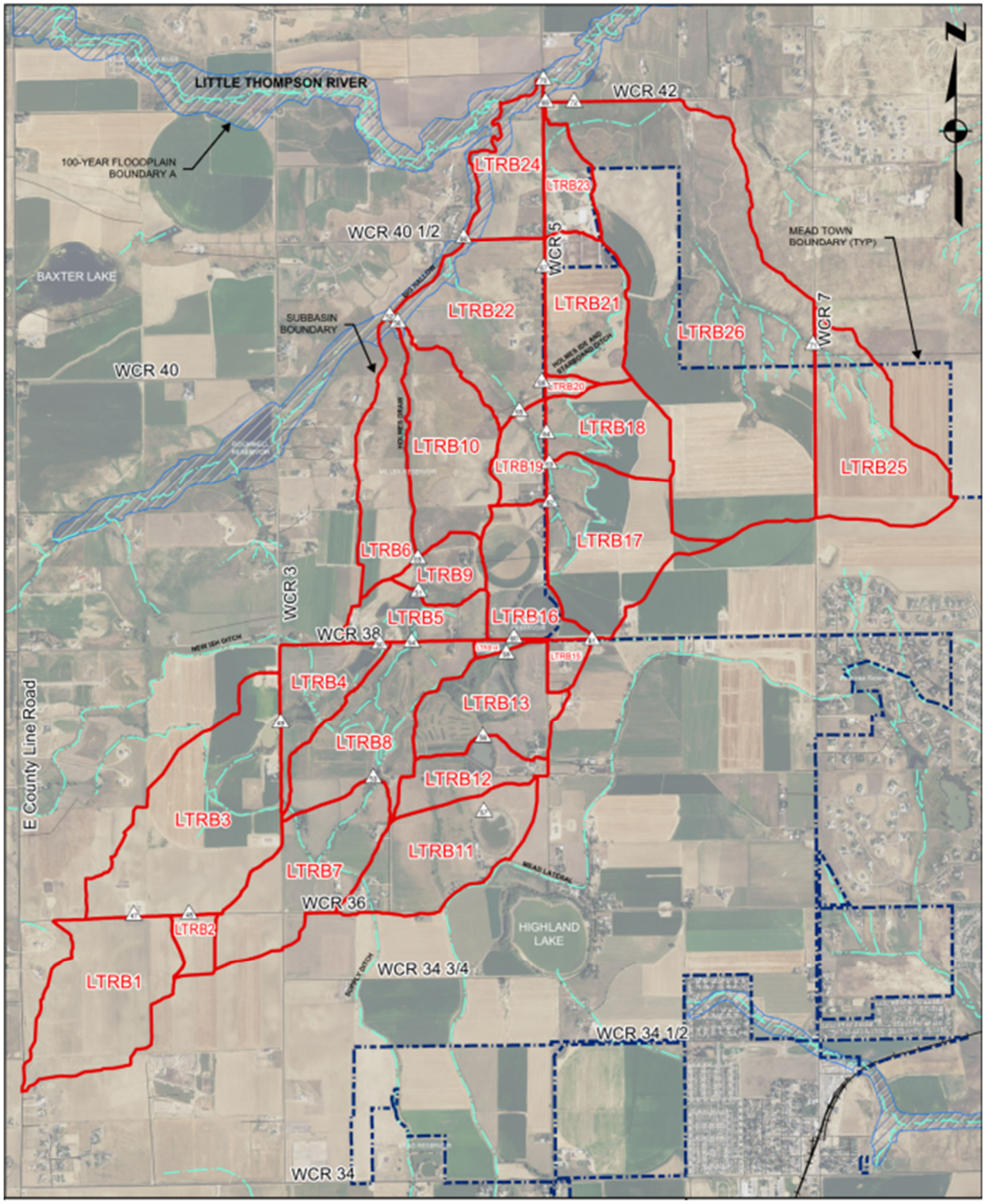

Figure 10. Little Thompson River Basin Map

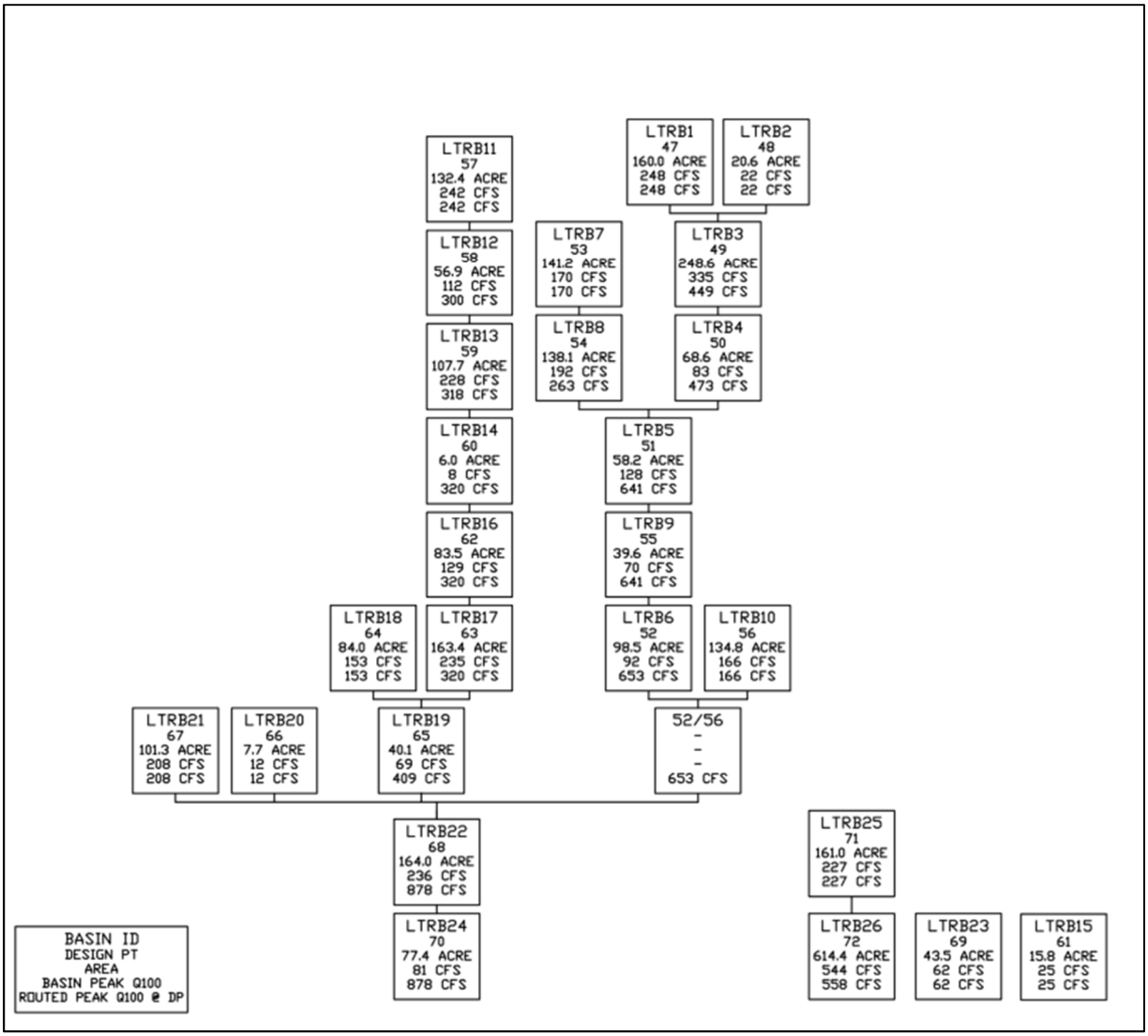

Figure 11. Little Thompson River Basin Flow Routing Schematic

LITTLE THOMPSON RIVER BASIN 1

Subbasin LTRB1 is a 160 acre basin located south of CR36 and east of CR1 that flows to the north. The land use is mainly farmland and undeveloped land with small patches of gravel drives. The southern boundary of the basin is CR36 with ridges that establish the east, north and west boundaries. Runoff overland flows to the north to the subbasin outfall defined by a low spot along the small roadside swale on the south side of CR36. At the low spot runoff sheet flows across CR36 into subbasin LTRB3. The basin is entirely outside of Town limits. The 100-year peak runoff rate was calculated at 248 cfs. Developed peak 100-year runoff was calculated to be 223 cfs, 90% of the existing peak runoff rate per Town Standards. When development occurs, a culvert crossing will be required to be constructed to transport the 100-year event flows under CR36. Furthermore, analysis of the downstream outfall systems will need to be analyzed to determine if the increased runoff volume effect the downstream ponding areas or existing systems require improvements.

LITTLE THOMPSON RIVER BASIN 2

Subbasin LTRB2 is a 20.6 acre basin located to the east of LTRB1 and south of CR36 that flows to the north. The subbasin consists of farmland and undeveloped land. The southern boundary of the basin is CR36 with ridges establishing the east, north and west boundaries. The outlet location of the subbasin is defined by a low spot along the small roadside swale on the south side of CR36. The runoff sheet flows across CR36 into subbasin LTRB3. The 100-year peak runoff rate was calculated at 22 cfs. Developed peak 100-year runoff was calculated to be 20 cfs, 90% of the existing peak runoff rate per Town Standards. When development occurs, a pipe crossing must be constructed to transport the 100-year event flows and downstream effects must be analyzed to reduce the risk of negative impact to outfall area subbasins the downstream basins and infrastructure.

LITTLE THOMPSON RIVER BASIN 3

Subbasin LTRB3 is a 248.6 acre basin located to the north of CR36 and west of CR3 that flows to the north and east. The subbasin consists of farmland, undeveloped land, multiple oil and gas well stations, and a rural residence. Supply Ditch also bisects the basin. LTRB3's outlet is a dammed retention pond on Holmes Draw located upstream of the waterways crossing of CR3. On the downstream end of the dam's embankment between the dam and CR3 there is a ponding area with a 192"x74" box culvert that transports flows under CR3 to the east. The culvert dimensions were measured at a site visit and the inverts and ponding area using LiDAR data. LTRB1 and LTRB2 both discharge into LTRB3 which has a calculated routed peak flow of 449 cfs. LTRB3's peak runoff rate was calculated at 335 cfs. Directly downstream of the culvert into subbasin LTRB4 is another retention area which will affect the ponding area on the west side of CR3. Due to the complexities of the retention areas it is suggested that further modeling of LTRB3 and LTRB4 should completed to determine existing volume and flow and the effects of future development. The developed release rate for the basin is 302 cfs, 90% of the existing peak runoff rate per Town Standards, with the assumption that further analysis will be completed on the volume capacity of the retention areas. The possibility of there being a permit for the retention areas is probable and detailed analysis will need to be completed when development occurs.

LITTLE THOMPSON RIVER BASIN 4

Subbasin LTRB4 is a 68.6 acre basin located to the south of CR38 and east of CR3 that flows into Holmes Draw which is a series of dammed retention areas running from the southwest corner of the basin to the northeast corner. The retention areas are surrounded by farmland and undeveloped land with gravel roads for access. The New Ish Ditch bisects the basin between two of the retention areas. Further investigation of the retention area volumes, outlet features, and discharge rates should be performed if any development occurs upstream of the basin including in basins LTRB1, LTRB2, and LTRB3 to ensure the embankments and outlets are designed for the increased conditions. The final outfall for LTRB4 at CR38 was not found during survey and other investigations by the Town. The peak routed flow from LTRB4, assuming the 100-year flows are not affected by the retention ponds, is 473 cfs. LTRB3's peak runoff rate was calculated at 83 cfs. A simplified SWMM model was built using LiDAR data for the retention pond at the subbasin outlet. The model indicated that the ponding area without an outlet is not sized large enough to contain the routed flows. However, there are several ponds upstream that effect the subbasins final outfall retention pond. The complex hydraulic nature of the Holmes Draw retentions ponds in LTRB4 should be analyzed in more detail if flooding effects the surrounding area, CR38, or if development occurs upstream. The developed 100-year peak flow was calculated to be 75 cfs,

90% of the exiting peak runoff rate, unless future research proves that the downstream system cannot manage the proposed flows and volumes. The possibility of there being a permit for the retention areas is probable and detailed analysis will need to be completed when development occurs.

LITTLE THOMPSON RIVER BASIN 5

Subbasin LTRB5 is a 58.2 acre basin located to the north of CR38 that flows into Holmes Draw which is a series of dammed retention areas running from the south central edge of the basin to the north central edge. The retention areas are surrounded by farmland and undeveloped land with gravel roads for access, a sod business establishment, and a rural residence. The outlet for LTRB5 is the retention ponds outlet. Currently, there is no information for the outlet information of the pond besides an overflow in the embankment. The peak flow from LTRB5 assuming the 100-year flows are not affected by the retention ponds within the subbasin is 128 cfs. The peak routed flow rate was calculated at 641 cfs. A dynamic wave SWMM model was built for the retention pond at the subbasin outlet to model the ponding and overflow. The results showed the pond volume and overflow are undersized for the influent routed flows. However, there are several ponds upstream of the retention pond that effect the influent flows and volume to the pond. Therefore, a more detailed model should be completed to understand the drainage is behaving throughout LTRB5 and in the upstream basins, LTRB1, LTRB2, LTRB3, and LTRB4. The developed 100-year peak flow was calculated to be 115 cfs, 90% of the exiting peak runoff rate, unless future research proves that the downstream system cannot manage the proposed flows and volumes. The possibility of there being a permit for the retention areas is probable and detailed analysis will need to be completed when development occurs.

LITTLE THOMPSON RIVER BASIN 6

Subbasin LTRB6 is the area to the west of Holmes Draw that drains in to the Draw downstream of the retention areas. The west side of the basin is defined by a ridge which splits flow to the west and the east. The subbasin ends to the north at Big Hallow Creek. LTRB6 is 98.5 acres and consists of farmland and undeveloped land with rural residences and an oil and gas well station. LTRB6 collects flow from several upstream subbasins including LTRB9, LTRB8, LTRB7, LTRB5, LTRB4, LTRB3, LTRB2, and LTRB1. The retention pond in LTRB9 collects all the flows from the upstream basins before the flow continues downstream via Holmes Draw. The routed peak flow at LTRB6's discharge point, which includes LTRB10, is 653 cfs and assumes that the retention ponds or dams in the upstream basins do not influence the upstream subbasin storm hydrographs. LTRB6's peak runoff rate was calculated at 92 cfs. The combined flows of LTRB10 and LTRB6 are the contributing eastern flows to the Big Hallow at the confluence with Holmes Draw. The developed 100-year peak flow was calculated to be 83 cfs, 90% of the existing peak runoff rate.

LITTLE THOMPSON RIVER BASIN 7

Subbasin LTRB7 is a 141.2 acre basin that drains to the northeast, crossing CR36 and Supply Ditch via sheet flow when the flow is then concentrated into an unnamed drainage channel that end at a dammed retention pond. Flow does also travel to the north along the west side of CR3, but there is a low spot in CR3 that causes the runoff to sheet flow to the east across CR3 and continue to the northeast to the subbasins outlet retention pond. The subbasin consists of gravel roads, farmland and undeveloped land, and rural residences and has a 100-year developed flow rate of 170 cfs. It was assumed flow will continue across Supply Ditch to the northeast without

being captured and transported in the ditch. The retention ponds outlet was not identified in the study and further investigation is required on its location, capacity, outlet characteristics, and discharge rate. According to the LiDAR data the pond is a little over two feet deep. The SWMM model created for the pond indicated that the pond is not sized to store the existing runoff volume with no outlet pipe, but there is an overflow or low spot in the embankment that will transport the excess flow to the north into LTRB8 once the pond reaches capacity. Depending on if the retention area has a permitted volume and release rate, development in the basin will require a readjustment to the permit and/or resizing of the pond to accommodate in the increased volume. The developed peak 100-year flow was calculated at 153 cfs, 90% of the existing peak runoff rate.

LITTLE THOMPSON RIVER BASIN 8

Subbasin LTRB8 is a 138.1 acre basin that drains from the east and west into an unnamed drainage channel in the center of the basin that flows to the north to CR38. There are gravel roads, farmland and undeveloped areas within the basin. Flow from LTRB7 discharges in LTRB8. The peak routed flow to the basins outlet is 263 cfs. LTRB8's peak runoff rate was calculated at 192 cfs. A SWMM model of the ponding area and 30-inch outlet pipe at the subbasin was created with the routed flow hydrograph using dynamic wave and indicate that the pond is flooding, and the outlet is undersized. The outlet pipe can transport approximately 121 cfs. Therefore, the developed 100-year peak runoff rate has been calculated to be 0.88 cfs/acre to account for the existing capacity of the 30-inch crossings and to not cause negative effects downstream of the outlet. Detailed analysis of the downstream systems response to the increased release rate from LTRB8 can be completed and the developed peak flow could be increased if the analysis showed the downstream system could accommodate the increased flows.

LITTLE THOMPSON RIVER BASIN 9

Subbasin LTRB9 is north of LTRB5 and receives flows from LTRB5. The basins outlet is a retention pond in Holmes Draw. The subbasin is 39.6 acres consisting of a rural residential property, undeveloped fields and a retention pond. The existing routed peak flow to the retention pond is 641 cfs. LTRB9's peak runoff rate was calculated at 70 cfs. However, there are several upstream retention areas that will affect the calculated routed peak flow and a more in-depth model should be created to analyze the drainage more accurately when development occurs. The subbasins retention ponds outlet is currently identified as the ponds embankment. Further investigation is required to determine the existence, location, capacity, outlet characteristics, and discharge rate of the ponds outlet pipe. The SWMM model created for the pond showed that the pond is not sized to store the entirety of the existing routed runoff volume, but the overflow in the pond's embankment will transport the excess flow once the pond reaches capacity. Runoff from the pond will overflow to the north over the gravel road and continue within Homes Draw to the north. Depending on if the retention area has a permitted volume and release rate, development in the basin will require a readjustment to the permit and/or resizing of the pond to accommodate the increased volume. The developed peak 100-year flow was calculated at 63 cfs, 90% of the existing peak runoff rate.

LITTLE THOMPSON RIVER BASIN 10

Subbasin LTBR10 is a 134.8 acre basin to the east of Holmes Draw that drains into the draw downstream of LTRB9. The subbasin is mainly undeveloped area with gravel roads, oil and gas well stations and a couple of rural residences. LTRB10 slopes to the west with the east edge being defined by a ridge west of CR5. The subbasin has a peak flow of 166 cfs. The combined peak

routed flows at the confluence subbasins of LTRB10 and LTRB6 and their upstream subbasins is 653 cfs, and assumes that the retention ponds or dams in the upstream subbasins do not influence the storm hydrographs. There were no hydraulic outfall calculations performed on Holmes Draw at the design point and the confluence with Big Hallow. The developed flow is calculated at 149 cfs, 90% of the exiting peak runoff rate, unless research proves that the downstream system cannot manage the proposed flows and volumes.

LITTLE THOMPSON RIVER BASIN 11

Subbasin LTRB11 is a 132.4 acre basin that drains to a depression area in the basin and has an overflow to the northwest into basin LTRB12 when the pond floods. The subbasin is located to the northwest of CR5 and CR36. The basin consists of several rural residences, open land and farmland, the ponding area, and gravel access drives. The subbasin generally slopes to the depression area in the center of the subbasin. The SWMM model showed that the ponding area has enough capacity to store the basins peak 100-year runoff, 242 cfs without flooding. The developed peak runoff rate is 218 cfs, 90% of the exiting peak runoff rate. If the depression area floods runoff will be directed into subbasin LTRB12 via an overflow swale. The capacity of the depression area should be analyzed when development occurs to ensure it can capture the increased volume and that downstream system can handle the overflow volume and runoff if the pond floods.

LITTLE THOMPSON RIVER BASIN 12

Subbasin LTRB12 is a 56.9 acre basin that drains to a two stage retention pond or water quality pond for the feedlot located on the north edge of the basin. The subbasin is west of CR5 and contain a feedlot, farmland and undeveloped land, gravel access roads, and the retention pond. There was no outlet found for the retention pond, but LiDAR contours show that the pond is approximately two feet deep and has an overflow located on the north side of the pond directing flow over a gravel drive into the downstream channel and a larger retention pond. LTRB12 currently has a 100-year peak runoff of 112 cfs and a routed peak runoff rate of 290 cfs. The pond is not adequately sized to retain the entirety of the peak 100-year runoff flows. Depending on if the retention area has a permitted volume and release rate, development in the basin will require a readjustment to the permit and/or resizing of the pond to accommodate in the increased volume. The capacity of the pond and outfall should be further analyzed when development occurs to ensure it can capture the increased volume and that downstream system can handle the overflow volume and runoff if the pond floods. The developed peak 100-year runoff was calculated to be 101 cfs, 90% of the exiting peak runoff rate.

LITTLE THOMPSON RIVER BASIN 13

Subbasin LTRB13 is a 107.7 acres basin drains into a large retention area whose northern embankment is New Ish Ditch. The subbasin is also upstream of small ponding area before CR38 at the southwest corner of CR5 and CR38. LTRB13 consists mostly of farmland and undeveloped land with a rural residence and gravel roads. There was no outlet to the retention pond found, but it is assumed there should be an outlet transporting flow under New Ish Ditch to the north. LTRB13's peak runoff rate was calculated at 228 cfs and its peak routed runoff rate was calculated at 318 cfs. The pond was model in SWMM with the routed hydrograph and the results indicated that the pond is adequately sized to retain the 100-year runoff flows. The calculated developed flow rate of 205 cfs, 90% of the exiting peak runoff rate, will not have a large effect on the retention pond. However, depending on the development land use the developed runoff volume into the

pond could dramatically increase and should be analyzed to ensure the increase in volume from development of both LTRB13 and LTRB12 does not cause the pond to flood.

LITTLE THOMPSON RIVER BASIN 14

Subbasin LTRB14 is located north of CR38 upstream of Thomas Reservoir with the New Ish Ditch along its southern boundary and CR38 to the north. The subbasin consists of 6.0 acres of undeveloped area, retention area, a rural residence. LTRB14 slopes to the west and the east into a drainage channel in the center of the basin that ponds at its outlet, a 36-inch CMP pipe under CR38 into Thomas Reservoir. The 100-year peak discharge rate for the subbasin is 8 cfs. The peak routed runoff rate was calculated at 320 cfs. The retention area was model in SWMM with the routed hydrograph and the results showed that the pond is not adequately sized to retain the 100-year runoff flows. The capacity of the pond should be further analyzed when development occurs to ensure it can capture the increased volume and that downstream system can handle the overflow volume and runoff if the pond floods. The developed peak 100-year runoff was calculated to be 7 cfs, 90% of the exiting peak runoff rate.

LITTLE THOMPSON RIVER BASIN 15

Subbasin LTRB15 is a 15.8 acre basin that drains directly into the New Ish Ditch and is bound by CR38, CR5 and a ridge. The New Ish Ditch runs to the east into the North Creek Basin and combining with Mead Lateral becomes the Farmers Extension Canal. The Canal runs to the east through the North Creek Basin across I-25 and then turns to the northeast through Maintenoma Reservoir Basin and ultimately directs to the north and drains into Little Thompson River. The subbasin consists of farmland, undeveloped area and rural residences. The runoff from LTRB15 is assumed to remain in the ditches and not affect the basins the ditches run through. Upon development of the subbasin it is possible the ditch company will not accept developed flows. Investigation and analysis of the possibility of discharging flows into Thomas Reservoir would need to be completed during development review. If the ditch company accepts the developed flows the effects of the increased volume should be analyzed downstream. The 100-year runoff rate is 25 cfs with the developed runoff rate of 23 cfs, 90% of the exiting peak runoff rate. Since most of the basin contains rural residences it is not assumed that the basin will be developed in the near future, however with the layout of the parcels the basin may become part of basin NCB1 which is east of LTRB15. If this occurs the peak runoff and routed flows of NCB1 and downstream basin should be reanalyzed.

LITTLE THOMPSON RIVER BASIN 16

Subbasin LTRB16 is a 83.5 acre basin that contains Thomas Reservoir, but ultimately drains into the roadside swale along the west side of CR5 until ponding in a depression area and crossing CR5 via sheet flow. The subbasin is mostly farmland and undeveloped area with the Thomas Reservoir located in the southeast corner of the subbasin. Downstream of Thomas Reservoir's outlet flows are splits to the east under CR5 via a 30-inch CMP at 4.4% slope and a discharge rate of 48.7 cfs into Ide and Starboard Ditch and north under a gravel drive via an 18-inch CMP at a slope of 0.12% and a discharge rate of 2.0 cfs and continues north using the roadside swale. The Ide and Starboard Ditches 30-inch pipe is offset 0.24 feet. The Town has identified the roadside swales for CR5 along the east side of Thomas Reservoir as an area that floods during storm events. Approximately 33% of the subbasins area drains to the confluence of the two pipe crossings north of the reservoir in the roadside ditch. The routed 100-year peak runoff flow into the LTRB16 and into Thomas Reservoir is 320 cfs which drains into Thomas Reservoir. LTRB16 has a peak 100-

year runoff flow rate of 129 cfs and a routed peak runoff rate of 320 cfs. Approximately 33% of LTRB16's basin drains to the swales located around the reservoir, a peak of 43 cfs. The swales converge at the two inlets north of the reservoir. The two outlet pipes should be adequate to transport the flows. However, the flow rate does not include any discharge flow from Thomas Reservoir, whose discharge rate is unknown at this time. The discharge rate of the reservoir needs to be investigated to determine if undersized pipes is causing any of the noted flooding in the area. Another cause of flooding is that flow from the east side of CR5 sheet flows across the road during storm events which can be mitigated by a pipe or proper roadside grading. Additional flow in the west roadside swale that will drain to the 18-inch pipe will also cause pipe capacity issues and flooding at the north end of Thomas Reservoir.

At the subbasins outlet there is a small ponding area that captures a large portion of the sites runoff that does not drain to the roadside swale. This pond will overtop when capacity is met and discharge the flows into the roadside swale before sheet flowing to the east over CR5. There is no outfall pipe to transport flows under CR5. When development occurs, a crossing should be investigated and installed to reduce flooding of CR5. The developed peak runoff is calculated to be 116 cfs, 90% of the exiting peak runoff rate.

LITTLE THOMPSON RIVER BASIN 17

Subbasin LTRB17 is a 163.4 acre basin located to the north of CR38 and east of CR5. There are several drainage channels that all transport flow to a larger drainage channel that outlets at a 36-inch CMP pipe under CR5. The subbasin consists mainly of undeveloped area, farmland, gravel drives, and portion of a rural residence. The Ide and Starboard Ditch bisects the subbasin, but it is assumed the Ditch does not capture any of the runoff flow. The 100-year peak discharge rate for the subbasin is 235 cfs. The peak routed 100-year runoff rate was calculated at 320 cfs. The 36-inch pipe outlet pipe is currently full of dirt and not transporting any flow. If clean out it has a capacity of approximately 40 cfs. According to the LiDAR contours the excess flow will continue north along the roadside swale until reaching the next pipe crossing and ponding area located in LTRB18. The recommended developed peak runoff is 0.24 cfs/acre which will decrease the runoff flows after development to the existing discharge rate of the 36-inch pipe after all the debris in and around the pipe has been removed. If the crossing capacity is increased the recommended discharge rate can be increased to match the new available capacity.

LITTLE THOMPSON RIVER BASIN 18

Subbasin LTRB18 is located north of LTRB17 and to the east of CR5. The 84.0 acre basin consists of undeveloped area and farmland with gravel path and is intersected by the Ide and Starboard Ditch. A drainage channel in the center of the subbasin collects runoff from the north and south of the subbasin and directs flows to the west until reaching CR5's roadside ditch. There is an 18-inch CMP at the outfall that transport the subbasin runoff under CR5 into LTRB19. The 100-year peak runoff rate was calculated at 153 cfs. The outfall pipe is located in a depression area with CR5 acting as an overflow. The two and a half foot ponding area and 18-inch outlet pipe was modeled in SWMM. The model showed that the ponding area and outlet are not adequately sized to transport the subbasin runoff flows without flooding CR5. To prevent flooding of CR5 and the downstream retention area the developed peak runoff rate is calculated at 0.19 cfs/acre; the 18-inch pipe has a capacity of 15.9 cfs. If the ponding area was increased or the outlet pipe under CR5 is increased to transport existing flows the developed outflow can be adjusted to reflect the updated outfall release rate.

LITTLE THOMPSON RIVER BASIN 19

Subbasin LTRB19 is a 40.1 acre basin located on the west side of CR5 and collects flows from LTRB17 and LTRB18. The subbasin consists mainly of undeveloped area, farmland, gravel drives, and rural residential properties. The subbasin slopes to the northwest to a retention pond that acts as the outlet for the subbasin. There was no identified outlet pipe for the retention pond with the overflow located along a gravel road along the northwest side of the pond. The SWMM model showed that the ponding area floods during the 100-year event using the routed influent flow hydrograph. The peak runoff rate for the subbasin was calculated at 69 cfs with the routed peak flow calculated at 409 cfs. Since the retention pond is most likely meant to overflow during larger storm events the developed peak runoff rate for the basin was calculated at 62 cfs, 90% of the exiting peak runoff rate. Further investigation of the ponding area and possible outfall should be conducted when development occurs to ensure there no negative impacts to existing infrastructure and downstream properties.

LITTLE THOMPSON RIVER BASIN 20

Subbasin LTRB20 is a 7.7 acre basin located north of LTRB18 and east of CR5. The subbasin collects a small portion of runoff from the farmland and undeveloped area east of CR5 with its eastern boundaries defined by ridge lines. Slopes direct flow to the center of the basin where a drainage channel has formed to transport flow to the west until reaching CR5 and a small ponding area at an 18-inch CMP outlet pipe. The peak 100-year runoff rate of 12 cfs. The ponding area and culvert were modeled in SWMM to determine how the culvert is function dynamically during storm events. The model showed that the pipe and minimal ponding area are adequately sized to capture and transport the runoff flows. The developed peak runoff rate was calculated at 11 cfs, 90% of the exiting peak runoff rate.

LITTLE THOMPSON RIVER BASIN 21

Subbasin LTRB21 is located north of LTRB20 and east of CR5. The 101.3 acre basin drains to the northwest and southeast until reaching CR5's roadside ditch which transport flows to the north and south until reaching the low spot along the ditch where there is a 36-inch CMP culvert under CR5. On the north side of the subbasin there is a feedlot with farm buildings that drain to the southeast, while the southern part of the subbasin is farmland and undeveloped area with gravel roads and an oil and gas well station that all drain to the northeast. The peak runoff rate for LTRB21 was calculated at 208 cfs. Only the culvert was model in SWMM because there was no ponding area around the culvert indicated in the LiDAR. The model results showed that to that the pipe and ponding area is not adequately sized to transport the peak runoff volume without flooding CR5. The capacity of the 36-inch pipe is approximately 195 cfs. The developed peak runoff rate was calculated at 187 cfs, 90% of the existing peak runoff rate. There has been observed flooding in the basin which can be attributed to the undefined roadsides swales that permit flows to sheet flow across CR5 rather than flowing in the swale to the outlet pipes.

LITTLE THOMPSON RIVER BASIN 22

Subbasin LTRB22 is a 164.0 acre basin that is located west of CR5 and north of CR 40 ½. The subbasin generally drains to the northwest into the Big Hallow. There is a drainage channel within the subbasin that runs northwest to the Big Hallow starting in the southeast corner of the subbasin near CR5. Most of the subbasin slopes to the drainage channel within the subbasin, the areas that do not are sloped to the north discharging flows into a drainage ditch along CR40 1/2 which is directed to the west to the Big Hallow. The subbasin consists of a few rural residents, and oil and

gas well station, farmland and undeveloped area. The subbasin transports flow from upstream basins LTRB1-LTRB10, LTRB14, and LTRB16-LTRB21. The peak routed flow for the subbasin represent the runoff flow for the eastern area that contributes to Big Hallow from the confluence of Holmes Draw at CR40 1/2. The peak runoff rate for LTRB22 was calculated at 236 cfs. The peak routed flows for LTRB22 is 878 cfs. Since the west side of the Big Hallow basin was not delineated and analyzed, the hydraulics of the Big Hallow crossing under CR40 ½ was not analyzed. There have been no reports of flooding of the road therefore, the developed peak 100-year runoff rate was calculated to be 212 cfs, 90% of the exiting peak runoff rate.

LITTLE THOMPSON RIVER BASIN 23

Subbasin LTRB23 is a 43.5 acre basin that is located north of LTRB21 and east of CR5. The basin contains a portion of a feedlot and its operations area, undeveloped area, a rural residence and gravel roads. LTRB23 slopes to the north and drains into CR5's eastern roadside ditch until reaching CR42. There is a 14-inch PVC culvert that transports the flows from the subbasin to the north under CR42 and eventually into the Little Thomas River via a roadside ditch. The pipe has a capacity of 8.4 cfs. The peak flow in the basin is 62 cfs. The outlet will overflow across CR42 to the north and continue to the north to Little Thomas River. The calculated developed 100-year runoff rate for the basin is 0.20 cfs/acre to reduce the risk of more flooding of CR42. If the pipe crossing is enlarged to accommodate the calculated 100-year runoff rate, then the outflow rate can be updated to match Town standards.

LITTLE THOMPSON RIVER BASIN 24

Subbasin LTRB24 is a 77.4 acre basin that includes the eastern portion of Big Hallow north of CR40 1/2 that drains into Little Thomas River and is bound to the east by CR5 and south by CR40 1/2. The basin consists of rural residents and undeveloped area. The peak runoff rate for LTRB24 was calculated at 81 cfs. The subbasin has a routed peak 100-year runoff rate of 878 cfs where the Little Thomas River crosses under CR5. The runoff rate is not indicative of the flowrate in the Little Thomas River because the flow from the contributing subbasins is a very small portion of the flows contributing to the River at CR5. The developed runoff rate is calculated at 73 cfs, 90% of the exiting peak runoff rate.

LITTLE THOMPSON RIVER BASIN 25

Subbasin LTRB25 is a 161.0 acre basin east of CR7, to the west of subbasin CR40B1, and north of the North Creek Basin. The subbasin generally drains to north and south into a drainage channel within the subbasin that collects runoff and transport the flows to the northwest to the subbasin outfall, a 36-inch CMP pipe located at CR7. LTRB25 consists of farmland, undeveloped areas, gravel access road and an oil and gas well station. The peak 100-year runoff rate was calculated at 227 cfs. The 36-inch pipe has a capacity of 111 cfs. The SWMM model of the outfall culvert and ponding area indicated that the outfall is not adequate to keep the runoff from overtopping CR7. There is area at the outlet that can be regraded to provide an more storage volume to mitigate flooding over CR7. The calculated developed 100-year runoff rate for the basin is 0.69 cfs/acre to reduce the risk of increased flooding of CR7 when development occurs.

LITTLE THOMPSON RIVER BASIN 26

Subbasin LTRB26 is 614.4 acre basin that contains the entire area west of CR7, south of CR42, north of CR38 and east of the subbasins that drain to the east to CR5. The outfall for the subbasin was hard to discern along CR42 using the LiDAR data and no culvert was found during a site visit.

A drainage channel is apparent at the upper portion of the drainage basin, but as the basin flattens the channel wanes. According to the LiDAR data, flows drain into CR42's southern roadside ditch and are directed to a low spot approximately 600 feet east of CR5 where runoff ponds and eventually sheet flows across CR42. Most of the subbasin is undeveloped land and farmland, with a few rural residents, oil and gas well stations and gravel access roads. The peak runoff rate for LTRB26 was calculated at 544 cfs. The routed peak runoff was calculated at 558 cfs. The developed basin peak runoff rate is calculated to be 490 cfs, 90% of the exiting peak runoff rate. Further investigation of the northern basin edge along CR42 should be completed and a pipe installed to transport flows under CR42 when development occurs.

Table 6. Little Thompson River Basin Discharge Summary

Basin ID	Design Point ID	Area (acre)	Existing Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
LTRB1	47	160.0	2.1%	248	248	223 cfs	N
LTRB2	48	20.6	2.0%	22	22	20 cfs	N
LTRB3	49	248.6	6.1%	335	449	302 cfs	Y
LTRB4	50	68.6	22.7%	83	473	75 cfs	Y
LTRB5	51	58.2	16.4%	128	641	115 cfs	N
LTRB6	52	98.5	3.0%	92	653	83 cfs	Y
LTRB7	53	141.2	4.3%	170	170	153 cfs	N
LTRB8	54	138.1	3.3%	192	263	0.88 cfs/acre	N
LTRB9	55	39.6	12.7%	70	641	63 cfs	N
LTRB10	56	134.8	11.2%	166	166	149 cfs	Y
LTRB11	57	132.4	4.5%	242	242	218 cfs	Y
LTRB12	58	56.9	10.9%	112	290	101 cfs	N
LTRB13	59	107.7	19.7%	228	318	205 cfs	Y
LTRB14	60	6.0	10.3%	8	320	7 cfs	N
LTRB15	61	15.8	11.9%	25	25	23 cfs	Y
LTRB16	62	83.5	23.0%	129	320	116 cfs	N
LTRB17	63	163.4	4.2%	235	320	0.24 cfs/acre	N
LTRB18	64	84.0	4.1%	153	153	0.19 cfs/acre	N
LTRB19	65	40.1	6.1%	69	409	62 cfs	N
LTRB20	66	7.7	4.9%	12	12	11 cfs	Y
LTRB21	67	101.3	19.4%	208	208	187 cfs	Y
LTRB22	68	164.0	5.2%	236	878	212 cfs	Y
LTRB23	69	43.5	26.6%	62	62	0.20 cfs/acre	N
LTRB24	70	77.4	13.4%	81	878	73 cfs	Y
LTRB25	71	161.0	3.2%	227	227	0.69 cfs/acre	N
LTRB26	72	614.4	3.4%	544	558	490 cfs	N

*Adequate capacity is based on routed 100-year peak flow rate

HWY66 Basin

Major basin HWY 66 Basin (H66B) includes a 2152.1 acre area that drains to Highway 66 via an unnamed drainage channel that runs from the northwest to southeast starting north of CR34 and west of CR3 and continues until reaching the St. Vrain Creek. The channel has retention areas and road crossing that act as outfalls for the subbasins and were used to define the subbasin boundaries. The Town identified Highway 66 as the southern boundary for the study area based on the existing Town boundary. There is one area reported by the Town that has flooding issues in the roadside swales in the northeast corner of CR5 and CR32 and is located in basin H66B11. The basin is delineated into twelve subbasins.

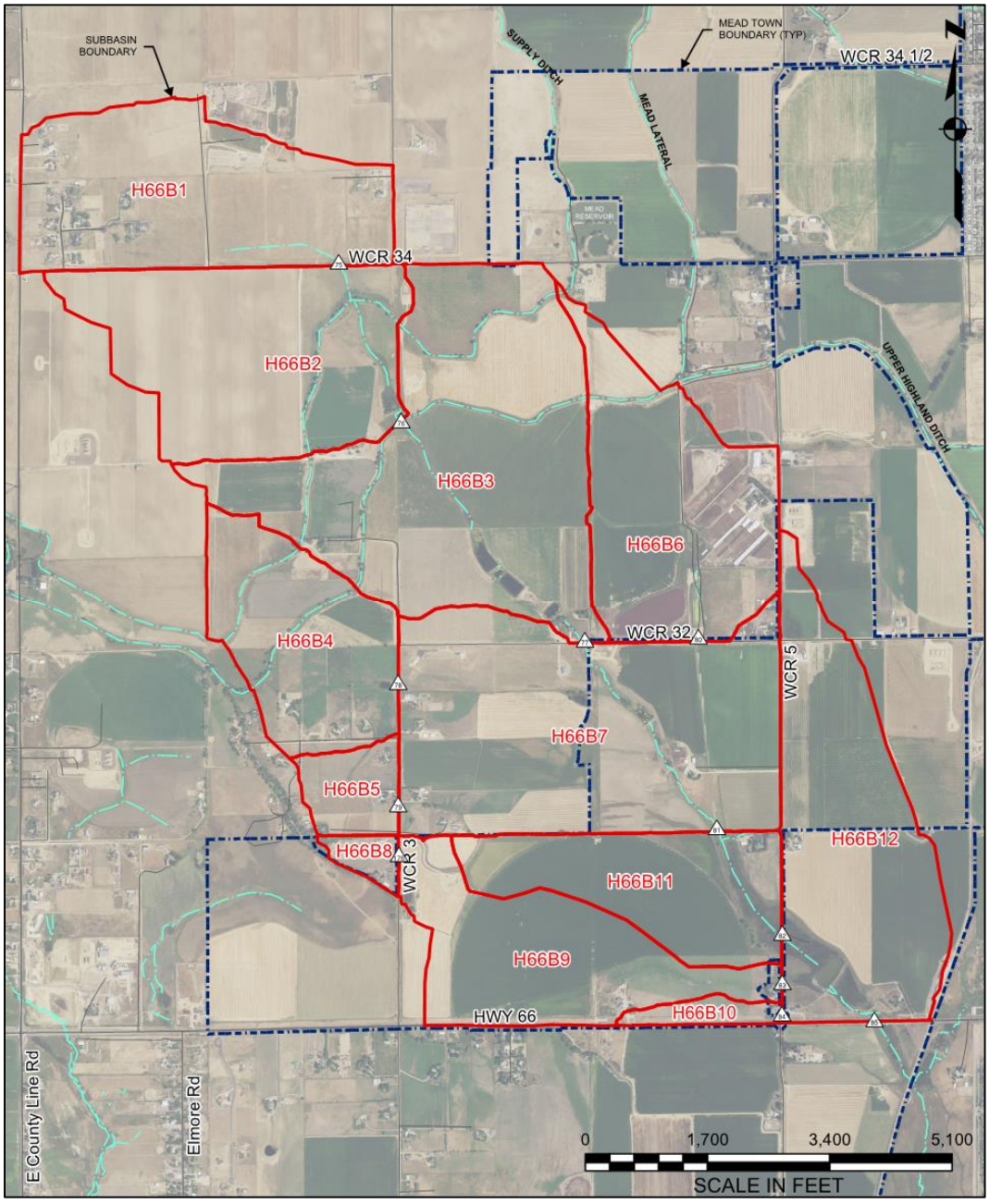

Figure 12. HWY66 Basin Map

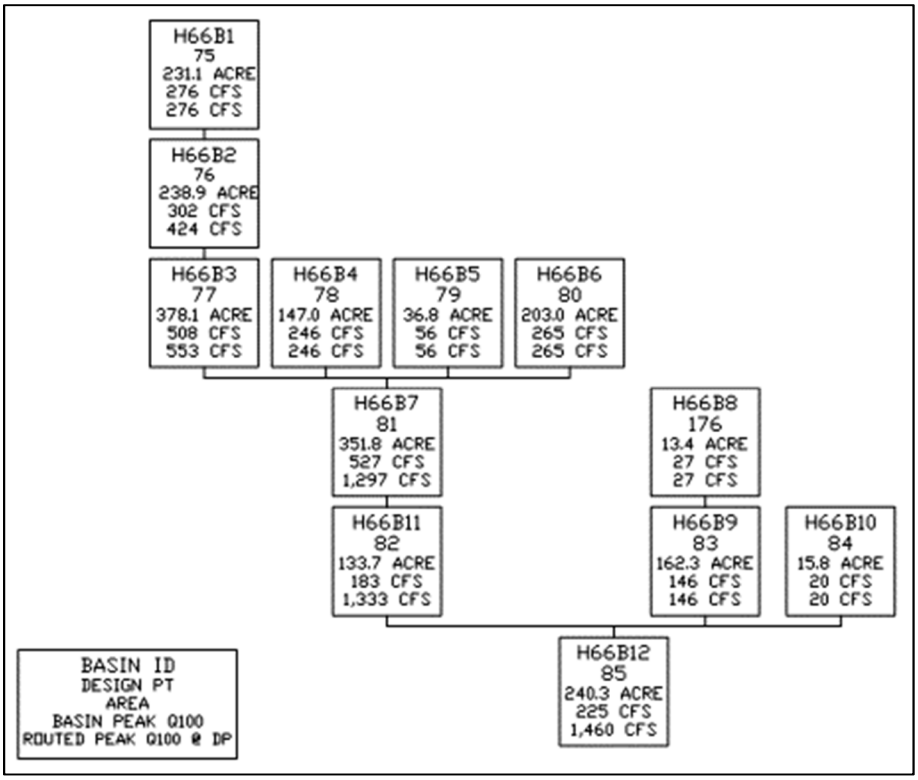

Figure 13. HWY66 Flow Routing Schematic

HWY66 BASIN 1

Subbasin H66B1 is a 231.1 acre basin that is located east of CR1, west of CR3, and north of CR34. The land use consists of a small estate development, separate rural residences, undeveloped area, a small portion of a feedlot, and farmland. The subbasin drains east and south until reach CR34's northern roadside swale which directs flow to a low spot along the road where runoff ponds before sheet flowing over CR34 to the south. The existing 100-year peak runoff for the subbasin is 276 cfs. A SWMM model of the low spot ponding area with the flow hydrograph using dynamic wave indicated that the low spot is not adequate to detain the 100-year routed runoff rate without overtopping CR34. The developed 100-year peak runoff rate was calculated at 248 cfs, 90% of the exiting peak runoff rate. As the subbasin is developed a culvert crossing at low spot along CR34 must be installed to transport the peak flows under CR34 to mitigate further flooding and reduce the risk of negative impacts to the downstream basins and infrastructure.

HWY66 BASIN 2

Subbasin H66B2 is a 238.9 acre basin that is located south of CR34 with is boundary defined by CR34 to the north, ridges long the east and west sides and a detention area and a retention area upstream of Upper Highland Ditch. H66B2 consists of farmland, undeveloped areas, an oil and gas well station, gravel access drives, and retention pond draining into the unnamed drainage channel. Supply Ditch also runs through the subbasin. Runoff generally flows from the west to east and south into a drainage channel and retention pond and ponding area located in the southeast corner of the subbasin. The retention pond within the drainage channel is upstream of the detention area that has a pipe under the Upper Highland Ditch. The outlet pipe was not able to be located at the time of the study. The existing 100-year peak runoff for the subbasin is 302 cfs. The routed existing 100-year peak flow was calculated to be 424 cfs. A SWMM model of the outfall was

created using the routed flow hydrographs and the pond areas indicated that the retention pond and detention pond with no outfall pipe under the Ditch are not adequate to detain the 100-year routed runoff rate without overflowing into the Ditch. As development occurs the retention and detention ponds and outlets should be further analyzed to determine the outlet pipe diameter and capacity and the effects the development will have on the existing capacity of the ponds and current infrastructure. The developed 100-year runoff rate for H66B2 was calculated to be 272 cfs, 90% of the exiting peak runoff rate.

HWY66 BASIN 3

Subbasin H66B3 is a 378.1 acre basin that is located downstream of H66B2. The subbasin consists of farmland, undeveloped areas, rural residences, and gravel roads. Both the Supply Ditch and Upper Highland Ditch cross through the subbasin. The site generally drains to the east and south with most of the runoff being collected in the major drainage channel that has a series of four retention ponds along channel and drains to the subbasin outfall at CR32. The area east of the major drainage channel sheet flow to the south to the detention area at the outfall and most of the flows bypass all but one of the retention areas. The existing 100-year peak runoff for the subbasin is 508 cfs. The peak routed 100-year runoff was calculated at 553 cfs. The routed storm hydrograph was modeled in SWMM along with the outfall detention area and 17 foot by 4.33 foot box culvert under CR32. The box culvert was found during Town site investigation, not during the survey by Flatirons Inc. The model results indicated that the detention pond and culvert are adequate transport the routed flows. The developed 100-year peak runoff rate was calculated to be 457 cfs, 90% of the exiting peak runoff rate. As development occurs the volume capacity for existing and developed conditions for all the retention ponds should be investigated and along with any existing permitting. Survey of the retention ponds, detention pond and culvert must be performed to confirm assumptions.

HWY66 BASIN 4

Subbasin H66B4 is a 147.0 acre basin that is located southwest of basin H66B3 and west of CR3. The subbasin consists of rural residents, undeveloped areas, farmlands, and gravel access roads and areas. Both the Supply Ditch and Upper Highland Ditch cross the basin. Runoff generally flows to the east to CR3 where it is then directed north and south along the western roadside swale of CR3 to the subbasin outfall, a 36-inch culvert under CR3 into H66B7. The 100-year runoff rate was calculated at 246 cfs. A SWMM model of the outfall was created using the subbasins flow hydrograph, the ponding area, and culvert and the results indicated that the outfall system is not adequate to detain the 100-year runoff rate without overflowing CR3. The 36-inch outlet has an approximate capacity of 62.2 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.42 cfs/acre. Further analysis and survey of the ponding area and existing culvert should be completed before development of the area to confirm the design assumptions and determine flooding mitigation options.

HWY66 BASIN 5

Subbasin H66B5 is a 36.8 acre basin that is located to the south of H66B4 and west of CR3. The subbasin consists of rural residents and undeveloped area with gravel access roads. Runoff generally flows to the east to CR3 where it is then directed north and south along the western roadside swale of CR3 to the subbasin outfall, a 24-inch culvert under CR3 into H66B7. The 100-year runoff rate was calculated at 56 cfs. A SWMM model of the outfall was created using the

subbasins flow hydrograph, the ponding area, and culvert and the results indicated that the outfall system is not adequate to detain the 100-year runoff rate without overflowing CR3. The 24-inch outlet has an approximate capacity of 15.7 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.43 cfs/acre. Further analysis and survey of the ponding area and existing culvert should be completed before development of the area to confirm the design assumptions and determine flooding mitigation options.

HWY66 BASIN 6

Subbasin H66B6 is a 203.0 acre basin that is comprised mostly of farmland, undeveloped area, rural resident, a feedlot and retention pond, and gravel access drives. The subbasin is located to the northwest of CR5 and CR32. Approximately 111.1 acres of subbasin drainage area drains into a 52 acre feedlots retention pond. The rest of the subbasin drains to the south to CR32 with runoff flowing within the roadside swale to the east and west until reaching the outfall, a 26-inch culvert under CR32. The subbasins existing peak runoff rate was calculated at 265 cfs including the area that drains into the feed lot retention pond. A SWMM model of the outfall was created using the subbasins flow hydrograph, the ponding area, and culvert. It is assumed that with future development of the area the feedlot will be removed, and the outfall will be required to transport the entirety of the subbasin flows. The model results indicated that the outfall system is not adequate to detain the 100-year runoff rate without overflowing CR32. The 26-inch outlet has an approximate capacity of 26.6 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.13 cfs/acre. Further analysis and survey of the ponding area and existing culvert should be completed before development of the area to confirm the design assumptions and determine flooding mitigation options.

HWY66 BASIN 7

Subbasin H66B7 is a 351.8 acre basin that has the runoff flow from subbasins H66B3-H66B6 discharge directly into the subbasin at separate locations. The land use consists of rural residences, undeveloped area, and gravel access drives. The subbasin is located between CR3 and CR5 and south of CR32. H66B7 drains into a drainage channel flowing north to south located centrally in the subbasin. The embankment between farm fields creates a swale that directs flow east and west to the drainage channel and defines the southern subbasin boundary. The low spot at the confluence of the drainage channel and the farm field embankment swale is the subbasin outfall. The low spot in the embankment swale is not large enough to affect the flows from the drainage channel. The existing 100-year peak runoff for the subbasin is 527 cfs. The existing 100-year routed runoff rate was calculated at 1,297 cfs. Since the outfall a low spot in the embankment that easily overflows, the developed flow rate was calculate at 474 cfs, 90% of the exiting peak runoff rate. As development occurs coordination with the Town will be required to determine the outfall configuration for the subbasin based on the proposed developed.

HWY66 BASIN 8

Subbasin H66B8 is a 13.4 acre basin located to the south of subbasin H66B5 and west of CR3. The subbasin consists of rural residences, gravel drives, and undeveloped areas. A roadside swale along the west side of CR3 collects flows from the east and transports them to the subbasin outfall, a 24-inch culvert under CR3. The existing 100-year peak runoff for the subbasin is 27 cfs. A SWMM model of the ponding area, 24-inch culvert, and the subbasin flow hydrograph using

dynamic wave was created and indicate that ponding area and culvert are adequately sized to transport the subbasin flows. The developed 100-year peak runoff rate was calculated to be 24 cfs, 90% of the exiting peak runoff rate.

HWY66 BASIN 9

Subbasin H66B9 is a 162.3 acre basin that is located west of CR5, east of CR3, and north of Highway 66. The subbasin consists of mainly undeveloped areas with some farmland and rural residences. The site generally slopes to the east and is defined by ridges that separate the subbasin from H66B10 and H66B11 and receives flow from H66B8. Runoff from H66B9 flow into CR5's roadside swale where it is then directed to the basin outfall, an 18-inch CMP culvert. The existing 100-year peak runoff for the subbasin is 146 cfs. The peak routed flow rate was calculated at 146 cfs. A SWMM model of the ponding area, 18-inch culvert, and the subbasin flow hydrograph using dynamic wave was created. The model indicated that ponding area and culvert are not adequately sized to transport the subbasin routed flows. The 26-inch outlet has an approximate capacity of 12.6 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.08 cfs/acre. Further analysis and survey of the ponding area and existing culvert should be completed before development of the area to confirm the design assumptions and determine flooding mitigation options.

HWY66 BASIN 10

Subbasin H66B10 is a 15.8 acre basin that is located to the north of Highway 66 and the east of CR5. The site consists mainly of farmland and a rural residence and is sloped to the east towards CR5. There is a small drainage channel parallel to Highway 66 that collects most of the subbasin runoff and transports the flows to CR5. There is no ponding area indicated in the LiDAR data and no outfall culvert under CR5 was found during site investigation by the Town. Therefore, the runoff flows from the subbasin will overflow CR5 to the east once reaching CR5. The 100-year runoff rate for the basin was calculated at 20 cfs. The developed peak runoff flow rate was calculated to be 18 cfs, 90% of the exiting peak runoff rate. When development occurs, a pipe crossing must be constructed to transport the 100-year event flows under CR5.

HWY66 BASIN 11

Subbasin H66B11 is a 133.7 acre basin located to the west of CR5 and north of Highway 66. The subbasin consists of farmland, undeveloped areas, and a rural residence. Runoff generally sheet flows into the drainage channel located on the east side of the subbasin near CR5. The drainage channel is slope north to south through the subbasin and transports flows to the subbasin outfall, a 36-inch culvert under CR5. The existing 100-year peak runoff for the subbasin is 183 cfs. The calculated routed peak flow in the basin is 1,333 cfs. There is a ponding area within the drainage channel upstream of the culvert crossing. A SWMM model of the ponding area, 36-inch culvert, and the routed flow hydrograph using dynamic wave was created. The model indicated that ponding area and culvert are not adequately sized to detain and transport the subbasin routed flows without overflowing CR5. The 18-inch outlet has an approximate capacity of 74.6 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.56 cfs/acre. With the retention and ponding areas upstream, the routing flows could be overestimated based on the simplified methodology of the Plan and the entire system can be modeled to understand more fully how the system is performing.

HWY66 BASIN 12

Subbasin H66B12 is the furthest downstream basin of H66B and is 240.3 acres. The subbasin consists of farmland, an oil and gas station, the drainage channel and its wetland area surrounding the channel, rural residences, and undeveloped open space. The subbasin slopes to the south toward Highway 66 along the south side of the subbasin and to the west to the drainage channel along the southwest corner of the subbasin. H66B1-H66B11 all drain into H66B12. The subbasin outfall is the drainage channels 60-inch culvert under Highway 66. The routed peak flow from H66B12 was calculated at 1,460 cfs. The existing 100-year peak runoff for the subbasin is 225 cfs. A SWMM model of the ponding area, the 60-inch culvert, and the routed flow hydrograph using dynamic wave was created. The model indicated that ponding area and culvert are not adequately sized to detain and transport the subbasin routed flows without overflowing Highway 66. The 60-inch RCP can transport approximately 662.2 cfs. Therefore, the H66B12's peak flows can easily be transported via the culvert and the developed 100-year runoff rate was calculated at 203 cfs, 90% of the exiting peak runoff rate. There is a discharge structure controlling flows upstream of the 60-inch culvert that could potentially affect the flows to the culvert depending on the depth of the sliding gate valve and channel capacity. Further investigation of the culvert and ponding area should be performed as development occurs within the subbasin and upstream subbasins to reduce the risk of negative impacts to the downstream basins and infrastructure.

Table 7. HWY66 Basin Discharge Summary

Basin ID	Design Point ID	Area (acre)	Existing Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
H66B1	75	231.1	7.3%	276	276	248 cfs	Y
H66B2	76	238.9	2.7%	302	424	272 cfs	Y
H66B3	77	378.1	6.1%	508	553	457 cfs	Y
H66B4	78	147.0	7.4%	246	246	0.42 cfs/acre	N
H66B5	79	36.8	10.9%	56	56	0.43 cfs/acre	N
H66B6	80	203.0	32.7%	265	265	0.13 cfs/acre	N
H66B7	81	351.8	6.2%	527	1,297	474 cfs	Y
H66B8	176	13.4	25.9%	27	27	24 cfs	Y
H66B9	83	162.3	4.8%	146	146	0.08 cfs/acre	N
H66B10	84	15.8	19.3%	20	20	18 cfs	N
H66B11	82	133.7	4.9%	183	1,333	0.56 cfs/acre	N
H66B12	85	240.3	5.6%	225	1,460	203 cfs	N

*Adequate capacity is based on routed 100-year peak flow rate

CALKINS LAKE BASIN

The Calkins Lake Basin (CLB) is a 278.7 acre basin located in the southwest corner of the study area and contains two subbasins that include the western most portion of the existing Town Limits. The two subbasins ultimately drain to the Calkins Lake located to the south of the CLB. The basin was not extended to include the entirety of the Calkins Lake watershed due to the study area boundary.

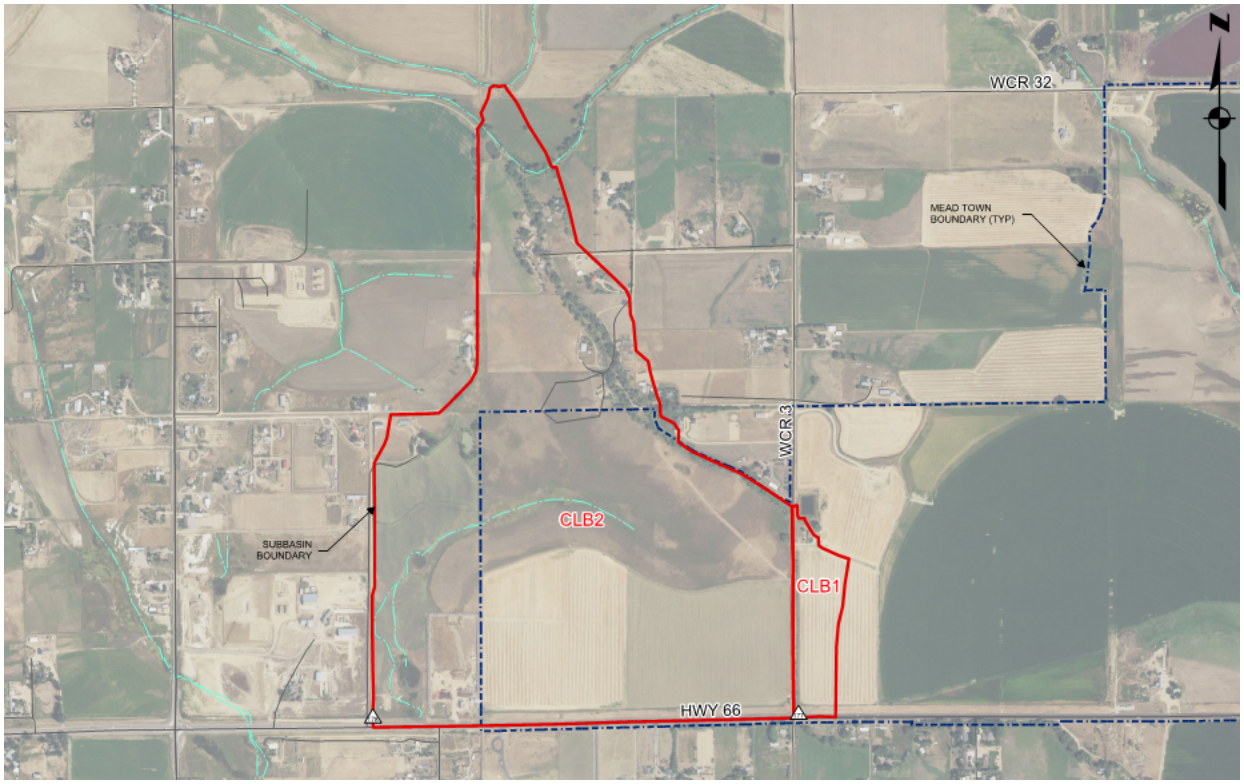

Figure 14. Calkins Lake Basin Map

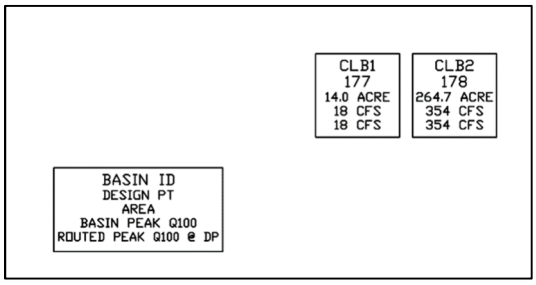

Figure 15. Calkins Lake Basin Schematic Routing

CALKINS LAKE BASIN 1

Subbasin CLB1 is a 14 acre basin that is located north of Highway 66 and east of CR3. The basin is comprised of farmland, 0.7 acres of developed land in the northeast corner of the basin, the eastern half of CR3, and the northern half of Highway 66. The site generally flows from northwest to southwest by sheet flow to a 96"x36" concrete box culvert under Highway 66 into a

basin outside of the Town of Mead. The box culvert also transports irrigation ditch flows. The routed existing 100-year peak flow was calculated to be 18 cfs. A SWMM model was run for the ponding area with the 36" x 96" Concrete Box outfall showing that the ponding area is sufficient to prevent flooding of Highway 66 during the 100-year runoff event. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 16.2 cfs, 90% of the exiting peak runoff rate.

CALKINS LAKE BASIN 2

Subbasin CLB2 is a 264.7 acre basin that is located north of Highway 66 and west of CR3. The subbasin is comprised of farmland, undeveloped land, 17.5 acres of developed land in the northeast and southwest corners of the basin, the western half of CR3, and the northern half of Highway 66. The subbasin generally flows from northwest to southwest by sheet flow into a ditch then to an 80"x24" open channel under a cattle guard and two 24" CMPs under the private drive in the southwest corner of the basin. The culverts discharge to the west into the roadside swale outside of Town limits. The routed existing 100-year peak flow was calculated to be 354 cfs. A SWMM model was run for the ponding area with the 80"x24" open channel and two 24" CMPs outfalls showing that the ponding area is sufficient to prevent flooding of the private drive during the 100-year runoff event. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 318.6 cfs, 90% of the exiting peak runoff rate.

Table 8. Calkins Lake Basin Discharge Summary

Basin ID	Design Point ID	Area (acre)	Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
CLB1	177	14.0	8.1%	18	18	16.2	Y
CLB2	178	264.7	6.5%	354	354	318.6	Y

*Adequate capacity is based on routed 100-year peak flow rate

West St. Vrain Creek Basin

The West St. Vrain Creek Basin (WSVCB) is a 2,131.8 acre basin that is located west of the HWY66 Basin. The basin generally drains from north to south from CR34 to St. Vrain Creek and is bound by the Upper Highland Ditch along most of the east side of the basin. A drainage channel along the southwest side of the basin defines the western edge of the basin and is where most of the subbasin discharge into before discharging into the St. Vrain Creek. The basin is moderately developed with two subdivision and Mead High School contributing to most of the developed areas. The basin crosses several major roadways, CR34, CR32, CR5, Highway 66, CR28, CR26, and CR7, and analysis of the capacity of the outfalls for the subbasins will provide pertinent information on the probability of flooding and negatively affecting the roadway infrastructure. There is a drainage channel along the west side of the basin that will collect flows from several of the subbasins. The drainage channel will also collect and transport flows from the HWY66 basin and watersheds to the east of the Study Area. An analysis of the drainage channel was not completed and the routed flows from HWY 66 basin were not included in the routed peak flow analysis for the WSVCB as it pertains to the flows through the described drainage channel. A basic analysis peak flows in the drainage channel at each major road crossing should be performed in the future to provide a complete understanding of the performance of the storm infrastructure and possible flooding.

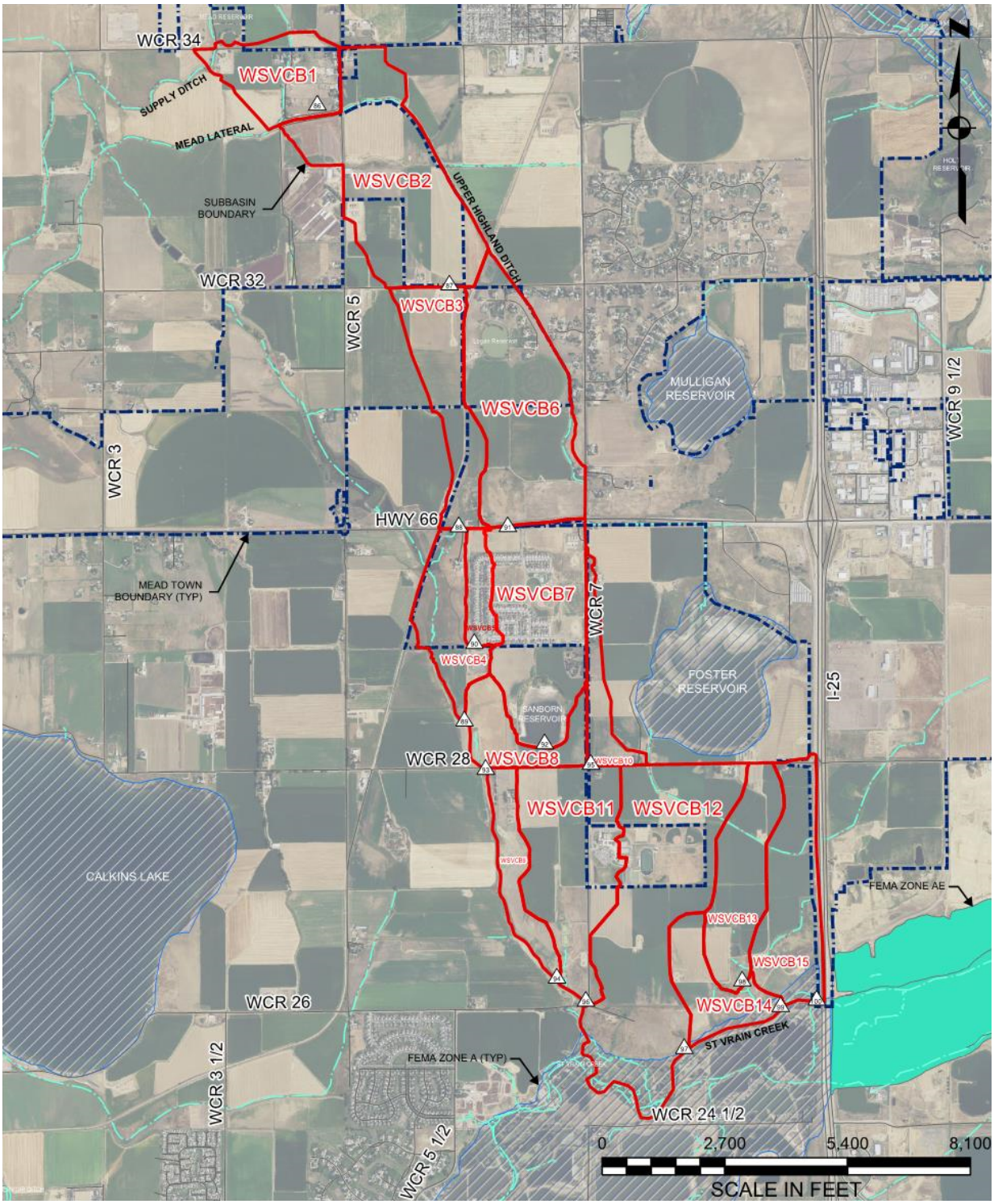

Figure 16. West St. Vrain Creek Basin Map

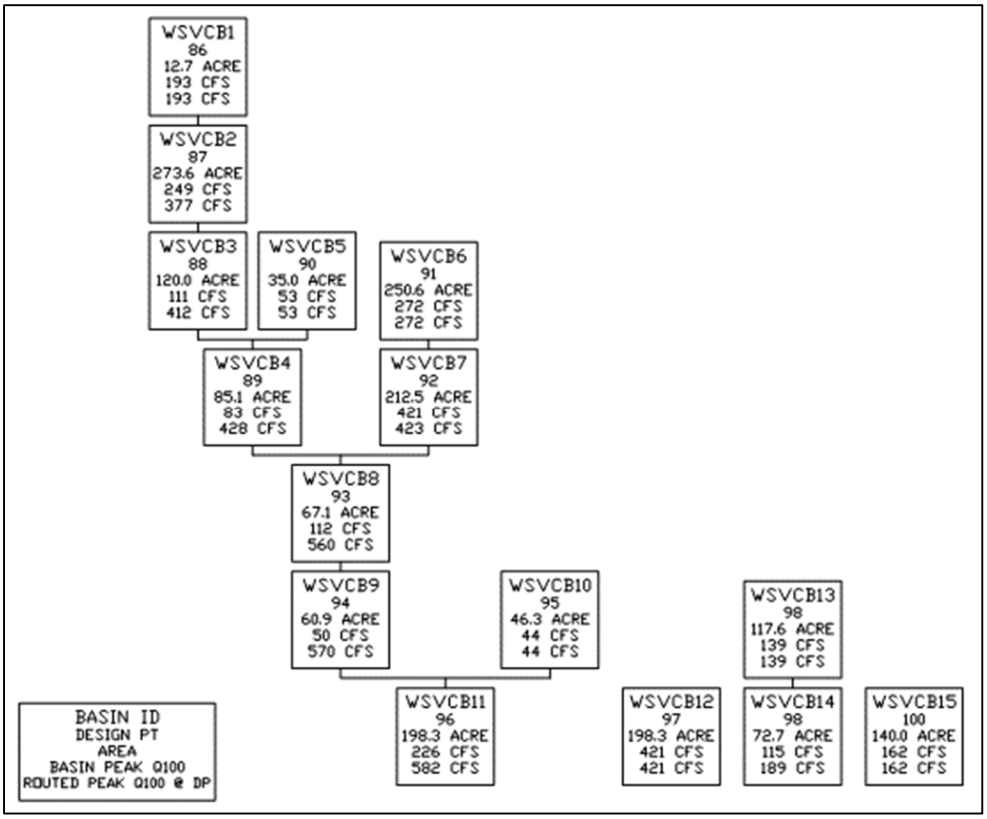

Figure 17. West St. Vrain Creek Flow Routing Schematic

WEST ST. VRAIN CREEK BASIN 1

Subbasin WSVCB1 is a 102.7 acre basin located to the south of NCB16 and to the West of Weld CR5. The subbasin is comprised mainly of farm land with 27 acres of developed land including rural residence and a commercial development. The subbasin contains a half a mile long stretch of CR34. The water sheet flows to the south east corner of the subbasin where there is a low point in an undeveloped field. There is also a swale following both sides of CR34 that conveys water to the east side of the subbasin where it sheet flows to the subbasins low spot. There are two culverts that convey the water under CR34 from the north side to the south side once the low spot is at capacity and overflows. The 100-year runoff rate for the subbasin was calculated to be 193 cfs. The SWMM model created for the low point shows that the pond is not sized to store the existing runoff volume with no outlet pipe. Currently, the runoff will flood first the commercial and residential developments and then south over CR5. Depending on if the retention area has a permitted volume and release rate, which is unlikely, any development in the subbasin will require a readjustment to the permit and/or resizing of the pond to accommodate in the increased volume. Grading of the area to transport flow downstream instead of ponding must be investigated when development occurs. The developed peak 100-year flow was calculated at 173 cfs, 90% of the exiting peak runoff rate.

WEST ST. VRAIN CREEK BASIN 2

Subbasin WSVCB2 is a 273.6 acre basin that is located to the south of CR34 and to the east of Weld CR5. The subbasin is comprised mainly of farm land with 18 acres of rural residence and commercial development. The north end of the basin is defined by the Upper Highland Ditch and water sheet flows from the north end of the site down to the south end through a drainage ditch

that runs down the middle of the subbasin. The outfall is located at the south end of the site where there is an 18-inch CMP culvert to transport flows under CR34. There was also a 12-inch clay pipe identified near the 18-inch pipe but, it is sloped from the south to north under CR34. The LiDAR data shows there is minimal ponding available at the outfall. The SWMM model of the culvert with the routed flow hydrograph using dynamic wave indicate that the culvert is flooding, and the pipe can convey approximately 1.0 cfs of flow. Excess flows will overflow CR34 to the south. The 100-year runoff rate for the subbasin was calculated to be 249 cfs. The 100-year routed runoff rate for the subbasin was calculated to be 377 cfs. The existing pipe needs to be increased or a ponding area needs to be added to eliminate flooding in existing conditions. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure the developed runoff rate was calculated to be 0.01 cfs/acre. If the outfall for the subbasin is upgraded the subbasin developed peak flows can be increased to match the available capacity.

WEST ST. VRAIN CREEK BASIN 3

Subbasin WSVCB3 is a 120.0 acre basin that is located to the south of CR32 and to the east of the railroad. The subbasin is mainly comprised of farm land with 5 acres of commercial development. The runoff sheet flows from the north end of the basin until reaching a swale that runs along the west side of the railroad tracks that then conveys the runoff to a ponding area located on the north side of Highway 66. The ponding area has a 40-inch culvert which acts as the subbasin outfall and conveys runoff under CR32 into WSVCB4. The 100-year peak runoff rate for the subbasin was calculated at 111 cfs. The 100-year routed runoff rate for the subbasin was calculated to be 412 cfs. The subbasin receives the runoff from WSVCB2 and WSVCB1. A SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicated that the pond area and the outlet are not adequate to detain and transport the 100-year routed runoff rate without flooding Highway 66. The culvert can only transport approximately 141.7 cfs. The 111 cfs from WSVCB3 can easily be transported through the existing culvert, but the routed flows cannot. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 100 cfs, 90% of the exiting peak runoff rate.

WEST ST. VRAIN CREEK BASIN 4

Subbasin WSVCB4 is an 85.1 acre basin that is located to the south of Hwy 66 and to the east of the rail road tracks. The subbasin is mainly comprised of undeveloped land with a 3 acre power plant and 2 acres of rural residential development. The runoff sheet flows from the north end of the site until reaching an unnamed drainage ditch that runs down the middle of the basin to a small ponding area at the south end. The 100-year peak runoff rate for the subbasin was calculated to be 83 cfs. The 100-year routed runoff rate was calculated at 428 cfs and the subbasin receives the runoff from WSVCB1, WSVCB2, WSVCB3, and WSVCB5. A dynamic wave SWMM model was built for the retention pond at the basin outlet to model the ponding. The results showed the pond volume is undersized, however there the drainage ditch within the subbasin upstream of the ponding area that will retain some of the runoff reducing the influent flows and volume to the pond. Therefore, a more detailed model should be completed to understand the drainage is behaving throughout WSVCB4. As development occurs more details models will be required to understand the effects of the developed flows and volume on the retention pond to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 75 cfs, 90% of the exiting peak runoff rate.

WEST ST. VRAIN CREEK BASIN 5

Subbasin WSVCB5 is a 35.0 acre basin that is located to the south of Highway 66 and to east of CR5 1/2. The subbasin is mainly comprised of the western portion of the Liberty Ranch neighborhood. The runoff is conveyed through the neighborhood via curb and gutter. Flows are directed into a detention pond at the southwest corner of the subdivision and subbasin. The 100-year runoff rate for the subbasin was calculated to be 53 cfs. The detention pond has an outlet structure for water quality and restrictor plate. A dynamic wave SWMM model was built for the detention pond and the outlet was model according to the construction plans. The results showed the pond is adequately sized. If the basin is redeveloped the developed runoff rate was calculated at 48 cfs, 90% of the exiting peak runoff rate.

WEST ST. VRAIN CREEK BASIN 6

Subbasin WSVCB6 is a 250.6 acre basin that is to the north of Highway 66 and to the east of the railroad. The subbasin is comprised mainly of farm and undeveloped land but has 83.5 acres of rural development. The subbasin includes Logan Reservoir and is bound on the east side by the Upper Highland Ditch. Logan Reservoir captures some of the runoff from the rural residential development, but the rest of the water sheet flows to the south end of the site to the subbasin outfall, a ponding area with a 24-inch RCP culvert under Highway 66 into subbasin WSVCB7. The 100-year runoff rate for the basin was calculated to be 272 cfs. According to the SWMM model results, the outfall is adequately sized and should not flood during the 100-year storm event. The developed peak 100-year rate is 245 cfs, 90% of the exiting peak runoff rate.

WEST ST. VRAIN CREEK BASIN 7

Subbasin WSVCB7 is a 212.5 acre basin that is located to the south of Highway 66 and to the east of CR7. The subbasin is mainly comprised of undeveloped and farmland but contains the eastern section of the Liberty Ranch neighborhood and a few other rural developments. Most of the runoff in the subbasin sheet flows from the north end of the basin to the south where it is collected in Sanborn Reservoir. The runoff in the developed subdivision flows via the curb and gutter until reaching the subdivision detention pond and then discharging into a system with an ultimate outfall of the Sanborn Reservoir. The 100-year runoff rate for the subbasin was calculated to be 421 cfs. The 100-year routed runoff rate for the subbasin was calculated to be 423 cfs. The reservoir was modeled in SWMM and according to the Lidar contour date the reservoir can retain the entire 100-year peak runoff volume. As the subbasin is developed the volume of runoff will increase to the reservoir and a more in-depth analysis of the available volume and possible permitted influent volume to the reservoir should be completed to confirm the reservoir will not flood. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 379 cfs, 90% of the exiting peak runoff rate.

WEST ST. VRAIN CREEK BASIN 8

Subbasin WSVCB8 is a 67.1 acre basin that is located to the north of CR28 and to the west of CR7. The subbasin is mainly comprised of undeveloped land and farm land with a small pond at the southwest corner. The runoff sheet flows from the north end of the subbasin to the southeast corner where there is a series of two small ponds before subbasins 48-inch outlet culvert under CR28 into WSVCB9. The 100-year peak runoff rate for the basin was calculated to be 112 cfs. The 100-year peak routed runoff rate for the basin was calculated to be 560 cfs. A dynamic wave SWMM model was run for the lower ponding area and outlet indicate that the pond with the 48-inch outlet is not adequate to prevent flooding of CR28. The culvert has a capacity of

approximately 349 cfs and is large enough to transport the subbasins peak runoff flow, but not the routed peak flow rate. Therefore, the developed flow rate was calculated at 131 cfs, 90% of the exiting peak runoff rate. As the subbasin is developed the volume of runoff will increase and the upper ponding area along with the lower ponding areas should be further analyzed to mitigate further flooding and reduce the risk of negative impacts to the downstream basins and infrastructure.

WEST ST. VRAIN CREEK BASIN 9

Subbasin WSVCB9 is a 60.9 acre basin that is located to the south of CR28 and to the east of WSVCB11. The subbasin is mainly comprised of undeveloped land undeveloped land with 4 acres of rural development. Runoff generally sheet flows from northeast to southwest into the drainage channel that runs along the west side of the subbasin. The eastern edge of the subbasin is defined by a ridge that splits flows to the east and west. The drainage channel is directed to the south and ultimately discharges into St. Vrain Creek. There are several ponding areas within the drainage channel that collect and detain flows before overflowing and continuing to transport flows downstream. Flows from WSVCB9 continue into WSVCB11 via the drainage channel. The 100-year peak runoff rate for the subbasin was calculated to be 50 cfs. The 100-year peak routed runoff rate was calculated to be 570 cfs with routed flow from WSVCB8 and all its upstream subbasins. The flows from the basins west of the drainage channel are not accounted for in the routed peak flows reported into the drainage channel. Therefore, an accurate analysis of the capacity capabilities of drainage channel cannot be completed. According to the SWMM model, the drainage channel does have the capacity to transport the routed flows from the WSVCB9 and its upstream basins. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 45 cfs, 90% of the exiting peak runoff rate.

WEST ST. VRAIN CREEK BASIN 10

Subbasin WSVCB10 is a 46.3 acre basin that is located to the to the north of CR28 and to the east of CR7. The subbasin is mainly comprised of farmland with four rural residential developments. The site is generally sloped to the south towards CR28. The northern portion of the subbasin drains to the west into CR7's roadside swale that conveys the water to the south end of the subbasin. The subbasins outfall, an 18-inch RCP culvert, is located at the northeast corner of the CR7 and CR28 intersection where flows are first transported under CR7 and then under CR28 into WSVCB11. The 100-year peak runoff rate for this basin was calculated to be 44 cfs. A dynamic wave SWMM model was run for the small ponding area and 18-inch RCP. According to the model the ponding area and the outfall pipe are not adequate to prevent the intersection of CR28 and CR7 from flooding. The culvert can transport approximately 15.2 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.33 cfs/acre. Further analysis and survey of the ponding area and existing culvert should be completed before development of the area to confirm the design assumptions.

WEST ST. VRAIN CREEK BASIN 11

Subbasin WSVCB11 is a 198.3 acre basin that is located to the south of CR28 and to the east of WSVCB12. The basin mainly consists of farm land, undeveloped land, a 19 acre plot of land containing Mead High School, and a mile long section of CR7. Runoff sheet flows from the north to the south end of the subbasin where it drains into the same drainage channel referenced in

subbasin WSVCB9. The subbasins outfall, an 8-foot CMP culvert according to the site investigation, is located at the drainage channels crossing of CR26. The 100-year peak runoff rate for the basin was calculated to be 226 cfs. The 100-year peak routed runoff rate for the subbasin was calculated to be 582 cfs. The flows from the basins west of the drainage channel are not accounted for in the routed peak flows reported into the drainage channel. Therefore, an accurate analysis of the capacity capabilities of drainage channel cannot be completed. According to the SWMM model, the outfall and ponding area is adequately to transport the routed flows from the WSVCB11 and its upstream subbasins. Therefore, as development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 203 cfs, 90% of the exiting peak runoff rate.

WEST ST. VRAIN CREEK BASIN 12

Subbasin WSVCB12 is a 349.6 acre basin that is located to the south of CR28 and east of CR7 and WSVCB11. The subbasin mainly consists of undeveloped land and farm land but contains 58 acres of Mead High School. Runoff sheet flows from the north end to the south end of the site where drains directly into St. Vrain Creek. The 100-year peak runoff rate for the basin was calculated to be 421 cfs. The runoff flows from the subbasin are not indicative of the flowrate in the St. Vrain Creek at the subbasin outfall because the subbasin flows are a very small portion of the flows contributing to the Creek. Analysis of the St. Vrain Creek was not completed in this study and it is assumed that the existing Creek crossings are adequate to transport the existing 100-year peak flows from contributing watersheds. Therefore, the developed runoff rate is calculated at 279 cfs, 90% of the exiting peak runoff rate.

WEST ST. VRAIN CREEK BASIN 13

Subbasin WSVCB13 is a 117.6 acre basin that is located to the south of CR28 and to the west of WSVCB15. The subbasin is comprised mainly of undeveloped and farm land and has a series of three small ponding areas at the south end of the subbasin acting as the outfall. The 100-year peak runoff rate for the subbasin was calculated to be 139 cfs. A dynamic wave SWMM model was run for the southernmost ponding area in the subbasin and indicated that the pond area will flood the embankment along the southeast side of the pond during the 100-year storm event. Flows will continue to the south into WSVCB14 and the St. Vrain Creek. A more in-depth analysis should be completed as development occurs within the subbasin. Further investigation of the use and purpose of the ponding areas should also be investigated to determine permitting and design capacity. The developed runoff rate is calculated at 125 cfs, 90% of the existing peak runoff rate.

WEST ST. VRAIN CREEK BASIN 14

Subbasin WSVCB14 is a 72.7 acre basin that is located to the north of St. Vrain Creek and south of WSVCB13. The subbasin is comprised mainly of undeveloped and farm land with one rural development. The 100-year peak runoff rate for the subbasin was calculated to be 115 cfs. The 100-year peak routed runoff rate for the subbasin was calculated to be 189 cfs. The basin receives flows from basin WSVCB13. Runoff generally sheet flows from the north to south and is mostly collected into a drainage channel in the center of the subbasin that discharges into the St. Vrain Creek. The runoff flows from the subbasin are not indicative of the flowrate in the St. Vrain Creek at the subbasin outfall because the subbasin flows are a very small portion of the flows contributing to the Creek. Analysis of the St. Vrain Creek was not completed in this study and it is assumed that the existing Creek crossings are adequate to transport the existing 100-year peak flows from

contributing watersheds. Therefore, the developed runoff rate is calculated at 104 cfs, 90% of the exiting peak runoff rate.

WEST ST. VRAIN CREEK BASIN 15

Subbasin WSVCB15 is a 140.0 acre basin that is located to the east of I-25 and to the south of CR28. The subbasin is mainly comprised of farm land and undeveloped land and a few rural residences. The 100-year peak runoff rate for the subbasin was calculated to be 162 cfs. Runoff sheet flows from the east side to the west side of the site where there is a drainage channel along the east side of I-25 directing flow to the south into St. Vrain Creek. There are small ponding areas north of the Creek that will provide minor detainment of the flows before they enter the Creek. The runoff flows from the subbasin are not indicative of the flowrate in the St. Vrain Creek at the subbasin outfall because the subbasin flows are a very small portion of the flows contributing to the Creek. Analysis of the St. Vrain Creek was not completed in this study and it is assumed that the existing Creek crossings are adequate to transport the existing 100-year peak flows from contributing watersheds. Therefore, the developed runoff rate is calculated at 146 cfs, 90% of the exiting peak runoff rate.

Table 9. West St. Vrain Creek Discharge Summary

Basin ID	Design Point ID	Area (acre)	Existing Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
WSVCB1	86	102.7	12.7%	193	193	174 cfs	N
WSVCB2	87	273.6	6.3%	249	377	0.01 cfs/acre	N
WSVCB3	88	120.0	7.3%	111	412	100 cfs	N
WSVCB4	89	85.1	7.4%	83	428	75 cfs	N
WSVCB5	90	35.0	27.7%	53	53	48 cfs	N
WSVCB6	91	250.6	7.0%	272	272	245 cfs	Y
WSVCB7	92	212.5	34.7%	421	423	379 cfs	Y
WSVCB8	93	67.1	6.0%	112	560	131 cfs	Y
WSVCB9	94	60.9	8.2%	50	570	45 cfs	Y
WSVCB10	95	46.3	21.8%	44	44	0.33 cfs/acre	N
WSVCB11	96	198.3	8.9%	226	582	203 cfs	N
WSVCB12	97	349.6	6.4%	421	421	379 cfs	Y
WSVCB13	98	117.6	6.4%	139	139	125 cfs	N
WSVCB14	99	72.7	6.9%	115	189	104 cfs	N
WSVCB15	100	140.0	15.7%	162	162	146 cfs	Y

*Adequate capacity is based on routed 100-year peak flow rate

CR40 Basin

The CR40 Basin (CR40B) is a 532.4 acre basin that is combination of subbasins that drain to the north towards Little Thompson River, but are independent of each other. The subbasin are not hydraulically connected within CR40B. The study areas northern boundary of CR40 cuts off the basins before they can combine into the entire watershed. The southern edge of the basin is defined by a ridge that splits flows to the north and south. The eastern and western boundaries are delegated by either I-25 or ridges that split flows. The basin consists mainly of farmland with gravel drives and oil well gravel area. There are five (5) subbasins that make up the CR40B basin.

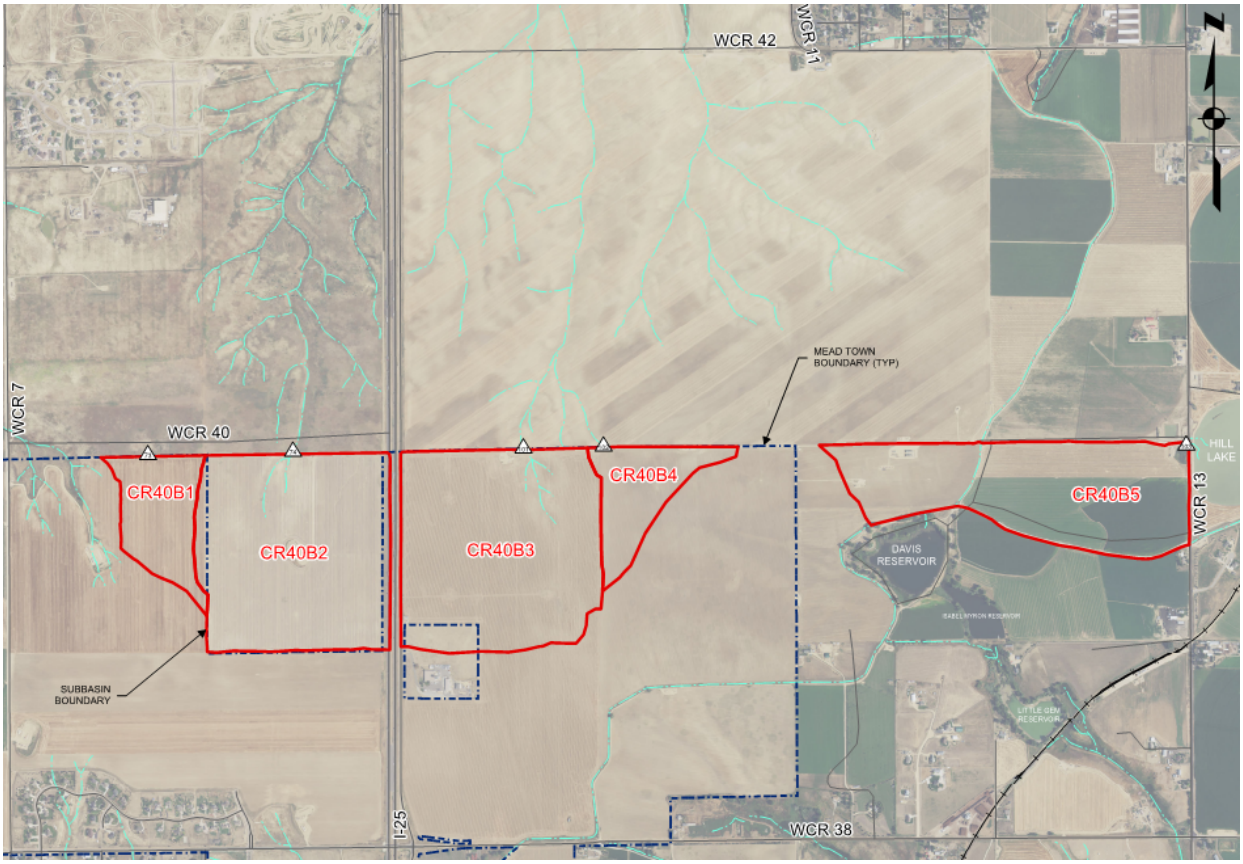

Figure 18. CR40 Basin Map

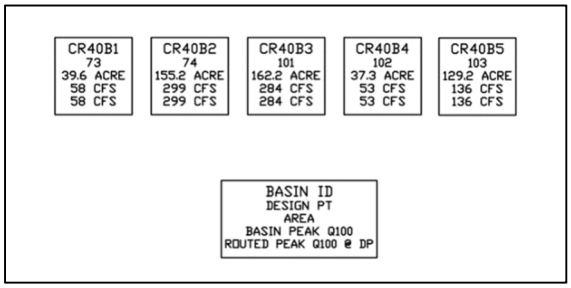

Figure 19. CR40 Routing Flow Schematic

CR40 Basin 1

Subbasin CR40B1 a 39.6 acre basin located west of I-25, east of CR7 and north of CR38. The subbasin is comprised entirely of undeveloped farmland that slopes to the north. CR40B1 is part of a much larger subbasin that ultimately drains into the Little Thompson River. The northern edge of the subbasin is defined by where CR40 will be built in the future, but is currently farmland. The subbasin does not drain to a specific outfall along the northern boundary. The 100-year peak runoff for the basin was calculated at 58 cfs. The developed peak runoff rate was calculated at 52 cfs, 90% of the exiting peak runoff rate.

CR40 Basin 2

Subbasin CRB2 is a 155.2 acre basin on the west side of I-25 to the east of subbasin CR40B1. The subbasin is comprised of farmland with an oil and gas well station located within the field. The boundary is defined by I-25 to the east, a ridge to the north and west and CR40 to the north. There is not a physical outfall for the basin, but there is the start of a drainage channel centrally located along the north edge of the subbasin. There is also a drainage swale running parallel with I-25 that collects runoff from the subbasin. CR40B1 is a part of a much larger subbasin that ultimately drains into the Little Thompson River. The 100-year peak runoff rate was calculated at 299 cfs and the developed peak runoff rate was calculated at 269 cfs, 90% of the exiting peak runoff rate.

CR40 Basin 3

Subbasin CRB3 is 162.2 acre basin located directly east of I-25 along the northern edge of the study area. The basin is comprised of farmland with gravel roads, an oil and gas well station, and part of single developed lot. CR40's gravel road defines the northern border of the basin, I-25 the western, and break lines on the south and east edges. The contours direct flow to the center of the basin where there is the start of a drainage channel. CR40B3 will ultimately drain to the Little Thomson River. According to the LiDAR contours, most of the subbasin drains across CR40 instead of through the 30-inch CMP and five (5) 24-inch CMP culverts under CR40. This is due to the undefined roadside ditch along the south side of CR40. The five 24-inch culverts are the crossing for the natural drainage channel within the subbasin. Currently, there is little evidence from the LiDAR data that there is any runoff directed to the 30-inch culvert for crossing CR40. The five 24-inch pipes are assumed to be the main discharge location of the basin and can transport approximately 141 cfs of flow. The 30-inch culvert has an approximate capacity of 49 cfs of flow if the roadside ditch can be graded to direct flows to the culvert. Therefore, there is an approximate total discharge capacity of 190 cfs under CR40 in the subbasin. The existing 100-year peak outflow runoff rate was calculated to be 284 cfs. The developed 100-year peak runoff rate has been calculated to be 1.17 cfs/acre to decrease developed discharge rates to the existing capacity of the crossings. As the subbasin develops, CR40's southern roadside ditch will need to be established to direct flows to the outfalls rather than sheet flowing across the road.

CR40 Basin 4

Subbasin CR40B4 is a 37.3 acres basin that is located to the east of subbasin CR40B3 and is defined by ridges to the west, south and east and CR40 to the north. CR40B4 currently contains mostly undeveloped farmland, gravel drives, and oil and gas well station. The subbasin drains to the north into the southern roadside ditch along CR40. This ditch directs flow to the west before sheet flowing across the road at a low point where it will ultimately drain to the Little Thomson River. There is no culvert found during the survey investigation at the low spot. The peak 100-

year runoff rate was calculated at 53 cfs and the developed peak runoff rate was calculated at 48 cfs. When development in the subbasin occurs a culvert and ponding area capable of transporting the 48 cfs, 90% of the exiting peak runoff rate, must be installed under CR40.

CR40 BASIN 5

Subbasin CR40B5 is a 129.1 acre basin located to the west of CR13 between CR40 and Farmers Extension Ditch. The basin drains to the east and is directed via drainage ditches to the northeast corner of the basin located at the corner of CR40 and CR13. The land use for the basin is mostly undeveloped farmland and open space with a few gravel roads, two oil and gas well locations. Farmers Extension Ditch bisects the basin without influencing the basins overall flow direction to the east. The assumption was made that during the 100-year storm event the ditch would be flowing full and not collect and transport flow. The outfall for the subbasin is a 36-inch culvert, with a capacity of 77 cfs, under CR13 that discharges flow into a ponding area on the east side of CR13 next to Hill Lake. Hill lake is the overflow for the small ponding area. The basins existing 100-year peak flow is calculated at 136 cfs. According to the SWMM model, the ponding area and outlet pipe are not large enough to keep the pond from flooding CR40 to the north. To prevent flooding of CR40 and CR13 and reduce the risk of negative impact to the downstream ponding area the developed runoff rate was calculated to be 0.49 cfs/acre. Further analysis and survey of the ponding area and existing culvert should be completed before development of the area to confirm the design assumptions.

Table 10. CR40B Discharge Summary

Basin ID	Design Point ID	Area (acre)	Existing Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
CR40B1	73	39.6	2.0%	58	58	52 cfs	Y
CR40B2	74	155.2	4.2%	299	299	269 cfs	Y
CR40B3	101	162.2	3.0%	223	223	1.17 cfs/acre	N
CR40B4	102	37.3	3.5%	53	53	48 cfs	Y
CR40B5	103	129.2	4.8%	136	136	0.60 cfs/acre	N

*Adequate capacity is based on routed 100-year peak flow rate

Miantenoma Reservoir Basin

The Miantenoma Reservoir Basin (MRB) is a 957.1 acre basin located in the northeast corner of the study area. The Miantenoma Reservoir is outside of the study boundary southeast of the Great Western Railway Railroad. Therefore, the entirety of the MRB watershed is not analyzed in this study, but the watershed area that is upstream of the Railroad crossings and the capacity of the outfalls are analyzed. There is a total of seven subbasin with five outfalls located under or across the railroad tracks.

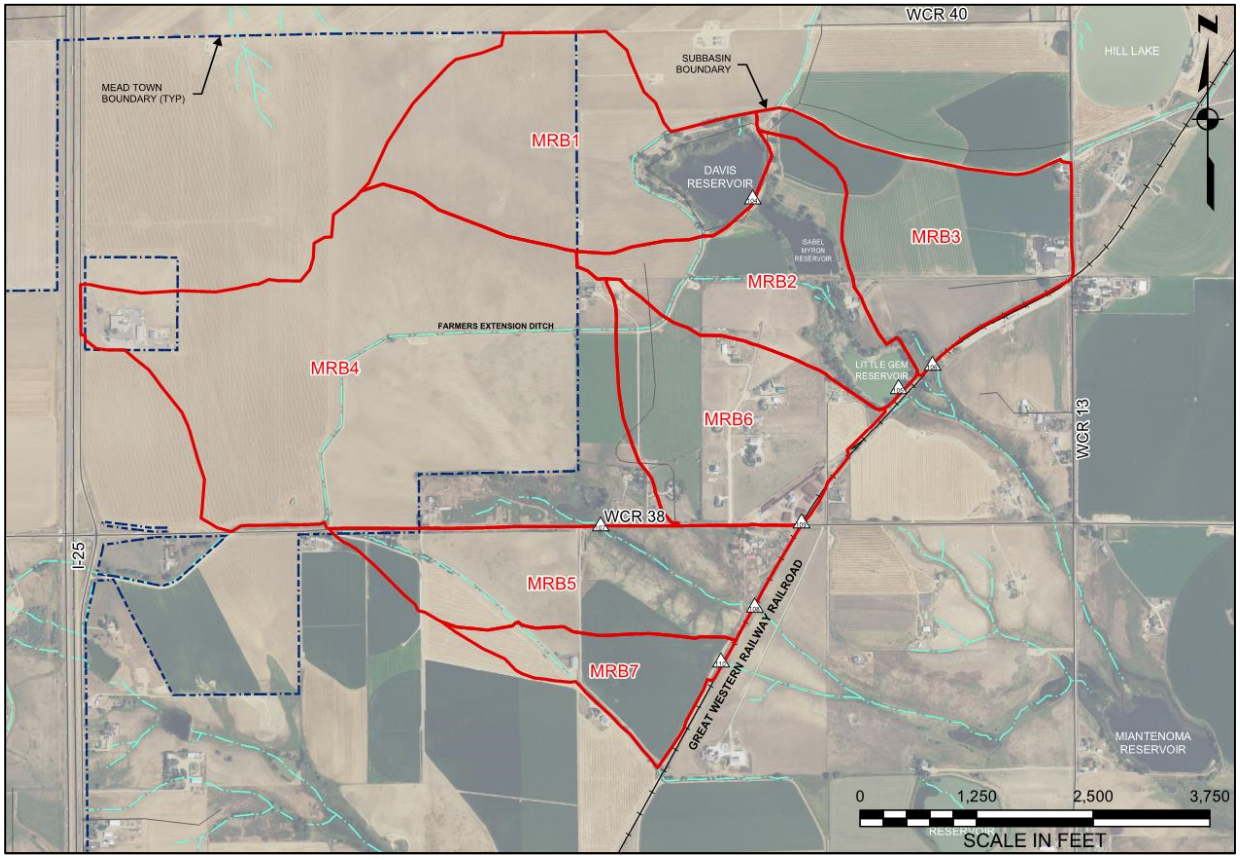

Figure 20. Miantenoma Reservoir Basin Map

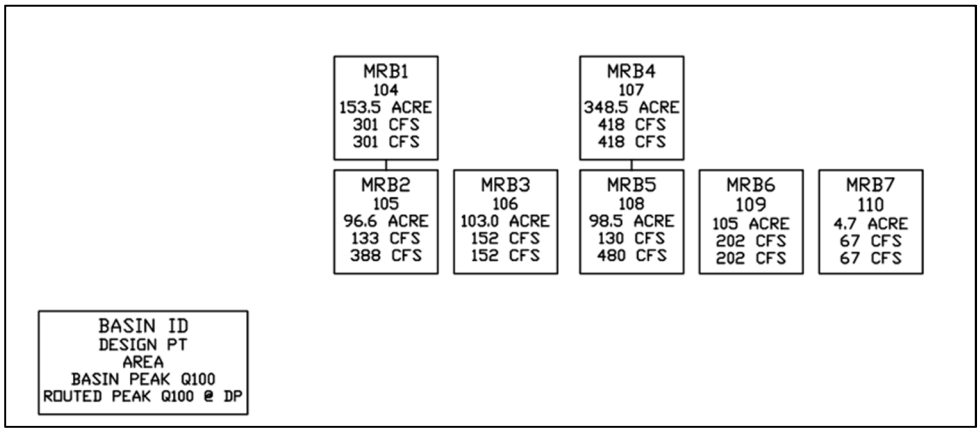

Figure 21. Miantenoma Reservoir Basin Flow Routing Schematic

MIANTENOMA RESERVOIR BASIN 1

Subbasin MRB1 is a 153.5 acre basin that is located south of CR40 and west of CR13. The subbasin is comprised of farmland, undeveloped land, 1.5 acres of developed land at the east side of the basin, the railroad at the north end of the basin, the southern half of CR40 and drains into Davis Reservoir. The subbasin generally flows from northwest to southeast by sheet flow into Davis Reservoir. The 100-year runoff rate for the basin was calculated to be 301 cfs. According to the SWMM model results, the reservoir should not flood during the 100-year storm event. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 270.9 cfs, 90% of the exiting peak runoff rate. Furthermore, the volume and capacity of the Davis Reservoir should be evaluated as part of the development runoff analysis. If the reservoir overflows, the excess flows will be transported downstream to subbasin MRB2. The capacity of the Reservoirs at existing conditions should be examined with developed to confirm there is volume available for developed flows. Coordination with the Reservoir owners for discharge modifications will be required.

MIANTENOMA RESERVOIR BASIN 2

Subbasin MRB2 is a 96.6 acre basin that is located south of CR40 and northwest of railroad. The subbasin is comprised of farmland, 4.0 acres of developed land at the west side and northwest corner of the basin, Isabel Myron Reservoir at the northeast corner of the basin, Farmers Extension Canal runs through the northwest corner of the basin and drains into the Little Gem Reservoir. The subbasin generally flows from northwest to southeast by sheet flow into Little Gem Reservoir or into the Isabel Myron Reservoir which is directly upstream of the Little Gem Reservoir. The routed existing 100-year peak flow was calculated to be 388 cfs. According to the SWMM model results, the reservoir should not flood over the railroad tracks during the 100-year storm event. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 120 cfs, 90% of the exiting peak runoff rate. The capacity of the Reservoirs at existing conditions should be examined with developed to confirm there is volume available for developed flows. Coordination with the Reservoir owners for discharge modifications will be required.

MIANTENOMA RESERVOIR BASIN 3

Subbasin MRB3 is a 103 acre basin that is located south of CR40 and west of CR13. The subbasin is comprised of farmland, 5.0 acres of developed land at the northeast and southeast corners of the basin, CR13, and the northern half of the railroad. The subbasin generally flows from northwest to southwest by sheet flow to a culvert under railroad into a basin outside the Study Area. The culvert was not found during the site investigations and will need to be found before development occurs. The routed existing 100-year peak flow was calculated to be 152 cfs. A SWMM model was run for the ponding area with no outfall and the ponding area was not sufficient to retain the existing runoff volume without an outfall. It was assumed the existing culvert is capable of transporting the existing 100-year runoff floes, the developed runoff rate was calculated at 136.8 cfs, 90% of the exiting peak runoff rate. If it is found that the existing culvert cannot transport the existing developed runoff rate, the developed runoff rate must be reduced to the allowable cfs/acre based of the capacity of the outfall pipe.

MIANTENOMA RESERVOIR BASIN 4

Subbasin MRB4 is a 348.5 acre basin that is located north of CR38 and east of I-25. The subbasin is comprised of farmland, undeveloped land, 17.8 acres of developed land at the

northwest, southeast, and northeast corners of the basin, the northern half of CR38, and I-25 North. The subbasin generally flows from northwest to southeast by sheet flow to a 24-inch CMP under CR38 into subbasin MRB5. At the time of the pipe survey, the culvert was under water and filled with debris. The existing peak 100-year flow to the subbasin outlet is 418 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR38. There is a ponding area upstream of the culvert crossing that will collect and store runoff from a portion of the subbasin that was not included in the SWMM analysis. The 24-inch CMP has a capacity of approximately 11.4 cfs when not filled with debris. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins the developed runoff rate was calculated to be 0.03 cfs/acre.

MIANTENOMA RESERVOIR BASIN 5

Basin MRB5 is a 105.8 acre basin that is located south of CR38 and west of railroad. The subbasin is comprised of farmland, undeveloped land, 9.4 acres of developed land at the northwest and northeast corners of the basin, the southern half of CR38, and the western half of the railroad. The subbasin generally flows from southwest to southeast by sheet flow to a 6'x7' culvert under the railroad into a basin outside of the Study Area. Flow from MRB4 drains into MRB5 either from flooding CR38 or from the outlet under CR38. The existing 100-year peak flow for the subbasin was calculated to be 130 cfs, and the subbasin routed peak 100-year flow rate at 480 cfs. The SWMM Model of the ponding area and outfall culvert showed that there is adequate ponding volume and pipe capacity to transport the calculated existing routed flows. The ponding area is approximately 22 feet deep and the modeled 100-year water surface elevation is at a depth of 3.3 feet. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 117 cfs, 90% of the exiting peak runoff rate.

MIANTENOMA RESERVOIR BASIN 6

Subbasin MRB6 is a 105 acre basin that is located north of CR38 and west of railroad. The subbasin is comprised of farmland, 29.8 acres of developed land in the center of the basin and at the northwest and southeast corners of the basin, the northern half of CR38, and the railroad. The subbasin generally flows from northwest to southeast by sheet flow to a 28-inch culvert under the railroad and CR38 into a basin outside of the Study Area. The routed existing 100-year peak flow was calculated to be 202 cfs. There is very little detention upstream of the outfall culvert per the LiDAR data. The SWMM model of the culvert with no detention indicates that culvert has a capacity of approximately 26.2 cfs. The culvert is flooding resulting in flooding the railroad and CR38 to the east and southeast. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins developed runoff rate was calculated to be 0.25 cfs/acre.

MIANTENOMA RESERVOIR BASIN 7

Subbasin MRB7 is a 44.7 acre basin that is located south of MRB5 and west of the railroad. The subbasin is comprised of farmland, undeveloped land, 0.7 acres of developed land in the center of the basin, and the western half of the railroad. The subbasin generally flows from northwest to northeast by sheet flow to an unidentified culvert under the railroad into a basin outside of the Study Area. The existing 100-year peak flow was calculated to be 67 cfs. The culvert will need to be field verified when development occurs and reanalysis of the available discharge capacity of the railroad culvert should be performed. A SWMM model was run for the ponding area with no outfall and the ponding area was not sufficient to retain the existing runoff volume without an

outfall. It was assumed the existing culvert is capable of transporting the existing 100-year runoff floes, the developed runoff rate was calculated at 60 cfs, 90% of the exiting peak runoff rate. If it is found that the existing culvert cannot transport the existing developed runoff rate, the developed runoff rate must be reduced to the allowable cfs/acre based of the capacity of the outfall pipe.

Table 11. Miantenoma Reservoir Basin Discharge Summary

Basin ID	Design Point ID	Area (acre)	Existing Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
MRB1	104	153.5	14.3%	301	301	271 cfs	Y
MRB2	105	96.6	16.6%	133	388	120 cfs	Y
MRB3	106	103.0	6.0%	152	152	137 cfs	Y
MRB4	107	348.5	6.1%	418	418	0.03 cfs/acre	N
MRB5	108	105.8	7.7%	130	480	117 cfs	Y
MRB6	109	105.0	17.5%	202	202	0.25 cfs/acre	N
MRB7	110	44.7	3.9%	67	67	60 cfs	Y

*Adequate capacity is based on routed 100-year peak flow rate

DIAMOND RESERVOIR BASIN

The Diamond Reservoir Basin (DRB) is a 3,971.7 acre basin consisting of 23 subbasins that is located east of I-25 and drains from east to west into the Diamond Reservoir. The Reservoir is located south of CR34 and west of CR17. Outflows from the Reservoir will continue to the east under CR17 and into the St. Vrain Creek. The basin is split into two major watersheds, the northern watershed collects flows into an unnamed drainage channel that drains from the northwest to the southeast and is as far north as CR38 and I-25. The southern watershed collects flows from the basins south of LTB and north of ESVCB. The subbasin from the southern watershed generally drain to the east and north into the unnamed drainage channel located in subbasin DRB17. The Lake Thomas is upstream of the DRB and the overflow from the Lake will be transported through an unnamed drainage channel in DRB17 to the Diamond Reservoir. There are several locations within the DRB where reports of flooding have been provided to the Town due to several of the outfall being undersized for larger storm events. For the most part it is assumed that decreasing the developed 100-year runoff rate to 90% of the existing conditions will be adequate for the subbasins that do not have culverts or piped outfalls. However, the effects of the increased volumes in the subbasins will not be investigated in this report and should be included in future detailed studies or during development review. The DRB drainage map and schematic flow routing figures are provided below.

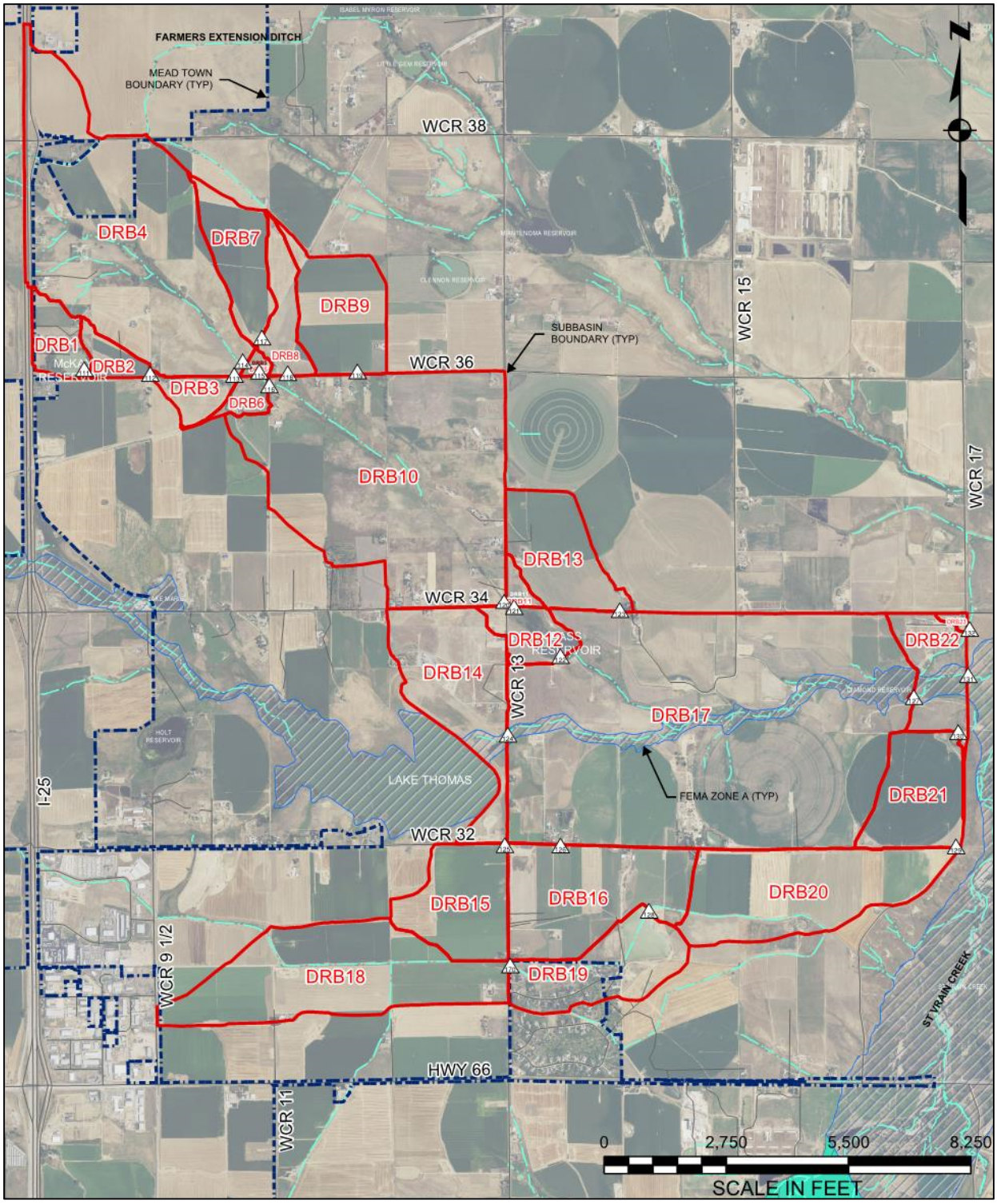

Figure 22. Diamond Reservoir Basin Map

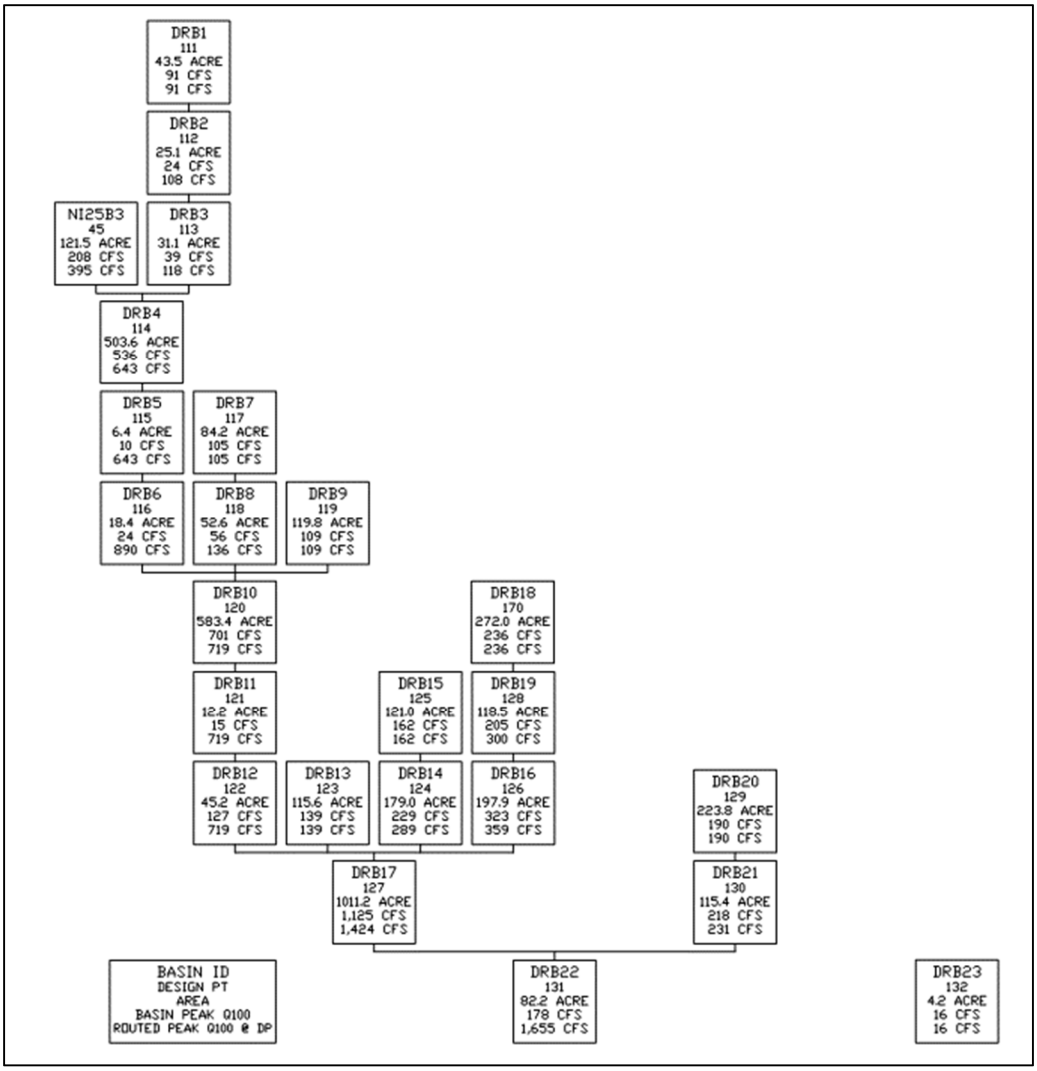

Figure 23. Diamond Reservoir Basin Flow Routing Schematic

DIAMOND RESERVOIR BASIN 1

Subbasin DRB21 is a 43.5 acre basin that is located north of CR36 to the east of I-25. The basin consists of an RV storage area that is gravel and a rural residence that all drains into McKay Reservoir. The site generally flows northwest to southeast by sheet flow to the McKay Reservoir. The routed existing 100-year peak flow was calculated to be 92 cfs. According to the SWMM model results, the McKay Reservoir should not flood during the 100-year storm event. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 82 cfs, 90% of the exiting peak runoff rate.

DIAMOND RESERVOIR BASIN 2

Subbasin DRB2 is a 25.1 acre basin and is located north of CR36 and east of McKay Reservoir. The basin consists mainly of farmland with portions of rural residences. The basin runoff flows northwest to the southeast to a 12" CMP and transported under CR36 into DRB3. The existing 100-year peak runoff rate was calculated at 24 cfs with the routed existing 100-year peak flow was calculated to be 108 cfs. The SWMM model of the ponding area with the routed flow hydrograph

using dynamic wave indicate that the pond is flooding resulting in flooding CR36 because the outlet is undersized, but can transport approximately 4.9 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins developed runoff rate was calculated to be 0.20 cfs/acre.

DIAMOND RESERVOIR BASIN 3

Subbasin DRB3 is a 31.1 acre basin located south of CR36 and west of the railroad. The basin consists of farmland with rural residential land. The basin runoff flows northwest to southeast to the drainage ditch at the railroad tracks and then to the northeast to an 18" CMP culvert transported under CR36 and into basin DRB4. The existing 100-year peak runoff rate was calculated at 39 cfs with the routed existing 100-year peak flow was calculated to be 118 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR36 because the outlet is undersized, but can transport approximately 22.4 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins developed runoff rate was calculated to be 0.72 cfs/acre.

DIAMOND RESERVOIR BASIN 4

Subbasin DRB4 is a 503.6 acre basin located east of I-25, north of CR36 and west of the railroad. The basin consists mainly of farmland with rural residential land and portions of I-25. The basin runoff generally flows to the southeast, through several reservoirs and the drainage channel, to a 5'x5' concrete box culvert under the railroad tracks into basin DRB5. The existing 100-year peak runoff rate was calculated at 536 cfs. The routed existing 100-year peak flow was calculated to be 643 cfs. A SWMM model was run for the ponding area with 5'x5' concrete box outfall showing that the ponding area is sufficient to prevent flooding of the railroad during the 100-year runoff event. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 482 cfs, 90% of the exiting peak runoff rate.

DIAMOND RESERVOIR BASIN 5

Subbasin DRB5 is a 6.4 acre basin location north of CR36 and east of the railroad. The basin consists main of farmland and a portion of one rural residence. The site generally flows to the southeast to a low spot at CR36. There was no pipe found at the outfall for the subbasin and once the ponding area is filled runoff will overtop CR36 to the south. The existing 100-year peak runoff rate was calculated at 10 cfs with the routed existing 100-year peak flow was calculated to be 539 cfs. Following the Town standards, the developed 100-year runoff rate was calculated at 9 cfs, 90% of the exiting peak runoff rate. However, without further investigation or improvements, the routed peak flows will continue to overtop CR36. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure an outfall culvert on CR36 for subbasin DRB5 needs to be installed to accommodate peak routed flows when development occurs.

DIAMOND RESERVOIR BASIN 6

Subbasin DRB6 is an 18.4 acre basin located south of CR36 and east of the railroad. The basin consists mainly of undeveloped land with about 1.1 acres of low density residential area. The site generally flows from southwest to northeast by sheet flow to a series of two 36" CMP culverts under a private road into basin DRB10. The existing 100-year peak runoff rate was calculated at 24 cfs with the routed existing 100-year peak flow was calculated to be 890 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the

pond is flooding resulting in flooding the private road because the outlet is undersized, but can transport approximately 81.1 cfs. The 24 cfs from DRB6 can easily be transported through the existing culverts, but the routed flows cannot. Therefore, the 100-year developed runoff rate is calculated at 22 cfs, 90% of the exiting peak runoff rate. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure the outfall culverts for DRB6 need to be upsized to accommodate peak routed flows when development occurs in any subbasin upstream of DRB6.

DIAMOND RESERVOIR BASIN 7

Subbasin DRB7 is an 84.2 acre basin located south of CR38, west of the railroad, and east of DRB4. The basin consists mainly of farmland and portions of private roads. The site generally flows from northwest to southeast by sheet flow to 5' x 5' concrete box culvert under the railroad into basin DRB8. The routed existing 100-year peak flow was calculated to be 105 cfs. A SWMM model was run for the ponding area with 5'x5' concrete box outfall showing that the ponding area is sufficient to prevent flooding of the railroad during the 100-year runoff event. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 95 cfs, 90% of the exiting peak runoff rate.

DIAMOND RESERVOIR BASIN 8

Subbasin DRB8 is a 52.6 acre basin located north of CR36 and east of DRB7. The subbasin consists mainly of farmland, the railroad, the northern half of CR36, and some developed land. The site generally flows from northeast to southwest by sheet flow to a 56" CMP under CR36 into subbasin DRB10. The existing 100-year peak runoff rate was calculated at 56 cfs with the routed existing 100-year peak flow was calculated to be 136 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding the private road because the outlet is undersized, but can transport approximately 121.2 cfs. The 24 cfs from DRB6 can easily be transported through the existing culvert, but the routed flows cannot. Therefore, the 100-year developed runoff rate is calculated at 50 cfs, 90% of the exiting peak runoff rate. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure the outfall culvert for DRB8 needs to be upsized to accommodate peak routed flows when development occurs in any subbasin upstream of DRB8.

DIAMOND RESERVOIR BASIN 9

Subbasin DRB9 is a 119.8 acre basin located north of CR36 and west of DRB8. The basin consists mainly of farmland, the railroad, the northern half of CR36, and some developed land. The site generally flows from northwest to southeast by sheet flow to the ditch along the private drive to a 16" CMP under CR36 into basin DRB10. The routed existing 100-year peak flow was calculated to be 109 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR36 because the outlet is undersized, but can transport approximately 6.2 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins developed runoff rate was calculated to be 0.05 cfs/acre.

DIAMOND RESERVOIR BASIN 10

Subbasin DRB10 is a 583.4 acre basin located south of CR36 and west of CR13. The basin consists mainly of farmland, undeveloped land, private drives, the northern half of CR34, the southern half of CR36, the western half of CR13, and developed land. The site generally flows from northwest

to southeast by sheet flow to the irrigation ditch to a 12'x2' culvert under CR13 into basin DRB11. The existing 100-year peak runoff rate was calculated at 701 cfs with the routed existing 100-year peak flow was calculated to be 719 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR13 because the outlet is undersized, but can transport approximately 300.9 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins developed runoff rate was calculated to be 0.52 cfs/acre.

DIAMOND RESERVOIR BASIN 11

Subbasin DRB11 is a 12.2 acre basin located north of CR34 and east of CR13. The subbasin consists mainly of farmland, undeveloped land, the northern half of CR34, the eastern half of CR13, and some developed land. The site generally flows from northwest to southeast by sheet flow to the irrigation ditch to a 12'x2' culvert under CR34 into subbasin DRB12. The existing 100-year peak runoff rate was calculated at 15 cfs with the routed existing 100-year peak flow was calculated to be 719 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR34 because the outlet is undersized, but can transport approximately 495.0 cfs. The 15 cfs from DRB11 can easily be transported through the existing culvert, but the routed flows cannot. Therefore, the 100-year developed runoff rate is calculated at 14 cfs, 90% of the exiting peak runoff rate. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure the outfall culvert for DRB11 needs to be upsized to accommodate peak routed flows when development occurs in any subbasin upstream of DRB11.

DIAMOND RESERVOIR BASIN 12

Subbasin DRB12 is a 45.2 acre basin located south of CR34 and east of CR13. The subbasin consists mainly of farmland, undeveloped land, the southern half of CR34, the eastern half of CR13, some developed land, and drains into the Bass Reservoir. The site generally flows northwest to southeast by sheet flow to the Bass Reservoir. The existing 100-year peak runoff rate was calculated at 127 cfs with the routed existing 100-year peak flow was calculated to be 719 cfs. The subbasin receives the runoff from all the subbasins upstream from DRB1 through DRB11. Bass Reservoir was modeled in SWMM and according to the LiDAR contour data, the reservoir cannot retain the 100-year runoff volume. As the contributing subbasins are developed the volume of runoff will increase to the reservoir and a more in-depth analysis of the available volume and possible permitted influent volume to the reservoir should be completed to verify the reservoir will not flood further. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 114 cfs, 90% of the exiting peak runoff rate.

DIAMOND RESERVOIR BASIN 13

Subbasin DRB13 is a 115.6 acre basin located north of CR34 and east of CR13 and DRB11. The subbasin consists mainly of farmland, undeveloped land, private drives, the northern half of CR34, the eastern half of CR13, and some developed land. The site generally flows northwest to southeast by sheet flowing to a ditch along the private drive until CR34 where flows pond before over topping CR34 to the south into subbasin DRB17. The routed existing 100-year peak flow was calculated to be 139 cfs. There was culvert located at the subbasin outfall to transport flows under CR34. Following the Town standards, the developed 100-year runoff rate was calculated at 125 cfs, 90% of the exiting peak runoff rate. However, without further investigation or improvements,

the routed peak flows will continue to overtop CR34. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure an outfall culvert on CR34 for subbasin DRB13 needs to be installed to accommodate flows when development occurs.

DIAMOND RESERVOIR BASIN 14

Subbasin DRB14 is a 179.0 acre basin located south of CR34 and west of CR13. The subbasin consists mainly undeveloped land, private drives, the southern half of CR34, the western half of CR13, and developed land. The site generally flows from northwest to southeast by sheet flow to the ditch along CR13 to a 36" culvert under CR13 into subbasin DRB17. The existing 100-year peak runoff rate was calculated at 229 cfs with the routed existing 100-year peak flow was calculated to be 289 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding of CR13 because the outlet is undersized, but can transport approximately 89.3 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins developed runoff rate was calculated to be 0.50 cfs/acre.

DIAMOND RESERVOIR BASIN 15

Subbasin DRB15 is a 121.0 acre basin located south of CR32 and west of CR13. The subbasin consists mainly of farmland, private drives, the southern half of CR32, the western half of CR13, and some developed land. The site generally flows from southwest to northeast by sheet flowing to an 18" CMP under CR32 into subbasin DRB14. The existing 100-year peak runoff rate was calculated at 162 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR32 because the outlet is undersized and can only transport approximately 11.0 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins developed runoff rate was calculated to be 0.09 cfs/acre.

DIAMOND RESERVOIR BASIN 16

Subbasin DRB16 is a 197.9 acre basin located south of CR32 and east of CR13. The subbasin consists mainly of farmland, undeveloped land, private drives, the southern half of CR32, the eastern half of CR13, and developed land. The site generally flows from southwest to northwest by sheet flowing to a 17" CMP under CR32 into subbasin DRB17. The existing 100-year peak runoff rate was calculated at 323 cfs with the routed existing 100-year peak flow was calculated to be 359 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR32 because the outlet is undersized and can only transport approximately 11.0 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins developed runoff rate was calculated to be 0.06 cfs/acre.

DIAMOND RESERVOIR BASIN 17

Subbasin DRB17 is a 1,011.2 acre basin located south of CR34 and east of CR13. The subbasin consists mainly of farmland, undeveloped land, the southern half of CR34, the eastern half of CR13, the northern half of CR32, private drives, developed land, and drains into the Diamond Reservoir. The site generally flows southwest to northeast by sheet flow to a ditch then to the Diamond Reservoir. The existing 100-year peak runoff rate was calculated at 1,125 cfs with the routed existing 100-year peak flow was calculated to be 1,424 cfs. The subbasin receives the

runoff from all the subbasins upstream from DRB1 through DRB16, NI25B1 through NI25B3, and including DRB18 and DRB19. The Diamond Reservoir was modeled in SWMM and according to the LiDAR contour data, the reservoir cannot retain the 100-year runoff volume. As the subbasins are developed the volume of runoff will increase to the reservoir intensifying flooding. A more in-depth analysis of the available volume and possible permitted influent volume to the reservoir and discharge rate from the reservoir should be completed to verify the reservoir will not flood now or in the future. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 1,013 cfs, 90% of the exiting peak runoff rate.

DIAMOND RESERVOIR BASIN 18

Subbasin DRB18 is a 272.0 acre basin located south of DRB15 and west of CR13. The subbasin consists mainly of farmland, private drives, the western half of CR13, and some developed land. The site generally flows from southwest to southeast by sheet flowing to a 28" CMP under CR13 into subbasin DRB19. The existing 100-year peak flow was calculated to be 236 cfs. The SWMM model of the ponding area with the flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR13 because the outlet is undersized and can transport approximately 44.5 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins developed runoff rate was calculated to be 0.16 cfs/acre.

DIAMOND RESERVOIR BASIN 19

Subbasin DRB19 is a 118.5 acre basin located south of DRB16 and east of CR13. The subbasin consists mainly of residential developed land, the eastern half of CR13, undeveloped land, private drives, and drains into the reservoir south of basin DRB16. The site generally flows southwest to northeast by sheet flowing to the reservoir east of the residential developed land. The existing 100-year peak runoff rate was calculated at 205 cfs with the routed existing 100-year peak flow was calculated to at 300 cfs. The subbasin receives the runoff from DRB18. The reservoir was modeled in SWMM and according to the LiDAR contour data, the reservoir cannot retain the 100-year runoff volume. As the subbasins are developed the volume of runoff will increase to the reservoir and a more in-depth analysis of the available volume and possible permitted influent volume to the reservoir should be completed to verify the reservoir will not flood further. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 185 cfs, 90% of the exiting peak runoff rate.

DIAMOND RESERVOIR BASIN 20

Subbasin DRB20 is a 223.8 acre basin located south of CR32 and west of CR17. The subbasin consists mainly of farmland, undeveloped land, private drives, the southern half of CR32, the western half of CR17, and some developed land. The site generally flows southwest to northeast by sheet flowing to a ditch along CR32 to low spot at CR32. The existing 100-year peak flow was calculated to be 190 cfs. With no outlet pipe or culvert found during site investigation, the ponding area at CR32 eventually fills and overtops CR32 to the north into DRB21. Following the Town standards, the developed 100-year runoff rate was calculated at 171 cfs, 90% of the exiting peak runoff rate. However, without further investigation or improvements, the flows will continue to overtop CR32. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure an outfall culvert on CR32 for subbasin DRB20 needs to be installed to accommodate peak flows when development occurs.

DIAMOND RESERVOIR BASIN 21

Subbasin DRB21 is a 115.4 acre basin located north of CR32 and west of CR17. The subbasin consists mainly of farmland, the western half of CR17, the northern half of CR32, undeveloped land, private drives, and drains into a pond in the northeast corner of the basin. The site generally flows southwest to northeast by sheet flow to the pond south of basin DRB22. The existing 100-year peak runoff rate was calculated at 218 cfs with the routed existing 100-year peak flow was calculated to be 231 cfs. The basin receives the runoff from DRB20 when the water overtops CR32. The pond was modeled in SWMM and according to the LiDAR contour data, the pond cannot retain the 100-year runoff volume. As the basins are developed the volume of runoff will increase to the pond and a more in-depth analysis of the available volume and possible permitted influent volume to the pond should be completed to verify the pond will not flood. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 196 cfs, 90% of the exiting peak runoff rate.

DIAMOND RESERVOIR BASIN 22

Subbasin DRB22 is a 82.2 acre basin located north of DRB21, east of DRB17, and west of CR17. The subbasin consists mainly of undeveloped land, farmland, private drives, the western half of CR17, ditches, and developed land. The site generally flows from southwest to northeast by sheet flowing to a ditch along CR17 then to two adjacent 48-inch CMPs under CR17 into basin outside the Town of Mead. The existing 100-year peak runoff rate was calculated at 178 cfs with the routed existing 100-year peak flow was calculated to be 1,655 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR17 because the outlets are undersized and can only transport approximately 367.0 cfs. The 178 cfs from DRB22 can easily be transported through the existing culverts, but the routed flows cannot. Therefore, the 100-year developed runoff rate is calculated at 160 cfs, 90% of the exiting peak runoff rate. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure the outfall culverts for DRB22 need to be upsized to accommodate peak routed flows when development occurs in any subbasin upstream of DRB22.

DIAMOND RESERVOIR BASIN 23

Subbasin DRB23 is a 4.2 acre basin located south of CR34 and west of CR17. The subbasin consists mainly the southern half of CR34, the western half of CR17, and developed land. The site generally flows northwest to southeast by sheet flowing to an unknown culvert under CR17. The existing 100-year peak flow was calculated to be 16 cfs. With no outlet pipe or culvert found, the runoff will eventually pond at the outfall and overtop CR17 to the east. Following the Town standards, the developed 100-year runoff rate was calculated at 14 cfs, 90% of the exiting peak runoff rate. However, without further investigation or improvements, the routed peak flows will continue to overtop CR34. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure an outfall culvert on CR17 for subbasin DRB23 needs to be installed to accommodate flows when development occurs.

Table 12. Diamond Reservoir Basin Discharge Summary

Basin ID	Design Point ID	Area (acre)	Existing Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
DRB1	111	43.5	25.2%	91	91	82 cfs	Y
DRB2	112	25.1	5.3%	24	108	0.20 cfs/acre	N
DRB3	113	31.1	13.0%	39	118	0.72 cfs/acre	N
DRB4	114	503.6	8.2%	536	643	482 cfs	Y
DRB5	115	6.4	13.7%	10	643	9 cfs	N
DRB6	116	18.4	9.0%	24	890	22 cfs	N
DRB7	117	84.2	3.3%	105	105	95 cfs	Y
DRB8	118	52.6	6.5%	56	136	50 cfs	N
DRB9	119	119.8	4.1%	109	109	0.05 cfs/acre	N
DRB10	120	583.4	9.4%	701	719	0.52 cfs/acre	N
DRB11	121	12.2	12.0%	15	719	14 cfs	N
DRB12	122	45.2	25.5%	127	719	114 cfs	N
DRB13	123	115.6	6.1%	139	139	125 cfs	Y
DRB14	124	179.0	8.7%	229	289	0.50 cfs/acre	N
DRB15	125	121.0	3.8%	162	162	0.09 cfs/acre	N
DRB16	126	197.9	6.4%	323	359	0.06 cfs/acre	N
DRB17	127	1,011.2	6.7%	1,125	1,424	1,013 cfs	Y
DRB18	170	272.0	5.9%	236	236	0.16 cfs/acre	N
DRB19	128	118.5	32.8%	205	300	185 cfs	Y
DRB20	129	223.8	3.6%	190	190	171 cfs	Y
DRB21	130	115.4	3.6%	218	231	196 cfs	Y
DRB22	131	82.2	23.8%	178	1,655	160 cfs	N
DRB23	132	4.2	63.2%	16	16	14 cfs	Y

*Adequate capacity is based on routed 100-year peak flow rate

LAKE THOMAS BASIN

The Lake Thomas Basin (LTB) is a 2,295.5 acre basin consisting of 17 subbasins that is located east of I-25 and drains from west to east into Lake Thomas. The Lake is located west of CR13 and north of CR32. Outflows from the Lake will continue to the east under CR13 and into DRB that eventually drains into the St. Vrain Creek. The basin is split into two major watersheds, the northern watershed collects flows into unnamed drainage ditches after flowing under CR34 and drains north to southeast into Lake Thomas. The southern watershed collects flows from the basins north of ESVCB and flows into unnamed drainage ditches after flowing under CR32 and drains south to northeast into Lake Thomas. Subbasins NI25B4, NCB14, and NCB29 are upstream of the LTB and the runoff drains into LTB1 which eventually drains into Lake Thomas. There are several locations within the DRB where reports of flooding have been provided to the Town due to several of the outfall being undersized for larger storm events. The LTB drainage map and schematic flow routing figures are provided below.

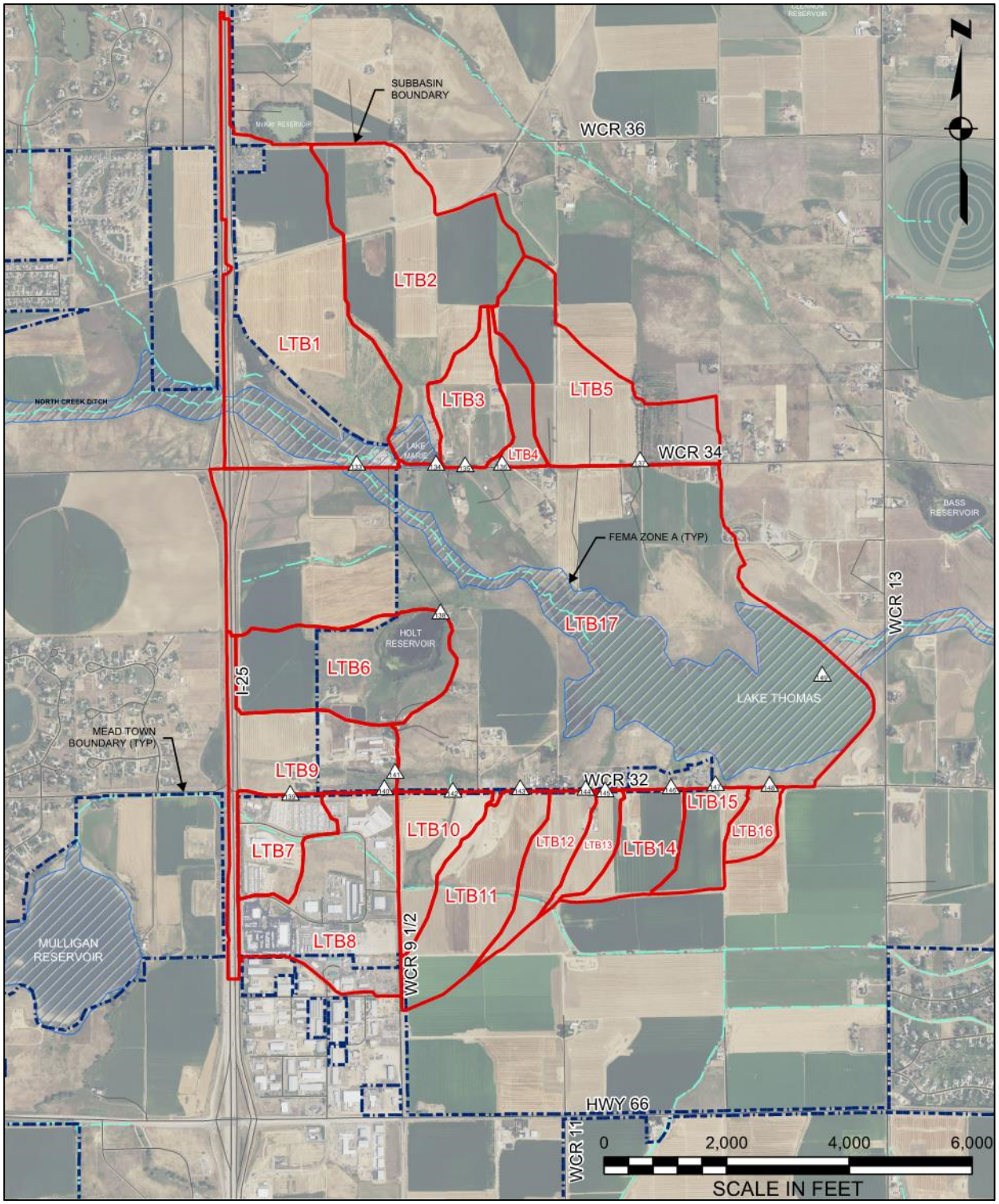

Figure 24. Lake Thomas Basin Map

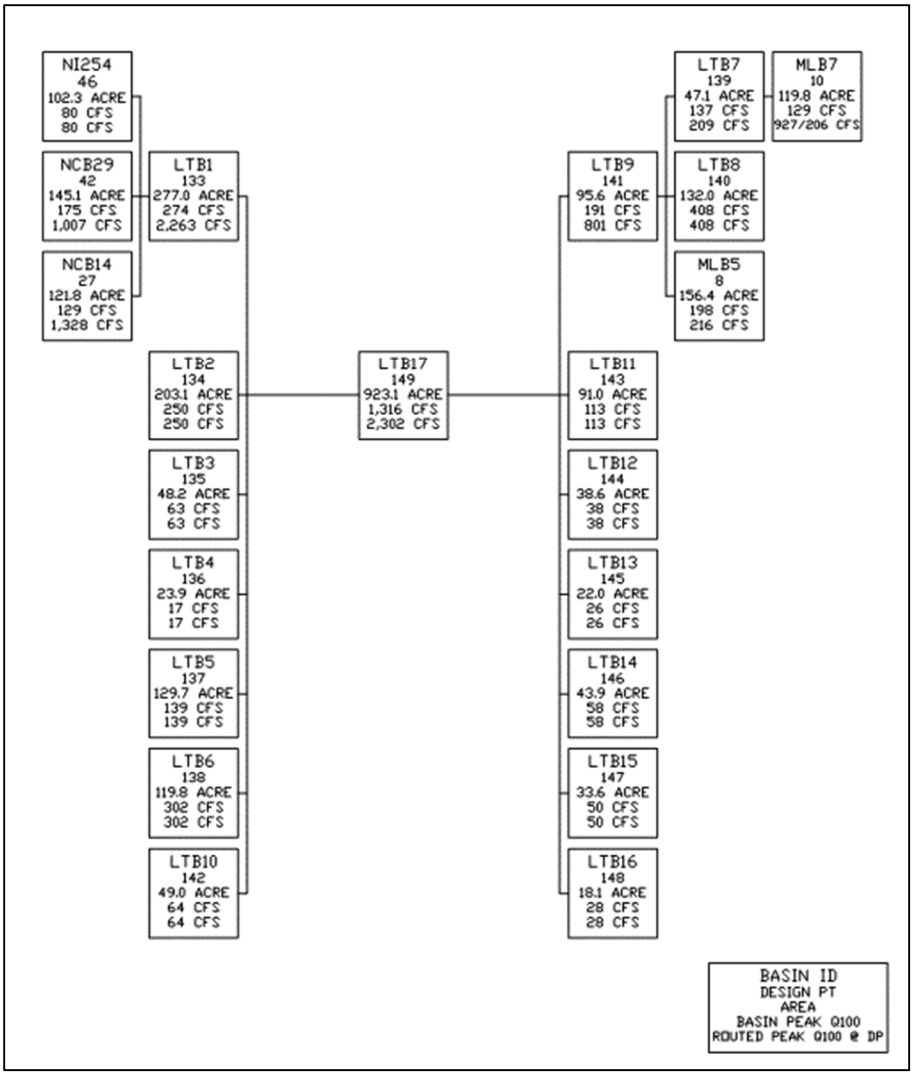

Figure 25. Lake Thomas Basin Flow Routing Schematic

LAKE THOMAS BASIN 1

Subbasin LTB1 is a 277 acre basin that is located north of CR34 and east of I-25. The subbasin is comprised of farmland, undeveloped land, 9.0 acres of developed land at the northwest and southeast corners of the subbasin, the railroad at the north end of the basin, the eastern half of I-25, and an abandoned race track in the southwest corner of the basin. The subbasin generally flows from northeast to southeast by sheet flow, through a culvert under the railroad, and sheet flow to a 128" x 192" CMP under CR34 into subbasin LTB17. The entire North Creek Basin drains under I-25 into subbasin LTB1 along with NI25B4. The peak flow rate for the subbasin was calculated at 274 cfs with the routed existing 100-year peak flow calculated to be 2,263 cfs. A SWMM model was run for the ponding area with the 128" x 192" CMP outfall showing that the ponding area and outfall is sufficient to prevent flooding of CR34 during the 100-year runoff event. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 247 cfs, 90% of the exiting peak runoff rate. An analysis of the outfall system should be completed as development occurs to ensure the increased volumes can be detained in the system with causing adverse conditions.

LAKE THOMAS BASIN 2

Subbasin LTB2 is a 203.1 acre basin that is located north of CR34 and east of I-25. The subbasin is comprised of farmland, 5.4 acres of developed land at the northeast corner and south end of the basin, the railroad at the north end of the subbasin, and drains into Lake Marie. The subbasin generally flows from northwest to southeast by sheet flow, through a culvert under the railroad, and sheet flowing into Lake Marie. The peak 100-year runoff rate was calculated to be 250 cfs. The Lake was modeled in SWMM and according to the LiDAR contour date, the Lake cannot contain the entire 100-year runoff volume and resulting in flooding CR34 into subbasin LTB17. There was no identified culvert outfall for the Lake. As the subbasin is developed the volume of runoff into the Lake will increase and cause further flooding. A more in-depth analysis of the Lake and outfall will need to be completed as development occurs to ensure the Lake capacity and outfall are adequate. The developed 100-year runoff rate was at 225 cfs, 90% of the exiting peak runoff rate. However, due to existing flooding issues an outfall will need to be installed under CR34 to mitigate the Lake flooding and transport the excess flows.

LAKE THOMAS BASIN 3

Subbasin LTB3 is a 48.2 acre basin that is located north of CR34 and east of I-25 and Lake Marie. The subbasin is comprised of farmland and 6.1 acres of developed land at the south end of the basin. The subbasin generally flows from northeast to southwest by sheet flow to a 17-inch CMP under CR34 into subbasin LTB17. The peak 100-year runoff rate was calculated to be 63 cfs. A SWMM model was run for the ponding area with the 17-inch CMP outfall showing that the outfall system is sufficient to prevent flooding of CR34 during the 100-year runoff event. As development occurs the developers should follow the Town Standards and reduce the subbasins total calculated existing 100-year runoff rate to 57 cfs, 90% of the exiting peak runoff rate.

LAKE THOMAS BASIN 4

Basin LTB4 is a 23.9 acre basin that is located north of CR34 and east of LTB3. The subbasin is comprised of farmland and 0.2 acres of developed land at the west side of the basin. The subbasin generally flows from northwest to southwest by sheet flow to a 15-inch CMP under CR34 into subbasin LTB17. The peak 100-year runoff rate was calculated to be 17 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the outfall system is flooding resulting in flooding CR34. The capacity of the culvert was calculated at approximately 5.9 cfs. In order to mitigate flooding and reduce the risk of negative impact to outfall area subbasins the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.25 cfs/acre.

LAKE THOMAS BASIN 5

Subbasin LTB5 is a 129.7 acre basin that is located north of CR34 and west of Colorado Blvd. The subbasin is comprised of farmland, 13.4 acres of forested area, and 1.6 acres of developed land at the east side and southwest corner of the basin. The subbasin generally flows from northwest to southeast by sheet flow to a 17-inch CMP under CR34 into subbasin LTB17. The peak 100-year runoff rate was calculated to be 139 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR34. The capacity of the culvert was calculated at approximately 4.0 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.03 cfs/acre.

LAKE THOMAS BASIN 6

Subbasin LTB6 is a 119.8 acre basin that is located north of CR32 and east of I-25. The subbasin is comprised of farmland and 6.7 acres of developed land at the southeast and northeast corners of the subbasin that drain into the Holt Reservoir. The subbasin generally flows from northwest to northeast by sheet flow into Holt Reservoir. The peak 100-year runoff rate was calculated to be 302 cfs. According to the SWMM model results, the reservoir should not flood during the 100-year storm event. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 272 cfs, 90% of the exiting peak runoff rate.

LAKE THOMAS BASIN 7

Subbasin LTB7 is a 47.1 acre basin that is located south of CR32 and east of I-25. The subbasin is comprised of undeveloped land and developed commercial lots with the Rademacher Business Park. The subbasin generally flows from southwest to northeast by sheet flow to a 12-inch CMP under CR32 into subbasin LTB9. The peak 100-year runoff rate was calculated to be 137 cfs. The routed peak flow including runoff from MLB7 was calculated at 209 cfs. The SWMM model of the outfall system with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR32 because the outlet is undersized but can transport approximately 4.5 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.10 cfs/acre.

LAKE THOMAS BASIN 8

Subbasin LTB8 is a 132 acre basin that is located south of CR32 and west of CR9 ½. The subbasin is comprised of undeveloped land, 76.1 acres of developed commercial lots a part of the Rademacher Business Park. The subbasin generally flows from southwest to northeast by sheet flow to a 16-inch CMP under CR32 into basin LTB9. The peak 100-year runoff flow rate was calculated to be 408 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR32 because the outlet is undersized but can transport approximately 13.3 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.10 cfs/acre.

LAKE THOMAS BASIN 9

Subbasin LTB9 is a 95.6 acre basin that is located north of CR32 and east of I-25. The subbasin is comprised of farmland, 18.3 acres of developed land at the south end and northeast corner of the subbasin. The subbasin generally flows from northwest to southeast by sheet flow to a 16-inch CMP under a private drive into subbasin LTB17. The peak 100-year runoff rate was calculated at 191 cfs with the routed existing 100-year peak flow was calculated to be 801 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding, resulting in flooding the private drive because the outlet is undersized but can transport approximately 12.6 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.13 cfs/acre.

LAKE THOMAS BASIN 10

Subbasin LTB10 is a 49 acre basin that is located south of CR32 and east of CR9 ½. The subbasin is comprised of farmland and the eastern half of CR9 ½. The subbasin generally flows from

southwest to northeast by sheet flow to a 38" x 30" CMP under CR32 into subbasin LTB17. The routed existing 100-year peak flow was calculated to be 64 cfs. A SWMM model was run for the ponding area with the 38" x 30" CMP outfall showing that the ponding area is sufficient to prevent flooding of CR32 during the 100-year runoff event. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 58 cfs, 90% of the exiting peak runoff rate.

LAKE THOMAS BASIN 11

Subbasin LTB11 is a 91 acre basin that is located south of CR32 and east of LTB10. The subbasin is comprised of farmland and the eastern half of CR9 ½. The subbasin generally flows from southwest to northeast by sheet flow to an 18-inch CMP under CR32 into subbasin LTB17. The routed existing 100-year peak flow was calculated to be 113 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR32 because the outlet is undersized but can transport approximately 16.3 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.07 cfs/acre.

LAKE THOMAS BASIN 12

Subbasin LTB12 is a 38.6 acre basin that is located south of CR32 and east of LTB11. The subbasin is comprised of farmland and 2.7 acres of developed land at the northeast corner of the basin. The site generally flows from southwest to northeast by sheet flow to a 14-inch CMP under CR32 into subbasin LTB17. The routed existing 100-year peak flow was calculated to be 38 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR32 because the outlet is undersized but can transport approximately 5.25 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.14 cfs/acre.

LAKE THOMAS BASIN 13

Subbasin LTB13 is a 22 acre basin that is located south of CR32 and east of LTB12. The subbasin is comprised of farmland and 1.6 acres of developed land at the northwest corner of the basin. The subbasin generally flows from southwest to northeast by sheet flow to an 18-inch CMP under CR32 into subbasin LTB17. The routed existing 100-year peak flow was calculated to be 26 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR32 because the outlet is undersized but can transport approximately 11.8 cfs. The outlet would need to be upsized to a 27-inch pipe to pass the calculated routed flows without flooding. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.54 cfs/acre.

LAKE THOMAS BASIN 14

Subbasin LTB14 is a 43.9 acre basin that is located south of CR32 and east of LTB13. The subbasin is comprised of farmland and 1.9 acres of gravel drive and large equipment at the northwest corner of the basin. The site generally flows from southwest to northeast by sheet flow to an 18-inch CMP under CR32 into subbasin LTB17. The routed existing 100-year peak flow was calculated to be 58 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR32 because the

outlet is undersized but can transport approximately 17.23 cfs. The outlet would need to be upsized to a 30-inch pipe to pass the calculated routed flows without flooding. In order to mitigate flooding and reduce the risk of negative impact to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.39 cfs/acre.

LAKE THOMAS BASIN 15

Subbasin LTB15 is a 33.6 acre basin that is located south of CR32 and east of LTB14. The subbasin is comprised of farmland, 0.2 acres of developed land at the northeast corner of the basin, and the private drive. The site generally flows from southwest to northeast by sheet flowing to a 22"x30" CMP under CR32 into subbasin LTB17. The existing 100-year peak flow was calculated to be 50 cfs. The SWMM model of the ponding area and culvert with the routed flow hydrograph using dynamic wave indicate that the outfall is flooding resulting in flooding CR32 because the culvert is undersized and can only transport approximately 43.8 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream subbasins and infrastructure, the developed runoff rate was calculated to be 1.3 cfs/acre.

LAKE THOMAS BASIN 16

Subbasin LTB16 is an 18.1 acre basin that is located south of CR34 and east of LTB15. The subbasin is comprised of farmland and 0.4 acres of developed land at the northwest corner of the basin. The subbasin generally flows from southwest to northeast by sheet flow to a 12-inch CMP under CR32 into subbasin LTB17. The routed existing 100-year peak flow was calculated to be 28 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR32 because the outlet is undersized but can transport approximately 6.3 cfs. In order to mitigate flooding and reduce the risk of negative impact to the downstream subbasins and infrastructure, the developed runoff rate was calculated to be 0.35 cfs/acre.

LAKE THOMAS BASIN 17

Subbasin LTB17 is a 923.1 acre basin that is located north of CR32 and east of I-25. The subbasin is comprised of farmland, 61.8 acres of developed land at the north end and southwest corner of the subbasin, the railroad at the north end of the basin and Lake Thomas. The subbasin generally flows from northwest to southeast by sheet flow into Lake Thomas. The existing 100-year peak runoff rate was calculated at 1,316 cfs with the routed existing 100-year peak flow was calculated to be 2,302 cfs. According to the SWMM model results, the lake should not flood during the 100-year storm event. The Lake has a depth of 14 feet and the 100-year routed water surface elevation is shown to be 5.64 feet in the SWMM model. If flooding of the lake occurs flows will be transported to the west in an unnamed drainage channel under CR13 and into DRB17 which contains the Diamond Reservoir and further downstream to the St. Vrain Creek. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 1,184 cfs, 90% of the exiting peak runoff rate.

Table 13. Lake Thomas Basin Discharge Summary

Basin ID	Design Point ID	Area (acre)	Existing Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
LTB1	133	277.0	13.5%	274	2,263	247 cfs	Y
LTB2	134	203.1	6.8%	250	250	225 cfs	N
LTB3	135	48.2	10.2%	63	63	57 cfs	Y
LTB4	136	23.9	6.4%	17	17	0.25 cfs/acre	N
LTB5	137	129.7	6.2%	139	139	0.03 cfs/acre	N
LTB6	138	119.8	20.4%	302	302	272 cfs	Y
LTB7	139	47.1	54.8%	137	209	0.10 cfs/acre	N
LTB8	140	132.0	59.1%	408	408	0.10 cfs/acre	N
LTB9	141	95.6	31.6%	191	801	0.13 cfs/acre	N
LTB10	142	49.0	5.5%	64	64	58 cfs	Y
LTB11	143	91.0	4.0%	113	113	0.07 cfs/acre	N
LTB12	144	38.6	7.0%	38	38	0.14 cfs/acre	N
LTB13	145	22.0	6.6%	26	26	0.54 cfs/acre	N
LTB14	146	43.9	4.8%	58	58	0.39 cfs/acre	N
LTB15	147	33.6	5.2%	50	50	1.3 cfs/acre	N
LTB16	148	18.1	4.9%	28	28	0.35 cfs/acre	N
LTB17	149	923.1	25.7%	1,316	2,302	1,184 cfs	Y

*Adequate capacity is based on routed 100-year peak flow rate

East St. Vrain Creek Basin

The East St. Vrain Creek Basin is a 3,109.6 acre basin consisting of 25 subbasins that is located east of I-25 and drains from north to south into the Barefoot Lakes. The Barefoot Lakes are located south of CR28 and east of I-25. Outflows from the Lakes will continue to the south and into the St. Vrain Creek. The basin is split into two major watersheds, the northern watershed collects flows into a drainage ditch along Highway 66 that drains from west to east then into a basin outside of the Town of Mead which eventually drains south to St. Vrain Creek. The southern watershed collects flows from the basins south of Highway 66 and ESVCB1 and ESVCB2. The subbasins from the southern watershed generally drain northwest to southeast into the ditches along the County Roads perpendicular to Highway 66 and into the unnamed drainage channel located in subbasin ESVCB16. FRB3 is upstream of the ESVCB and drains under I-25 into ESVCB6. There are several locations within the ESVCB where reports of flooding have been provided to the Town due to several of the outfalls being undersized for larger storm events. The ESVCB drainage map and schematic flow routing figures are provided below.

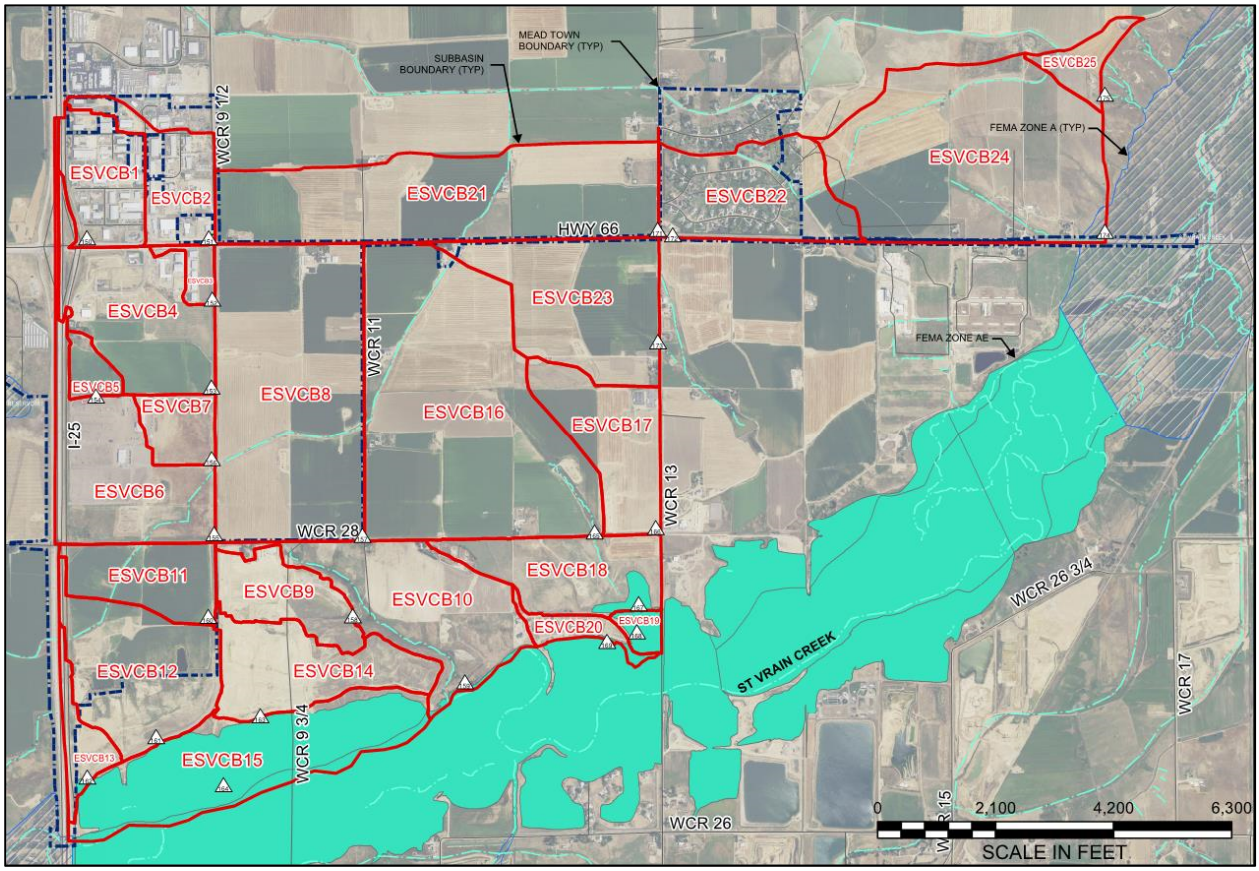

Figure 26. East St. Vrain Creek Basin Map

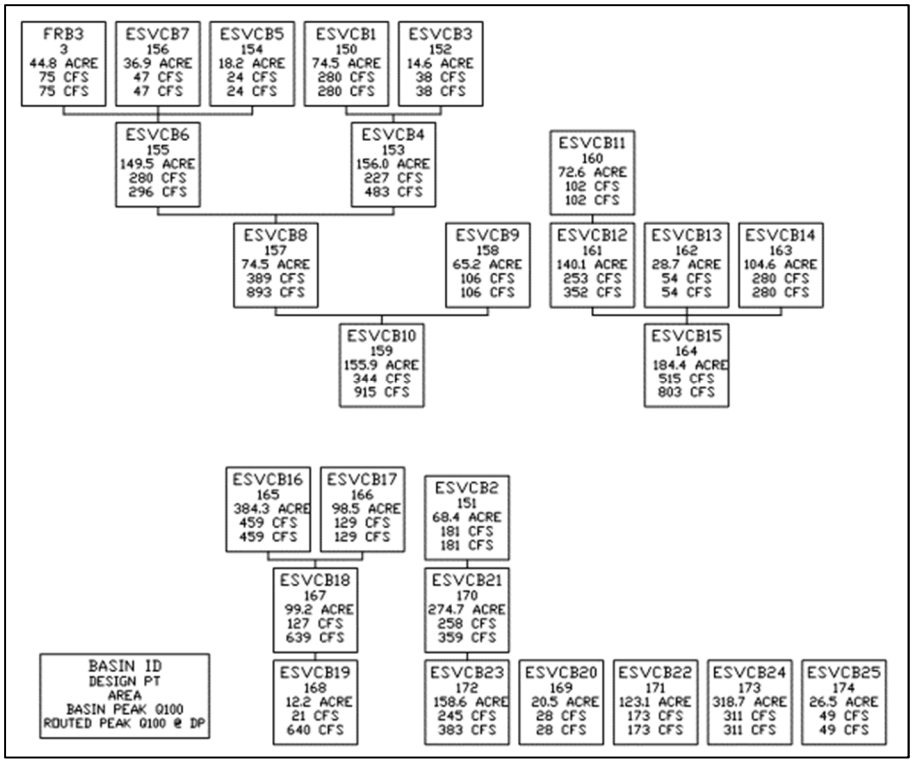

Figure 27. East St. Vrain Basin Flow Routing Schematic

EAST ST. VRAIN CREEK BASIN 1

Subbasin ESVCB1 is a 74.5 acre basin that is located north of Highway 66 and east of I-25. The subbasin is comprised of 64.7 acres of commercial developed land throughout the entire basin, with the remaining portion of the site green space. The subbasin generally flows from northwest to southwest by sheet flow into a ditch along I-25 North then into the commercial development's detention pond. A 36-inch RCP discharges flows under Highway 66 into basin ESVCB4. The peak existing 100-year runoff rate was calculated to be 280 cfs. A SWMM model was run for the detention area with the 36-inch RCP outfall showing that the system is sufficient to prevent flooding of Highway 66 during the 100-year runoff event. As more development occurs the developers should follow the Town Standards and reduce the subbasin calculated existing 100-year runoff rate to 252 cfs, 90% of the peak existing runoff rate.

EAST ST. VRAIN CREEK BASIN 2

Subbasin ESVCB2 is a 68.4 acre basin that is located north of Highway 66 and west of CR9 ½. The subbasin is comprised of 65.2 acres of commercial developed land located throughout the entire subbasin with green space as the remaining area. The subbasin generally flows from northwest to southeast by sheet flow to two adjacent 24-inch RCPs and a 24-inch RCPs further south all directed under CR9 ½ into subbasin ESVCB21. The peak existing 100-year runoff rate to the subbasins outlet is 181 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding Highway 66 because the outlets are undersized and can only transport approximately 72.3 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 1.06 cfs/acre.

EAST ST. VRAIN CREEK BASIN 3

Subbasin ESVCB3 is a 14.6 acre basin that is located south of Highway 66 and west of CR9 ½. The subbasin is comprised of undeveloped land, 6.5 acres of commercial developed land at the western half of the basin, the southern half of Highway 66, and the western half of CR9 ½. The subbasin generally flows from northwest to southeast by sheet flow into a ditch along CR9 ½ then to a 12" RCP into basin ESVCB4. The peak existing 100-year runoff rate to the subbasins outlet is 38 cfs. The SWMM model of the ponding area with the subbasin flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR9 ½ because the outlet is undersized and can only transport approximately 4.5 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.31 cfs/acre.

EAST ST. VRAIN CREEK BASIN 4

Subbasin ESVCB5 is a 156 acre basin that is located south of Highway 66 and west of CR9 ½. The subbasin is comprised of farmland, undeveloped land, 25.2 acres of developed commercial lots and the rest undeveloped lots and greenspace. The site generally flows from northwest to southeast by sheet flow to four 36-inch RCPs under CR9 ½ into basin ESVCB8. The peak existing 100-year runoff rate to the subbasins outlet is 227 cfs. The peak routed flow to the basins outlet is 483 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR9 ½ because the outlets are undersized and can only transport approximately 95.1 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.61 cfs/acre.

EAST ST. VRAIN CREEK BASIN 5

Subbasin ESVCB5 is an 18.2 acre basin that is located south of ESVCB4 and east of I-25. The subbasin is comprised of farmland and 3.2 acres of developed land at the north section of the basin. The site generally flows from northwest to southeast by sheet flow to low spot at the southcentral edge of the subbasin. A culvert was not found during site investigate. Subbasin ESCVB5 discharges into subbasin ESVCB6. The routed existing 100-year peak flow was calculated to be 24 cfs. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 22 cfs, 90% of the peak existing runoff rate.

EAST ST. VRAIN CREEK BASIN 6

Subbasin ESVCB6 is a 149.5 acre basin that is located north of CR28 and east of I-25. The subbasin is comprised of farmland, undeveloped land, 60.8 acres of commercial developed lots. The site generally flows from northwest to southeast by sheet flow to two adjacent 24-inch RCPs under CR9 ½ into basin ESVCB8. The peak existing 100-year runoff rate to the subbasins outlet is 280 cfs. The routed existing 100-year peak flow was calculated to be 296 cfs. A SWMM model was run for the ponding area with the two adjacent 24-inch RCP outfalls showing that the outfall system is not adequate to prevent flooding of CR9 ½ during the 100-year runoff event. The culverts can transport 42.8 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.29 cfs/acre.

EAST ST. VRAIN CREEK BASIN 7

Subbasin ESVCB7 is a 36.9 acre basin that is located south of ESVCB4 and west of CR9 ½. The subbasin is comprised of farmland, private drives, 4.0 acres of commercial developed land at the northwest corner of the basin. The site generally flows from northwest to southeast by sheet flowing across Ritchie Drive into basin ESVCB6. The peak existing 100-year runoff rate to the subbasins outlet is 47 cfs. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 42 cfs, 90% of the peak existing runoff rate. A culvert under Ritchie Drive must be installed when development occurs to mitigate the flooding at the Drive and provide a better form of flow transportation than sheet flowing over the road.

EAST ST. VRAIN CREEK BASIN 8

Subbasin ESVCB8 is a 323.8 acre basin that is located south of Highway 66 and east of CR9 ½. The basin is comprised of farmland, private drives, 7.6 acres of developed land at the northeast and southeast corners of the basin. The site generally flows from northwest to southeast by sheet flows to the roadside ditch along CR11 and CR28 to the southeast corner of the subbasin and a 16-inch CMP under CR28. The peak existing 100-year runoff rate to the subbasins outlet is 389 cfs. The routed existing 100-year peak flow was calculated to be 893 cfs. A SWMM model was run for the ponding area with the 16-inch CMP outfall showing that the outfall system is not adequate to prevent flooding of CR28 during the 100-year runoff event. The 16-inch culvert has a peak flow of 10.8 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.03 cfs/acre.

EAST ST. VRAIN CREEK BASIN 9

Subbasin ESVCB9 is a 65.2 acre basin that is located south of CR28 and east of CR9 ½. The subbasin is comprised of undeveloped land, 25.9 acres of residential developed land in the west half of the basin. The subbasin generally flows northeast to southeast by sheet flow to a low spot into basin ESVCB10. The subbasin is in the process of being developed and the development was considered in the runoff calculations. The peak existing 100-year runoff rate was calculated to be 106 cfs. As the rest of the development in the subbasin occurs the developers should follow the Town Standards and reduce the subbasin peak developed runoff to 90% of the peak existing runoff rate, 95 cfs.

EAST ST. VRAIN CREEK BASIN 10

Subbasin ESVCB10 is a 155.9 acre basin that is located south of CR28 and west of ESVCB9. The basin is comprised of farmland, undeveloped land, private drives, 6.9 acres of developed land at the northeast corner of the subbasin. The site generally flows northeast to southeast by sheet flow into Saint Vrain Creek or into a ponding area directly upstream of the Creek. The peak existing 100-year runoff rate was calculated to be 344 cfs. The pond will overflow if the entirety of the routed flow drains into it, which it does not. The routed existing 100-year peak flow was calculated to be 915 cfs. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 310 cfs, 90% of the peak existing runoff rate.

EAST ST. VRAIN CREEK BASIN 11

Subbasin ESVCB11 is a 72.6 acre basin that is located south of CR28 and west of CR9 ½. The subbasin is comprised of farmland, undeveloped land. The site generally flows northwest to southeast by sheet flow to a 14.5-inch CMP under CR9 ½ into basin ESVCB14, bur with only 1.8 cfs flow rate from the pipe the subbasin drains mostly into ESVCB12. The peak existing 100-year runoff rate and routed 100-year peak flow was calculated to be 102 cfs. A SWMM model was run for the ponding area with 14.5-inch CMP outfall showing that the ponding area is not adequate to prevent flooding of the gravel trail to the south during the 100-year runoff event. It is assumed that flows will continue to flow south along the west side of CR 9 ½ rather than into the developing subdivision of the east side of the road. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 92 cfs, 90% of the peak existing runoff rate. A means to transport the flows under the gravel drive should be investigated as development occurs.

EAST ST. VRAIN CREEK BASIN 12

Subbasin ESVCB12 is a 140.1 acre basin that is located south of ESVCB11 and west of CR9 ½. The subbasin is comprised of farmland, undeveloped land, private drives, 10.5 acres of developed land at west section and the northeast corner of the basin. The site generally flows northwest to southwest by sheet flow to an unknown culvert under CR9 ½ into basin ESVCB15. The peak existing 100-year runoff rate was calculated to be 253 cfs. The routed existing 100-year peak flow was calculated to be 352 cfs. Further investigation of the outfall locations needs to be completed as development occurs to ensure flows as adequately transported into subbasin ESVCB15. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 228 cfs, 90% of the peak existing runoff rate.

EAST ST. VRAIN CREEK BASIN 13

Subbasin ESVCB13 is a 28.7 acre basin that is located north of Barefoot Lakes and east of I-25. The basin consists of undeveloped land, private drives, 2.7 acres of developed land at the east section of the subbasin. The site generally flows northeast to south by sheet flow into a ditch along I-25 North to a 12-inch CMP under CR9 ½ into basin ESVCB15. The peak existing and routed 100-year flows to the subbasins outlet is 54 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR9 ½ because the outlet is undersized and can only transport approximately 4.5 cfs. The outlet would need to be upsized to a 36-inch pipe to pass the calculated routed flows without flooding. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.16 cfs/acre.

EAST ST. VRAIN CREEK BASIN 14

Subbasin ESVCB14 is a 104.6 acre basin that is located north of Barefoot Lakes and east of CR9 ½. The subbasin consists of undeveloped land, paved neighborhood roads, and 39.3 acres of residential developed land at the west section of the basin. The site generally flows northwest to southwest by sheet flow to a 36-inch RCP under Barefoot Lakes Parkway into subbasin ESVCB15. The peak existing and routed 100-year flows to the subbasins outlet is 280 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding Barefoot Lakes Parkway because the outlet is undersized and can only transport approximately 241 cfs. The subbasin should be

almost fully developed in the near future. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 2.3 cfs/acre.

EAST ST. VRAIN CREEK BASIN 15

Subbasin ESVCB15 is a 184.4 acre that is located north of Saint Vrain River and east of I-25. The basin consists of undeveloped land, private drives, I-25 North, CR9 ½, and drains into Barefoot Lakes. The site generally flows north to south by sheet flow to the Barefoot Lakes. The existing peak 100-year runoff rate was calculated at 515 cfs and the routed 100-year peak flow was calculated to be 803 cfs. According to the SWMM model results, the Barefoot Lakes should not flood during the 100-year storm event and will more than likely not be developed. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 464 cfs, 90% of the peak existing runoff rate.

EAST ST. VRAIN CREEK BASIN 16

Subbasin ESVCB16 is a 384.3 acre that is located north of CR28 and east of CR11. The subbasin consists of undeveloped land, farmland, and private drives. The site generally flows northwest to southeast by sheet flow to a ditch then to a 40-inch CMP under CR28 into basin ESVCB18. The existing peak 100-year subbasin runoff rate and the peak routed flows to the basins outlet is 459 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR28 because the outlet is undersized and can only transport approximately 180.3 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and the infrastructure, the developed runoff rate was calculated to be 0.47 cfs/acre.

EAST ST. VRAIN CREEK BASIN 17

Subbasin ESVCB17 is a 98.5 acre that is located north of CR28 and west of CR13. The subbasin consists of farmland, 2.4 acres of developed land at the northeast corner of the basin. The site generally flows northwest to southeast by sheet flow to a 24-inch CMP under CR28 into basin ESVCB18. The existing peak 100-year subbasin runoff rate and the peak routed flows to the basins outlet is 129 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR28 because the outlet is undersized and can only transport approximately 20.1 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.20 cfs/acre.

EAST ST. VRAIN CREEK BASIN 18

Subbasin ESVCB18 is a 99.2 acre basin that is located south of CR28 and west of CR13. The subbasin consists of undeveloped land, private drives, and 0.6 acres of developed land in the northwest corner of the basin. The site generally flows northwest to southeast by sheet flow to two 32-inch CMPs into subbasin ESVCB19. The existing subbasin 100-year peak runoff rate was calculated at 127 cfs. The peak routed flow to the basins outlet is 639 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding because the outlets are undersized and can only transport approximately 64.6 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.65 cfs/acre.

EAST ST. VRAIN CREEK BASIN 19

Subbasin ESVCB19 is a 12.2 acre basin that is located south of ESVCB18 and west of CR13. The subbasin consists of undeveloped area, and a retention area. The site generally flows northeast to southeast by sheet flow to the retention area. The existing subbasin 100-year peak runoff rate was calculated at 28 cfs. The 100-year routed runoff of 640 cfs and the basin receives the runoff from ESVCB16, ESVCB17, and ESVCB18. The retention area was modeled in SWMM and according to the LiDAR contour data, the retention area is not adequate to retain the 100-year runoff volume and runoff overflows into the Lake to the southwest of the subbasin. As the subbasin is developed the volume of runoff will increase to the retention area and a more in-depth analysis of the available volume and possible permitted influent volume to the retention area should be completed to verify the retention area will not flood. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 19 cfs, 90% of the peak existing runoff rate.

EAST ST. VRAIN CREEK BASIN 20

Subbasin ESVCB20 is a 20.5 acre basin that is located south of ESVCB18 and west of ESVCB19. The subbasin consists of undeveloped land and 16.9 acres of residential developed land at the north and south section of the basin. The site generally flows northwest to southeast by sheet flow to the lake south of the subbasin. The existing peak 100-year subbasin runoff rate and the routed existing 100-year peak flow was calculated to be 28 cfs. According to the SWMM model results, the lake south of the basin should not flood during the 100-year storm event. As the subbasin is developed the volume of runoff will increase to the retention area and a more in-depth analysis of the available volume and possible permitted influent volume to the retention area should be completed to verify the retention area will not flood. The developed 100-year runoff rate was calculated at 25 cfs, 90% of the peak existing runoff rate.

EAST ST. VRAIN CREEK BASIN 21

Subbasin ESVCB21 is a 274.7 acre basin that is located north of Highway 66 and east of CR9 ½. The basin consists of undeveloped land, farmland, private drives, and 11.0 acres of development land at the southwest and northeast corners of the basin. The site generally flows northwest to southeast by sheet flowing to the roadside ditch along Highway 66 then to a 48-inch RCP under Highway 66 into basin ESVCB23. The existing subbasin 100-year peak runoff rate was calculated at 258 cfs. The peak routed flow to the subbasins outlet is 359 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding Highway 66 because the outlet is undersized and can only transport approximately 61.7 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.22 cfs/acre.

EAST ST. VRAIN CREEK BASIN 22

Subbasin ESVCB22 is a 123.1 acre that is located north of Highway 66 and east of CR13. The basin consists of farmland, undeveloped land, paved neighborhood roads, golf course, and 63 acres of residential developed land at the northwest, southwest, and northeast corners of the basin. The site generally flows northeast to southwest by sheet flow to a ditch along Highway 66 and CR13. The flows are collected in separate pipes at the intersection of CR13 and Highway 66 before combining and discharging via a 32-inch RCP under Highway 66 into a basin outside of the Study Area and eventually into St. Vrain Creek. The existing peak 100-year subbasin runoff

rate and the peak routed flows to the basins outlet is 173 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding Highway 66 because the outlet is undersized and can only transport approximately 29.4 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.24 cfs/acre.

EAST ST. VRAIN CREEK BASIN 23

Subbasin ESVCB23 is a 158.6 acre that is located south of Highway 66 and west of CR13. The basin consists of undeveloped land, farmland, and 4.8 acres of developed land at the northwest and southeast corners of the subbasin. The site generally flows northwest to southeast by sheet flow to a 12-inch CMP under CR13 into a basin outside of the Study Area and eventually into St. Vrain Creek. The existing subbasin 100-year peak runoff rate was calculated at 245 cfs. The peak routed flow to the basins outlet is 383 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR13 because the outlet is undersized and can only transport approximately 5.1 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins and infrastructure, the developed runoff rate was calculated to be 0.03 cfs/acre.

EAST ST. VRAIN CREEK BASIN 24

Subbasin ESVCB24 is a 318.7 acre that is located north of Highway 66 and west of CR17. The subbasin consists of farmland, undeveloped land, private drives, 9.3 acres of developed land at the southeast corner of the basin. The site generally flows from northwest to southeast by sheet flow to a 42-inch RCP under CR17 into a basin outside of the Study Area and eventually into St. Vrain Creek. The existing peak 100-year subbasin runoff rate and the peak routed flows to the basins outlet is 311 cfs. The SWMM model of the ponding area with the routed flow hydrograph using dynamic wave indicate that the pond is flooding resulting in flooding CR17 because the outlet is undersized and can only transport approximately 103.3 cfs. In order to mitigate flooding and reduce the risk of negative impacts to the downstream basins developed runoff rate was calculated to be 0.32 cfs/acre.

EAST ST. VRAIN CREEK BASIN 25

Subbasin ESVCB25 is a 26.5 acre that is located north of ESVCB24 and west of CR17. The subbasin consists of farmland, undeveloped land, and private drives. The site generally flows northeast to southeast by sheet flow to a ditch along CR17 to an unknown culvert under CR17 into a basin outside of the Study Area and eventually into St. Vrain Creek. The routed existing 100-year peak flow was calculated to be 49 cfs. A SWMM model was run for the ponding area and the unknown culvert would have to be a 24-inch CMP or greater to be sufficient to prevent flooding during the 100-year runoff event. As development occurs the developers should follow the Town Standards and reduce the sites calculated existing 100-year runoff rate to 44 cfs, 90% of the peak existing runoff rate.

Table 14. East St. Vrain Creek Basin Discharge Summary

Basin ID	Design Point ID	Area (acre)	Existing Percent Impervious	Existing Peak Flow (cfs)	Existing Routed Peak Flow (cfs)	Fully Developed Peak Flow	Outfall Capacity Adequate* (Y/N)
ESVCB1	150	74.5	82.2%	280	280	252 cfs	Y
ESVCB2	151	68.4	83.8%	181	181	1.06 cfs/acre	N
ESVCB3	152	14.6	57.1%	38	38	0.31 cfs/acre	N
ESVCB4	153	156.0	26.9%	227	483	0.61 cfs/acre	N
ESVCB5	154	18.2	7.8%	24	24	22 cfs	Y
ESVCB6	155	149.5	41.8%	280	296	0.29 cfs/acre	N
ESVCB7	156	36.9	21.3%	47	47	42 cfs	Y
ESVCB8	157	323.8	6.7%	389	893	0.03 cfs/acre	N
ESVCB9	158	65.2	31.2%	106	106	95.4 cfs	Y
ESVCB10	159	155.9	7.0%	344	915	310 cfs	Y
ESVCB11	160	72.6	5.9%	102	102	92 cfs	N
ESVCB12	161	140.1	13.0%	253	352	228 cfs	N
ESVCB13	162	28.7	27.5%	54	54	0.16 cfs/acre	N
ESVCB14	163	104.6	30.2%	280	280	2.3 cfs/acre	N
ESVCB15	164	184.4	56.0%	515	803	464 cfs	Y
ESVCB16	165	384.3	5.6%	459	459	0.47 cfs/acre	N
ESVCB17	166	98.5	6.9%	129	129	0.20 cfs/acre	N
ESVCB18	167	99.2	5.3%	127	639	0.65 cfs/acre	N
ESVCB19	168	12.2	27.3%	21	640	19 cfs	N
ESVCB20	169	20.5	23.6%	28	28	25 cfs	Y
ESVCB21	171	274.7	7.1%	258	258	0.22 cfs/acre	N
ESVCB22	172	123.1	19.6%	173	173	0.24 cfs/acre	N
ESVCB23	173	158.6	5.9%	245	383	0.03 cfs/acre	N
ESVCB24	174	318.7	6.8%	311	311	0.32 cfs/acre	N
ESVCB25	175	26.5	11.2%	49	49	44 cfs	Y

*Adequate capacity is based on routed 100-year peak flow rate

SECTION 6 – CAPITAL IMPROVEMENTS PLAN

The analysis of the subbasin outfalls indicated that a large number of outfalls within the study area that have been identified as having inadequate capacity to transport the 100-year event routed flows without overflowing a road or embankment. This includes subbasin outfalls that are undersized, are nonexistent, and/or the volume of the storage area is not adequate. Furthermore, the Town identified 19 specific areas where ponding or flooding has been reported to the Town. Additional investigation and discussions with the Town ascertained that of these identified areas, there are two proposed improvements that are require in the near future and will be incorporated into the capital improvements plan (CIP) to be completed in the near term. The other locations identified will be monitored and included in a future CIP if flooding continues to occur. There are two stormwater budget items beyond the two major CIP's that will be included in the estimated budget, improvement projects and maintenance projects.

IMPROVEMENT PROJECTS

The improvement projects budget includes projects that require upsizing existing culverts and/or storm systems or installing a new system. Most of the study area is undeveloped land outside of the Town limits and therefore are not a high priority for the Town. Projects will generally be development driven based on location and apparent need for improvements. In order to efficiently use available stormwater improvement funds, the Town will work with developers as areas are developed to complete system improvements that are affected by each development. This will greatly reduce the required funds by the Town to improve all the identified inadequate outfalls throughout the study area. The Town will provide engineering efforts and/or a set amount of funds to be used to construct the required improvements. The improvement funds will also be used if there is an immediate need to upsize or to construct a new storm system within the Town limits due to continuous reported flooding of an area.

MAINTENANCE PROJECTS

The maintenance projects budget includes projects that require cleaning, regrading, or replacement of existing storm systems that are damaged but otherwise adequate. A complete survey of the storm outfall systems, specifically within Town limits, but also in the study area, needs to be completed to determine the condition, invert elevation, size, and material of the outfalls. Once completed maintenance can be performed to ensure the system is functioning at maximum capacity. The maintenance budget will be used to complete a yearly assessment of the system and repairs as needed. The maintenance repairs will include removal of debris and sediment within pipes, inlets and swales and replacing in kind damaged pipes and grading of roadside swales.

CAPITAL IMPROVEMENTS PLAN

The CIP consists of near term projects, budget for improvement projects, and budget for maintenance projects. There are currently two near term projects identified by the Town and JVA that require detailed analysis to create an understanding of the existing drainage system and

determine the appropriate method to mitigate flooding issues and provide efficient drainage for the areas. The two projects are the East I-25 Business Park and CR9 ½ Drainage and the North Creek Ditch Floodplain Analysis. The 5-year CIP is provided in Table 15.

Project 1 – East I-25 Business Park and CR9 ½ Drainage

Project 1 is the area located between CR9 ½ and I-25 to the east and west, CR28 to the north and south of the properties north of Mulligan Street, see Appendix A Figure 1. This area includes the developed Sekich Business Park, Lyon Pacific 66 Business Park, the Ritchie Brothers Lots, and the Iglesia De Jesucristo Palabra Miel that have or will have detention basins and stormwater systems in place, the undeveloped surrounding lots, and the roadside drainage for CR9 ½, CR28, and Highway 66. The major constraints of the project are the flat terrain and Lateral 3 Ditch that crosses CR9 ½ and CR28 and bisects the southern portion of the drainage area.

The design will include the collection and analysis of existing information such as drainage reports and as-built documents, a survey of the area and roadside swales including the discharge location south of CR28, and preliminary alignment alternatives of possible drainage systems, detention areas, pipes, and culverts that will transport the 100-year routed flows to the discharge location.

The preliminary opinion of probable cost (OPC) includes the costs associated with installing new pipes and culverts to transport the routed flows to the proposed outlet and costs for improvements to the existing detention areas and swales for optimization of areas and volumes. The engineering cost, $50,000, included in the OPC will reflect the costs associated with background research and analysis, survey of the Business Park and other areas within the project area, required geotechnical services, analysis of design alternatives, flood modeling, phased design documents, specifications, and bidding. The total preliminary cost for Project 1 is $441,000. The breakdown of the OPC is attached in Appendix A.

Project 2 – North Creek Ditch Floodplain Analysis

Project 2 is the North Creek Ditch Floodplain analysis for the main branch. The current FEMA floodplain map number 08123C1860E effective date of 01/20/2016 and 08123C1880E effective date of 01/20/2016 show the floodplain boundary for the North Creek Ditch within the North Creek subdivision is an Zone A, Special Flood Hazard Area without base flood elevation, see Appendix A. A more accurate representation of the floodplain including peak routed flows to be used for modeling is necessary to complete an analysis and generate an updated floodplain boundary. The major design constraint on the project is determining if the existing drainage ditch from Highlands Reservoir is being used or can be used as a stormwater channel to transport flows from upstream south of the North Creek Ditch and subdivision under CR34 ½ and into the Town's existing regional detention and water quality system.

The engineering design will include research on the Highland Reservoir and outfall to understand the employment of the existing outfall ditch. Information on the existing drainage systems will need to be collected and analyzed to determine the capacity of the existing systems and the possible changes to the flow pattern. SWMM and HEC-RAS models of the floodplain will be created once better knowledge of the distribution of upstream runoff is determined and how the flows should be split to minimize the 100-year floodplain boundary. Depending on the results of the Highland

Reservoir research it is possible that the existing system could be sufficient or will only need minimal upsizing.

The preliminary OPC includes the costs associated with installing new culverts throughout the existing North Creek Ditch alignment upstream of CR7 to improve the transport of flows downstream and reduce flooding and the floodplain boundary area. The OPC assumes that the Highland Reservoir Ditch cannot be used to transport upstream stormwater runoff flows. The engineering and modeling costs, $70,000, included in the OPC will reflect background research on the Highland Reservoir and Ditch, analysis of design alternatives, required survey and geotechnical services, flood modeling, phased design documents, specifications, and bidding. The total preliminary cost for Project 2 is $326,000. The breakdown of the OPC is attached in Appendix A.

The improvement and maintenance projects will each have separate budgets with the improvement projects budget at $40,000 per annum and the maintenance projects budget at $50,000 per annum. The annual improvements projects budget does not start until 2020 when it is assumed the two major CIP projects will be completed. The annual maintenance project budget starts in 2018.

FUNDING OPTIONS

Low interest loans and grants are available to governmental entities for stormwater and non-point source projects. The Water Pollution Control Revolving Fund (WPCRF) provides low interest loans, Colorado Department of Public Health and Educations Water Quality Control Division, Department of Local Affairs (DOLA), and the Colorado Water Resources and Power Development Authority jointly administer funds that could also be used for Town stormwater projects. DOLA has an Administrative Grant through its Energy and Mineral Impact Assistance Fund (EIAF) that could be used for planning and preliminary design projects. Water Quality Improvement Fund (WQIF) grants are available for water quality improvement projects, stormwater management training and best management training to prevent or reduce the pollution of state waters.

The annual costs for maintenance of roadside ditches, culverts, along with culvert replacement and new stormwater conveyance utility has a significant financial impact on the Town's general fund. To supplement this fund, a stormwater utility fee and user charge can be implemented to provide additional revenue needed for annual stormwater maintenance, replacement, and prioritized stormwater conveyance capital projects. JVA recommends that a user rate study be completed to determine a base utility fee that is suitable and defensible based on the five year capital improvement project costs provided in this report.

To complete a user rate study, the Town will be required to hire a financial consulting firm. This firm will create a financial plan for the Town's stormwater utility which includes creating a profile of the Town's operation and maintenance expenses, capital costs, capital funding, and other inputs and outputs that result in the quantification of the annual stormwater revenue requirements for the study period. The firm will then develop financial planning scenarios that will account for different capital expenditures, funding, or growth scenarios. A proposed stormwater utility fee and future fee schedule are developed from the user rate study. The financial plan and proposed fees will then need to be proposed to the Town board for approval.

TABLE 15. 5-YEAR CIP

Sewer Capital / Replacement Project	Quantity per Year	Estimated Quantity	2018	2019	2020	2021	2022	5 - Year Total
East I-25 Business Park and CR9 1/2 Drainage	N/A	N/A	$441,000	$ -	$-	$-	$-	**$441,000**
North Creek Ditch Flood Analysis	N/A	N/A	$-	$326,000	$-	$-	$-	**$326,000**
Maintenance - Culvert	8	EA	$30,000	$30,000	$30,000	$30,000	$30,000	**$150,000**
Maintenance - Swale Grading	4,000	LF	$20,000	$20,000	$20,000	$20,000	$20,000	**$100,000**
Culvert Upsizing (Contribution to Development/Drainage Analysis)	N/A	N/A	$-	$-	$40,000	$40,000	$40,000	**$120,000**
TOTAL			**$491,000**	**$376,000**	**$90,000**	**$90,000**	**$90,000**	**$1,130,000**